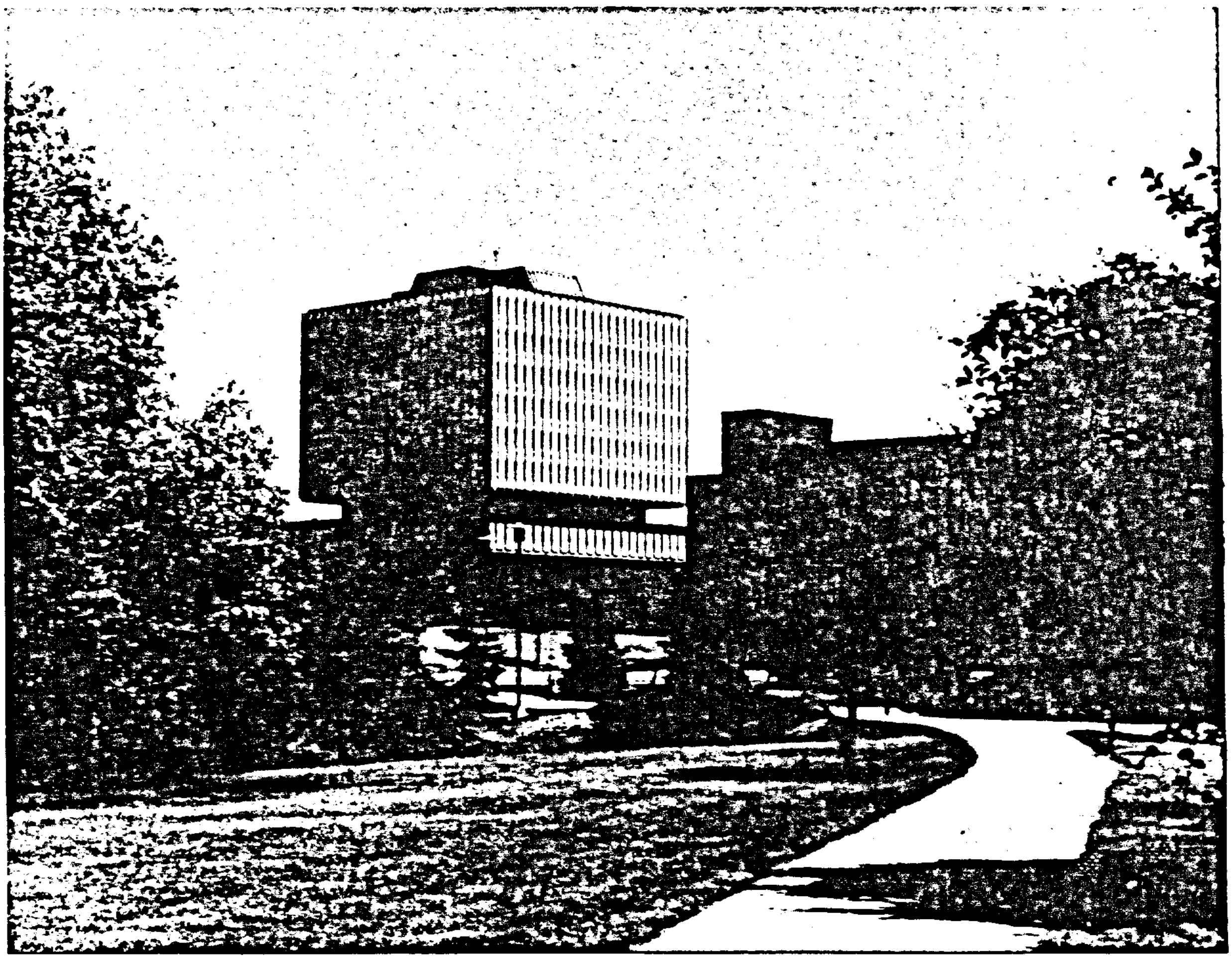
FEDERAL REPUBLIC OF GERMANY/CANADA
WORKSHOP ON

COMMERCIALIZATION OF THE RESULTS OF PUBLICLY FUNDED RESEARCH

December 2 - 4, 1986
University of Waterloo, Waterloo, Ontario, Canada



Workshop Proceedings

Second Printing

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FEDERAL REPUBLIC OF GERMANY / CANADA

SCIENCE & TECHNOLOGY AGREEMENT

WORKSHOP ON

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WATERLOO, DECEMBER 2-4, 1986

Comments on the Second Printing

The Department of External Affairs and the Natural Sciences and Engineering Research Council of Canada have jointly sponsored the second printing of this report in response to continued demand for copies.

Some participants listed on pages x - xiii and individuals named in the directories beginning on page 348 have moved to new positions or retired. However, the organizations listed continue to provide a number of services to facilitate development and transfer of technology, and may be contacted for additional information and assistance.

The workshop was organized by Dr. E.L. Holmes, the former Dean of Research, University of Waterloo, Waterloo, Ontario, and by Mr. Helmut K. Bianchi, International Bureau, GKSS-Forschungszentrum Geesthacht GMBH, Geesthacht, Federal Republic of Germany. The organizers gratefully acknowledge the financial support of the workshop by the Natural Sciences and Engineering Research Council of Canada, and the Bundesministerium fuer Forschung und Technologie (German Federal Ministry for Research and Technology).

The Workshop on Commercialization of Publicly Funded Research was held under the auspices of the Federal Republic of Germany/Canada Agreement on Scientific and Technological Cooperation. An earlier workshop on "Promotion of Technology Based Small and Medium Sized Enterprises and Technology Transfer in Canada and Germany" was held in Berlin, Federal Republic of Germany in December 1985. Copies of the report of the Berlin Workshop may be found in government libraries in Canada and the Federal Republic of Germany.

Department of External Affairs
European Community Programs Division (REP)
Science and Technology Division (TDS)

Natural Sciences and Engineering Research Council of Canada

Ottawa, March 23, 1989

GERMAN/CANADIAN WORKSHOP

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December 8, 1986

GERMAN/CANADIAN WORKSHOP ON THE COMMERCIALIZATION OF THE RESULTS OF RESEARCH FROM PUBLICLY FUNDED LABORATORIES

DECEMBER 2, 3, 4, 1986

GENERAL COMMENTS

The Workshop produced a series of well-articulated presentations followed by full, frank and lively discussions. The rapport established between all the participants was excellent and made for much stimulating informal discussions during meal breaks, coffee breaks and at the end of the various sessions.

After two and one-half days of interchange of ideas and experiences, the final session was devoted to a discussion of future activity of a bilateral nature. There seemed to be agreement that some effort must be made to bring about more inter-company contacts. It was suggested that this be the focus of a future workshop which would include company visits as part of its format. Participants also agreed to give some thought to more immediate prospects of such interactions and some initial discussion took place and some concrete suggestions made which will be followed up by various participants - e.g. a possible visit of company representatives from Berlin to the Waterloo Region, Guelph and Toronto to visit companies and meet with various company representatives. Exchange of information among participants regarding such possibilities was agreed upon. It was felt that much could be gained by having standing workshops, and to the building on a regional approach,based on the establishment of personal contacts.

Clearly,much was learned by all participants and much needs to be digested and reflected upon on the spectrum of activities discussed, ranging from the approach to spin-off companies through to the Co-operative Education concept.

December 8, 1986.

E. L. Holmes,
University of Waterloo.

/mb

German/Canadian Workshop
December 2,3,4, 1986
University of Waterloo

Commercialization of the Results of Publicly Funded Research

Tuesday, Dec. 2 9:15 a.m.	Welcome and presentation on Canadian Technology.	Dr. D. Wright President (Univ. of Waterloo)
	Introduction.	Dr. E.L. Holmes Dean of Research (Univ. of Waterloo)
	Transfer Mechanisms and examples from the National Research Council Laboratories.	Miss M. Lofthouse (National Research Council Canada)
	Discussion.	
Noon	Lunch - Laurel Room.	
2:00 p.m.	Transfer of Aerospace technology to industry by co-operation and personnel transfer - the DFVLR Experience.	Dr. P. Tonn DFVLR - German Aerospace Research & Testing Instit (Germany)
	Tools of Technology Transfer in National Research Centres as described by the example of the Karlsruhe Nuclear Research Centre.	Dr. J. Wüst Karlsruhe Nuclear Researc Centre (Germany)
	Discussion.	
	Transfer from a specific federal government laboratory (CANMET).	Ms. J. Kuryllowicz (Energy, Mines & Resourc Canada)
	Commercializing Results of Research From Provincial Research Organization.	Mr. H. Baumans (Centre de Recherche Industrielle du Quebec)
	Discussion.	
Evening	Reception and Dinner University Club.	

Wednesday, Dec. 3 9:15 a.m.	Work of a University Commercial Development Office.	Mr. R. Nally Commercial Development Officer (Univ. of Waterloo)
	Co-operation between Universities and Industry-Viewed from the Universities.	Prof. Dr. K. Landfried Vice-President, Kaiserslautern University (Germany)
	Discussion.	
	Examples and special experiences and mechanisms from Quebec.	Dr. D. Beaudry (Centre de Développement Technologique de l'École Polytechnique de Montreal Campus de l'Universite de Montréal)
	Discussion.	
Noon	Lunch - University Club.	
2:00 p.m.	Examples and special experiences and mechanisms from Alberta.	Ms. E. White Office of Technology Transfer (Univ. of Calgary)
	Examples and special experiences and mechanisms from British Columbia.	Dr. J. Murray Office of Research Services & Industry Liaison (Univ. of British Columbia)
	Discussion.	
	Co-operation Between Fachhochschule and Industry.	Prof. Dr. R. Dalheimer President of Fachhochschule Hamburg (Germany)
	Discussion.	
	Two-way technology transfer through people movement - example of Co-op education.	Dr. J. Westlake Dept. of Co-operative Education & Career Services (Univ. of Waterloo)

Thursday, Dec. 4 9:15 a.m.	Process Technology - methods and experiences in transfer to industry.	Dr. E. Rhodes/Mr. E. Cross Waterloo Centre for Process Development (Univ. of Waterloo)
	Discussion.	
	Computer Software - a special opportunity.	Mr. P. Sprung, Manager, Software Co-ordination (Univ. of Waterloo)
	Discussion.	
Noon	Lunch - University Club.	
	Analysis and Perspective of Technology Transfer between University and Industry.	Mr. J. Allesch Technology Transfer Agency (Germany)
	1) Overview - University Technology Transfer Offices - a national study by the Science Council of Canada.	Dr. M. Farley (Dept. of External Affairs and Science Council of Canada)
	2) Dept. of External Affairs services to assist technology transfer between Canada and Germany.	
	Discussion.	
	General concluding discussions and consideration of prospects and opportunities and possible future action for bilateral technology transfer.	
	Concluding remarks - Germany - Canada.	

Objective:
To increase understanding of the process in each country by comparing mechanisms instruments and models and exchange of experiences, and to consider prospects opportunities and possible future actions towards bilateral technology transfer.

GERMAN/CANADIAN WORKSHOP
DECEMBER 2,3,4, 1986

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GERMAN/CANADIAN WORKSHOP

OPENING ADDRESS

CANADIAN TECHNOLOGY: DR. DOUGLAS WRIGHT,
PRESIDENT,
UNIVERSITY OF WATERLOO

Dr. Wright's presentation was based upon one given to recent visitors from Japan.

The script of that presentation is included.

Douglas Wright
President
University of Waterloo

PRESENTATION

To Japanese economic mission to Canada

Vancouver, B.C.

October 1, 1986

Caveat

I presume I have been asked to speak today because my university, the University of Waterloo, is among the strongest in Canada in terms of research capability and activity, because it has a record of cooperation with industry, and because of the excellence of its graduates, particularly those who move into technology-related positions in the private sector.

ONE CONSEQUENCE, OF COURSE, IS THAT I MUST INEVITABLY TALK MOST ABOUT THAT WHICH I KNOW BEST . . . THAT IS, ABOUT WATERLOO.

I SHOULD LIKE TO STRESS AT THE OUTSET THEREFORE THAT THOUGH THERE WILL BE, IN THESE REMARKS, SOME EMPHASIS ON ONE PARTICULAR CANADIAN UNIVERSITY, THERE ARE MANY EXCITING THINGS HAPPENING ON MANY OTHER CAMPUSES ALL ACROSS CANADA . . . IN SUCH CITIES AS VANCOUVER, EDMONTON, WINNIPEG, LONDON, TORONTO, KINGSTON, MONTREAL, HALIFAX AND SO ON.

BY WAY OF ILLUSTRATION, ONLY THE OTHER DAY I NOTED A LENGTHY ARTICLE IN ONE OF OUR LARGEST DAILY NEWSPAPERS, THE TORONTO STAR, WRITTEN BY G. E. HEINKE, DEAN OF THE FACULTY OF APPLIED SCIENCE AND ENGINEERING AT THE UNIVERSITY OF TORONTO. IN IT, HEINKE OUTLINED HIS AND HIS UNIVERSITY'S COMMITMENT TO "PARTNERSHIP WITH INDUSTRY AND GOVERNMENT IN THE CREATION OF WEALTH." DR. HEINKE IS NOT UNUSUAL AMONG CANADIAN ACADEMICS THESE DAYS. AS IN THE U.S.A., CANADIAN UNIVERSITIES ARE COMMITTED TO A COMBINATION OF ACADEMIC EXCELLENCE WITH AN ATTITUDE OF COOPERATION WITH INDUSTRY AND COMMERCE.

HAVING SAID THAT, LET ME OFFER YOU A FEW IDEAS — REPRESENTATIVE HIGHLIGHTS, IF YOU WILL — THAT I HOPE YOU WILL FIND INTERESTING.

No. 1

PICTURE — PHOTO OF THE ECONOMIST

<u>THE BATTLE OF THE TITANS</u>

THE UNITED KINGDOM PUBLICATION, THE ECONOMIST, NOTED IN ITS AUG. 23 ISSUE THAT "BATTLE LINES" ARE BEING DRAWN FOR A TRADE WAR IN THE HIGH TECH (OR TO USE A MORE CONTEMPORARY TERM, "ULTRA TECH") ERA. THE TWO TECHNOLOGICAL SUPERPOWERS ARE JAPAN AND THE UNITED STATES.

WHAT I AM CONCERNED TO POINT OUT TODAY, IS THAT CANADA HAS A NUMBER OF RESEARCH STRENGTHS THAT ARE RELEVANT.

LET'S LOOK AT SOME OF THE THINGS CANADA CAN OFFER!

No. 2

PICTURE — HIGH TECH

FIRST LET ME POINT OUT THAT TECHNOLOGY IS NOT ONLY "KNOW HOW," IT IS ALSO "KNOW WHY."

No. 3

PICTURE — "PEOPLE" LANDSCAPE

TECHNOLOGY DEPENDS ON THE QUALITY OF HUMAN RESOURCES.

No. 4

PICTURE — CANADIAN SCENE (URBAN LANDSCAPE)

<u>WHAT DO CANADIANS HAVE GOING FOR THEM?</u>

In the face of ultra tech competition between the United States and Japan, Canadians have some good things to offer:

* An educated population.
* An established industrial base.
* Good basic and applied research
* Abundant natural resources.
* An enviable geographic, political, and social environment that offers stability, civility, spaciousness, cleanliness, industriousness and personal safety.

No. 5

Picture — Clipping of math contest winners

EDUCATION

Canada has good schools and a well-educated population; 22 per cent of our young people, in the 18-to-20 age bracket, are enrolled in our universities in undergraduate programs; 14 per cent of 22-to-24 year olds are in advanced and graduate study, according to the most recent StatCan figures.

As for technology-related education, Canadians start young!

For example, every year 65,000 of Canada's brightest high school mathematics students compete in the nationwide Canadian Mathematics Competitions.

THE CONTEST HAS DONE MUCH TO STIMULATE INTEREST IN MATHEMATICS. WINNERS RECEIVE CASH PRIZES, TROPHIES, ATTENDANCE AT A WEEK-LONG SEMINAR (WHERE THEY GET SPECIAL LECTURES FROM SENIOR MATH PROFESSORS, PLUS COMPUTER INSTRUCTION). TOP STUDENTS ARE ALSO GIVEN NATIONAL MEDIA COVERAGE AND THEIR PERFORMANCE IS IMPORTANT IN CONNECTION WITH SOME UNIVERSITY SCHOLARSHIP OFFERS.

No. 6

PICTURE — STUDENTS IN JANET LAB

CREAM OF THE CROP

ENGINEERING AND COMPUTER SCIENCE PROGRAMS OFFERED BY CANADIAN UNIVERSITIES ATTRACT STUDENTS OF VERY HIGH QUALITY. AT THE UNIVERSITY OF WATERLOO, VIRTUALLY EVERY ENGINEERING FRESHMAN COMING OUT OF HIGH SCHOOL HAS, FOR YEARS, HAD TO HAVE AN 80 PER CENT OVERALL AVERAGE. IN PROGRAMS FOCUSSING ON COMPUTERS AND ELECTRONICS, THE AVERAGE HAS BEEN MUCH HIGHER.

No. 7

PICTURE — THE PUTNAM LIST

CANADIAN STUDENTS CAN COMPETE

EVERY YEAR, MATHEMATICS STUDENTS FROM UNIVERSITIES ACROSS NORTH AMERICAN (2,000 STUDENTS OR MORE, REPRESENTING ABOUT 350

INSTITUTIONS) COMPETE IN THE PUTNAM MATHEMATICAL COMPETITION SPONSORED BY THE MATHEMATICAL ASSOCIATION OF AMERICA. THESE ARE THE CREAM OF THE CROP!

THE UNIVERSITY OF WATERLOO IS A PERENNIAL LEADER. WATERLOO'S TEAM HAS BEEN IN THE TOP 10, SEVEN TIMES DURING THE PAST 10 YEARS, AND WAS FIRST ON ONE OCCASION. WATERLOO IS NOT THE ONLY CANADIAN UNIVERSITY TO HAVE BEEN FIRST (TORONTO WAS FIRST ON A COUPLE OF PREVIOUS OCCASIONS) BUT WEE HAVE BEEN IN THE TOP TWO OR THREE SEVERAL TIMES. THIS YEAR WE FINISHED FIFTH.

IN 1983 FIVE OF THE TOP 11 SCHOOLS WERE CANADIAN . . . WATERLOO'S PERFORMANCE IS THUS JUST PART OF AN OVERALL EXCELLENT RECORD ON THE PART OF HUNDREDS OF BRIGHT YOUNG CANADIANS.

No. 7A

PICTURE — MATH BUILDING

WORLD CLASS MATH SCHOOL

WATERLOO'S FACULTY OF MATHEMATICS HAS AN ENROLMENT OF 4,015 STUDENTS, WHICH WE UNDERSTAND TO BE THE LARGEST UNIVERSITY ENROLMENT IN MATHEMATICS AND COMPUTER SCIENCE IN THE WORLD.

No. 8

PICTURE — LASER PICTURE?

NEW EXCITEMENT OVER SCIENCE

ADDED TO THIS THERE HAS BEEN A REAWAKENING OF INTEREST IN SCIENCE AND MATHEMATICS IN CANADA OF LATE, AND A LIVELY NEW INTEREST IN EXPLOITING RAPIDLY EMERGING TECHNOLOGIES SUCH AS:

* MICROELECTRONICS TECHNOLOGY
* INFORMATION TECHNOLOGY
* MATERIALS TECHNOLOGY
* BIOTECHNOLOGY
* ADVANCED MANUFACTURING TECHNOLOGIES

No. 9

PICTURE — HIGH TECH LAB — MICROCHIPS?

CANADIANS ON THE MOVE

THERE IS CONCERN IN CANADA TO:

(1) IMPROVE OUR EXPLOITATION OF NATURAL RESOURCES, USING NEW TECHNOLOGIES

(2) DIVERSIFY OUR INDUSTRIAL BASE

(3) DEVELOP INDIGENOUS TECHNOLOGIES

(4) ABSORB AND ADAPT TECHNOLOGIES PRODUCED ELSEWHERE

No. 10

PICTURE — SCIENTIST AND BUSINESSMAN

MAJOR PLAYERS

MAJOR PLAYERS IN THE GAME ARE:

(1) BUSINESS AND INDUSTRY
(2) THE UNIVERSITIES
(3) GOVERNMENT LABS

No. 11

PICTURE — NSERC GRANTS LIST

A PRE-ADVANTAGE

CANADA HAS STRONG BASIC RESEARCH BUILT ON:

(1) ITS PEER-REVIEW SYSTEM FOR RESEARCH GRANTS;

(2) NSERC (THE NATURAL SCIENCES AND ENGINEERING RESEARCH COUNCIL) — ONE OF THE WORLD'S MOST ENVIED RESEARCH GRANTING SYSTEMS.

No. 12

PICTURE — A CANADIAN CAMPUS

HIGH STANDARDS

NSERC AND THE PEER-REVIEW SYSTEM HAVE PRODUCED SOME RENOWNED CENTRES OF RESEARCH EXCELLENCE, OFTEN REFLECTING THE GEOGRAPHY OF THE COUNTRY. THUS WE HAVE RESEARCH ON:

(1) FOREST PRODUCTS IN BRITISH COLUMBIA
(2) PETROLEUM IN ALBERTA

(3) Agriculture in Saskatchewan

(4) Manufacturing in Ontario

(5) Oceanography in the Atlantic Provinces

No. 13

Picture -- Current Contents list

HIGH STANDARDS

As an example of high standards -- the Guelph-Waterloo Centre for Graduate Work in Chemistry currently ranks third in the world according to Current Contents, Institute of Scientific Information, Philadelphia, Pa.

Six Guelph-Waterloo research papers were reported to have been "most cited" (that is, cited 35 times or more in recent articles in major chemistry journals) . . . more than for any other research centre in the world except M.I.T. and the University of California.

A total of 10 Canadian research papers earned "most cited" status during the period in question . . . a better record than the U.S., U.K., Italy, Denmark, Switzerland, Japan, per capita.

No. 14 and 14A

Picture -- Davis Building

COMPUTER SOFTWARE

CANADIANS AND CANADIAN UNIVERSITIES ARE RENOWNED FOR THEIR COMPUTER SOFTWARE. THE NEW DAVIS BUILDING, A CENTRE FOR COMPUTER RESEARCH, IS CURRENTLY UNDER CONSTRUCTION AT WATERLOO. IT WILL HOUSE HUNDREDS OF COMPUTER RESEARCHERS INCLUDING MANY VISITORS FROM THE PRIVATE SECTOR. IT IS BEING BUILT FOR WATERLOO'S HIGHLY SUCCESSFUL INSTITUTE FOR COMPUTER RESEARCH.

No. 15

PICTURE — THE FOLDER OF THE CANADIAN SOCIETY FOR FIFTH GENERATION RESEARCH

CANADA-ICOT AGREEMENT

EARLIER THIS YEAR CANADIAN NEWS MEDIA REPORTED WIDELY ON THE AGREEMENT BETWEEN THE CANADIAN SOCIETY FOR FIFTH GENERATION RESEARCH (CSFGR) AND JAPAN'S INSTITUTE FOR NEW GENERATION COMPUTER TECHNOLOGY (ICOT). MANY CANADIAN UNIVERSITIES ARE INVOLVED, AMONG THEM:

* UNIVERSITY OF ALBERTA
* UNIVERSITY OF BRITISH COLUMBIA
* CENTRE DE RECHERCHE INFORMATIQUE DE MONTREAL
* QUEEN'S UNIVERSITY
* UNIVERSITY OF SASKATCHEWAN
* SIMON FRASER UNIVERSITY
* UNIVERSITY OF TORONTO
* UNIVERSITY OF WATERLOO
* UNIVERSITY OF WESTERN ONTARIO

No. 16

PICTURE — LIST OF ICR CORPORATE PARTNERS

A RECORD OF COOPERATION

SINCE ITS FORMATION IN 1982 WATERLOO'S INSTITUTE FOR COMPUTER RESEARCH HAS ATTRACTED MANY MAJOR HARDWARE AND SOFTWARE COMPANIES IN CANADA, AND MANY MAJOR USERS, AS PARTNERS AND AFFILIATES.

ITS SUCCESS HAS STIMULATED THE FORMATION OF OTHER CENTRES OF EXCELLENCE AND INSTITUTES.

No. 17

PICTURE -- MITSUBISHI LETTER

VISITORS ARE IMPRESSED!

YUKIHIHRO KAYAMA, ASSISTANT GENERAL MANAGER, TECHNOLOGY AFFAIRS DEPARTMENT, MITSUBISHI CORPORATION, RECENTLY VISITED CANADA AND SUBSEQUENTLY REFERRED TO THE UNIVERSITY OF WATERLOO AS COMPETITIVE WITH THE BEST UNIVERSITIES IN THE UNITED STATES IN A NUMBER OF AREAS INCLUDING COMPUTER SOFTWARE, COMMUNICATIONS, AND BIOTECHNOLOGY.

"ACTIVITY AT WATERLOO FOR HIGH TECH RELATED RESEARCH AND SEEDS DEVELOPMENT INTO COMMERCIAL PRODUCTS WAS . . . VERY HIGH," KAYAMA STATED.

No. 18

PICTURE — IBM ANNUAL REPORT

IBM AND CANADIAN UNIVERSITIES

A NUMBER OF LARGE U.S. MULTINATIONALS WORK CLOSELY WITH CANADIAN UNIVERSITIES — AMONG THEM IBM, HEWLETT-PACKARD, DIGITAL EQUIPMENT, HONEYWELL, TO NAME BUT A FEW.

IN ITS 1985 ANNUAL REPORT, IBM REFERS TO ITS MARKETING OF WATERLOO-CREATED COMPUTER SOFTWARE IN JAPAN, TAIWAN, HONG KONG, INDONESIA, SINGAPORE, MALAYSIA, THAILAND, THE PHILIPPINES, AND OTHER COUNTRIES.

No. 19

PICTURE — TECHNOLOGY PARK

TECHNOLOGY PARKS

TECHNOLOGY PARKS EXIST ON A NUMBER OF CANADIAN CAMPUSES INCLUDING SIMON FRASER UNIVERSITY, THE UNIVERSITY OF CALGARY, AND WATERLOO; THERE ARE OTHERS. THEY PERMIT INDUSTRY TO WORK MORE CLOSELY WITH UNIVERSITY RESEARCHERS IN THE DEVELOPMENT OF NEW PRODUCTS AND SERVICES, AND SYMBOLIZE A NEW ERA IN UNIVERSITY-INDUSTRY RELATIONS IN CANADA.

No. 20

Picture — Publications of CHEF

PARTNERSHIP FOR GROWTH

In recent years the Corporate-Higher Education Forum has been created, bringing together approximately 25 university presidents and about 30 top (CEO level) executives of major Canadian industrial and financial companies.

The mission of the Forum is to encourage economic and social development.

It has explored the advantages to both parties of such cooperation, and prepared recommendations to foster this objective. CHEF is one more step on the road to a better industrial future for Canada.

No. 21

Picture — Computer graphics magazine

WORLD LEADERSHIP

One of the world's most prestigious publications in the computer field is "Siggraph," devoted to computer graphics.

Siggraph's editorial board is chaired by Canadian computer scientists. Canadians also organized the huge Siggraph conference and graphics show in Detroit in 1983, attended by thousands.

No. 22

Picture — The NOED room (dictionaries & terminals)

A Mammoth Project

One of the greatest treasures of the English language is the Oxford English Dictionary . . . tracing the history of our words back for almost 1,000 years. The "OED" is thus the foundation for English language scholarship.

So vast is the Oxford English (60 million words), the decision has been made to computerize it; doing so will open up new ways of using this remarkable resource because it will make available in seconds, or at most, minutes, information that would otherwise take days to assemble.

After searching the world over the Oxford University Press selected the University of Waterloo to develop the software required. Work is under way and will produce many spin-offs in such areas as expert systems, artificial intelligence including language processing, and the management of large data bases.

No. 23

Picture — Bar chart of co-op work terms

New Way to Educate Professionals

An education concept that has been rapidly spreading across Canada involves the "co-operative" system which sees students alternating

BETWEEN CLASSROOMS AND JOBS IN THE WORKPLACE, EVERY FOUR MONTHS. THE IDEA WAS PIONEERED IN THIS COUNTRY BY WATERLOO AND HAS SPREAD TO MANY OTHER UNIVERSITIES ACROSS THE LAND. IT IS PARTICULARLY POPULAR FOR ENGINEERING AND BUSINESS STUDENTS, WHERE THE WORKPLACE EXPERIENCE SUPPLEMENTS CLASSROOM LEARNING, PROVIDING AN INTERNSHIP COMPONENT.

ADVANTAGES OF CO-OP INCLUDE:

* STUDENTS GAIN EXPERIENCE
* STUDENTS GAIN MATURITY
* STUDENTS FIND OUT IF THEY ARE ON RIGHT PATH
* STUDENTS CAN EVALUATE CAREER EMPLOYERS MORE SATISFACTORILY
* EMPLOYERS CAN EVALUATE STUDENTS
* STUDENTS REPORT ON JOB EXPERIENCES TO FACULTY MEMBERS, KEEPING THEM UP-TO-DATE
* UNIVERSITIES AND EMPLOYERS LEARN TO WORK TOGETHER
* STUDENTS EARN WHILE THEY LEARN

No. 24

PICTURE — WATCOM PRODUCTS

SPINNING OFF PROSPERITY

NEW ENTERPRISES ARE CONSTANTLY SPINNING OFF FROM BASIC, FUNDAMENTAL RESEARCH DONE ON UNIVERSITY CAMPUSES, INCLUDING THE SUCCESSFUL WATCOM GROUP OF WATERLOO, WHICH HAS MORE THAN 300,000 LICENCES, WORLDWIDE, INCLUDING KANJI VERSIONS OF SOFTWARE PRODUCTS, IN JAPAN.

SPINNING-OFF IS A MOST EFFECTIVE TECHNOLOGY TRANSFER TECHNIQUE.

CANADIAN SPINOFF ENTERPRISES INCLUDE:

* COMPUTER SOFTWARE COMPANIES
* COMPUTER PERIPHERAL MANUFACTURERS
* CUSTOM MICROCHIPS
* CONSULTING SERVICES
* DEVICES (E.G., MEDICAL AND RESEARCH INSTRUMENTS)
* PLASTICS
* ENVIRONMENT-RELATED SERVICES

No. 25

PICTURE -- TECHNOLOGY TRANSFER PICTURE

ENCOURAGING TECHNOLOGY TRANSFER

IF SPINNING OFF AND OTHER FORMS OF TECHNOLOGY TRANSFER ARE TO HAPPEN, THERE MUST BE MECHANISMS THAT PERMIT AND ENCOURAGE THIS. THESE HAVE BEEN DEVELOPING IN CANADA AND INCLUDE:

* THE TEACHING OF ENTREPRENEURSHIP SKILLS TO STUDENTS -- SOMETHING THAT IS POPULAR WITH STUDENTS, AND SPREADING.

* THE MOVEMENT OF STUDENTS OUT OF UNIVERSITIES INTO THE WORK ENVIRONMENT TAKING WITH THEM NEW TECHNOLOGIES.

* INNOVATION CENTRES (SUCH AS THE CANADIAN INDUSTRIAL INNOVATION CENTRE/WATERLOO) TO HELP MOVE INNOVATIONS FROM THE CONCEPT STATE TO REALITY IN THE MARKETPLACE.

* PROVINCIAL GOVERNMENT PROGRAMS ALSO BRIDGE THE GAP.

* SPECIAL FUNDING SUCH AS THE STRATEGIC GRANTS PROGRAM OF THE NATURAL SCIENCES AND ENGINEERING RESEARCH COUNCIL.

* TAX INCENTIVES TO SUPPORT INNOVATION WITHIN THE PRIVATE SECTOR.

No. 25A

PICTURE — RESEARCH

<u>CONTRACT RESEARCH</u>

ONE OF THE MOST EFFECTIVE SERVICES UNIVERSITIES CAN PROVIDE TO FURTHER THE INNOVATION PROCESS IS THROUGH CONTRACT RESEARCH. IT CAN BE CRUCIAL AT TIMES TO SMALL COMPANIES, UNABLE TO AFFORD THEIR OWN R & D PROGRAMS.

MORE AND MORE, CANADIAN UNIVERSITIES ARE ACTIVE IN CONTRACT RESEARCH. AT WATERLOO, WE HAVE BEEN DOING CONTRACT RESEARCH FOR 20 YEARS AND HAVE UNDERTAKEN SCORES OF PROJECTS, FOR LARGE COMPANIES AS WELL AS SMALL.

WE HAVE WORKED WITH THE CANADIAN AIRCRAFT INDUSTRY, THE SHOE INDUSTRY, THE SPORTS EQUIPMENT INDUSTRY, THE STEEL INDUSTRY, THE CONSTRUCTION INDUSTRY . . . AND MANY MORE.

UNIVERSITIES HAVE, OF COURSE, A CONCERN OVER THE "ACADEMIC" CHALLENGES INVOLVED IN THIS TYPE OF RESEARCH — THEY MUST BE PART OF IT; WE ALSO HAVE A CONCERN NOT TO IMPINGE ON THE AREAS OF THE

PROFESSIONAL CONSULTANTS. BUT ON MANY OCCASIONS UNIVERSITY INTERESTS AND THE INTERESTS OF INDUSTRY FIT TOGETHER VERY NICELY.

No. 26

PICTURE — MEL MARPLE PHOTO

<u>OTHER FORMS OF COOPERATION</u>

RECENTLY DR. MEL MARPLE, OF IBM, JOINED THE UNIVERSITY OF WATERLOO, SECONDED BY HIS EMPLOYER FOR A TWO-YEAR TERM. HIS TASK IS TO HELP US DEVELOP OUR INTEGRATED MANUFACTURING PROGRAM . . . SO OUR STUDENTS WILL BE BETTER EQUIPPED FOR THE INDUSTRIAL WORLD OF TOMORROW. MARPLE IS SERVING AS DIRECTOR FOR THE WATERLOO CENTRE FOR COMPUTER INTEGRATED MANUFACTURING.

STILL OTHER WAYS OF INTERACTING INCLUDE:

* THE OFFERING OF WORKSHOPS AND SPECIAL COURSES TO PEOPLE FROM INDUSTRY.

* LICENCING OF INVENTIONS AND NEW PRODUCTS COMING OUT OF CAMPUS RESEARCH.

* EXCHANGES OF INDUSTRIAL RESEARCH PERSONNEL AND ACADEMICS (ON SABBATICALS OR SPECIAL LEAVES)

No. 27

PICTURE — CHART OF UNIVERSITY-INDUSTRY COOPERATION?

WE'VE COME A LONG WAY BABY

INDUSTRY-UNIVERSITY COOPERATION IN CANADA IN THE RESEARCH AND DEVELOPMENT AREAS HAS COME A LONG WAY IN THE PAST 10 YEARS.

INDUSTRY IS, INCREASINGLY, COMING TO RECOGNIZE THAT UNIVERSITIES ARE THE WELLSPRINGS OF INNOVATION IN AN ULTRA-TECH ERA. UNIVERSITY RESEARCHERS, ON THEIR PART, ARE EAGERLY LOOKING FOR OPPORTUNITIES TO COLLABORATE IN THE UTILIZATION OF THEIR RESEARCH FINDINGS.

No. 28

PICTURE — THE CANADARM

CANADIAN ACHIEVEMENTS

CANADA HAS RECORDED MANY NOTEWORTHY ACHIEVEMENTS AND AMONG THE MOST SPECTACULAR HAVE BEEN SOME OF OUR ACCOMPLISHMENTS IN SPACE:

* THE U.S. SPACE SHUTTLE HAS USED SPAR AEROSPACE'S CANADARM REMOTE MANIPULATOR SYSTEM.

* SPAR WILL BE DEVELOPING THE MOBILE SERVICING CENTRE FOR THE U.S. SPACE STATION, INCORPORATING ADVANCED ARTIFICIAL INTELLIGENCE AND AUTOMATION.

* CANADA'S ANIK SATELLITES ARE WORLD CLASS AND HAVE FARED WELL IN INTERNATIONAL COMPETITION.

* CANADA WAS THE FIRST COUNTRY TO DEVELOP BROADCAST SATELLITES FOR COMMERCIAL USE.

No. 29

PICTURE -- FROM NORTHERN TELECOM

TELECOMMUNICATIONS TECHNOLOGY

THE DEVELOPMENT OF DIGITAL SWITCHING TECHNOLOGY LAUNCHED CANADA'S NORTHERN TELECOM ON ITS WAY TO WORLD CLASS STATUS IN THE TELECOMMUNICATIONS AREA. IT HAS NEVER LOOKED BACK.

No. 30

PICTURE -- REMOTE SENSING

REMOTE SENSING

CANADIAN COMPANIES AND CANADIAN ACADEMIC RESEARCHERS ARE AMONG THE WORLD LEADERS IN MANUFACTURING EQUIPMENT AND DEVELOPING SOFTWARE FOR THE GATHERING AND INTERPRETING OF DATA, VIA REMOTE SENSING.

THEIR WORK IS USEFUL IN AREAS SUCH AS FORESTRY MANAGEMENT, AGRICULTURAL MONITORING, GEOLOGICAL EXPLORATION AND OCEAN ICE SURVEILLANCE. EXPERT SYSTEMS AND ARTIFICIAL INTELLIGENCE ARE BEING APPLIED TO A WIDE RANGE OF DATA MANAGEMENT AND INTERPRETATION PROBLEMS.

No. 31

PICTURE — AIRPLANES

AIRCRAFT EXCELLENCE

THE CANADIAN-DEVELOPED DE HAVILLAND DASH 7 AIRCRAFT IS ONE OF THE BEST STOL (COMMUTER) AIRCRAFT IN THE WORLD. THE COMPANY'S NEWEST DEVELOPMENT, THE DASH 8, SEEN HERE, AGAIN LEADS THE WORLD IN ITS CLASS.

PRATT AND WHITNEY OF CANADA'S PT 6 TURBOPROP AIRCRAFT ENGINE IS STILL THE MOST POPULAR IN ITS CLASS IN THE WORLD. THE JT15D TURBO-FAN ENGINE IS IN USE IN CORPORATE JETS WORLDWIDE, INCLUDING THOSE PRODUCED BY MITSUBISHI. PW 100 SERIES ENGINES ARE ALSO IN USE IN AIRCRAFT, WORLDWIDE.

No. 32

PICTURE — MOO-YOUNG LAB

BIOTECHNOLOGY

1981 DR. ADOLFO DE BOLD, QUEEN'S UNIVERSITY, AND COLLEAGUES, HAVE LEARNED THAT THE MUSCLE OF THE HEART RELEASES A NATURAL SUBSTANCE WHICH LOWERS BLOOD PRESSURE . . . PROMISING NEW AND MORE EFFECTIVE WAYS TO CONTROL HYPERTENSION. TODAY, RESEARCH AROUND THE WORLD IS AIMED AT PURIFYING, PRODUCING AND TESTING THE SUBSTANCE, THROUGH BIOTECHNOLOGY.

RESEARCHERS AT WATERLOO AND GUELPH ARE CURRENTLY SEEKING A WAY TO SYNTHESIZE CODEIN. CANADIANS ARE ALSO INVOLVED IN BIOTECHNOLOGY RELATED TO THE EXTRACTION OF METALS FROM ORE, PRODUCTION OF FUEL (GASOHOL) . . . EVEN THE PRODUCTION OF PROTEIN FROM BIOWASTES.

No. 33 AND 33A

PICTURE — MEDICAL PICTURE

OTHER ULTRA TECH AREAS

OTHER ADVANCED TECHNOLOGY IN WHICH CANADA IS NOTABLE IN TERMS OF WORLD CLASS RESEARCH INCLUDE:

* URBAN TRANSIT VEHICLES
* COMPUTERIZED TRAFFIC CONTROL SYSTEMS
* COMPUTERIZED LIBRARY SYSTEMS
* MEDICINE — INCLUDING ARTIFICIAL MEMBRANES AND ENZYME-ENTRAPPING GELS (POLYMERS), AND TRANSPLANT AND OTHER MEDICAL TECHNOLOGY
* CONSTRUCTION TECHNOLOGY
* AGRICULTURE (GENETICS RESEARCH AND MECHANIZATION)
* COMPUTER LANGUAGES

No. 34

PICTURE — CANADIAN RESEARCH SPENDING CHART

CONCLUSION

CANADA IS SPENDING MORE THAN EVER BEFORE ON RESEARCH. THERE IS A NEW CLIMATE OF COOPERATION BETWEEN THE PRIVATE SECTOR AND THE UNIVERSITIES. GOVERNMENT LABS ARE ALSO INVOLVED, INTERACTING WITH UNIVERSITIES AND THE PRIVATE SECTOR, LOOKING FOR COMMERCIAL SPIN-OFFS, YET RETAINING THEIR UNDERSTANDABLE REGULATORY AND ENVIRONMENTAL CONCERNS.

THE CANADIAN RESEARCH COMMUNITY WELCOMES YOUR INTEREST, RECOGNIZING THAT COOPERATION CAN BE TO THE MUTUAL ADVANTAGE OF BOTH OUR COUNTRIES.

GERMAN/CANADIAN WORKSHOP
UNIVERSITY OF WATERLOO
2, 3, 4 DECEMBER 1986

TECHNOLOGY TRANSFER MECHANISMS AND EXAMPLES FOM THE NATIONAL RESEARCH COUNCIL LABORATORIES

Maureen Lofthouse, Senior Project Manager
Industrial Research Assistance Program
National Research Council Canada

In describing the National Research Council's Industrial Research Assistance Program (IRAP), I want to give you a sense of IRAP's philosophy. I plan to tell you something of IRAP's history and structure and of some new initiatives. I would like to leave you with the impression that we at IRAP have a flexible program, open to experimentation with new ideas, and that in the context of the objectives of this workshop we will be very willing to join you in considering new approaches aimed at encouraging the transfer of technology between our two countries.

The National Research Council is an agency of the Canadian government, similar to your national laboratories in Germany, and is directed by a governing council. NRC's laboratories in Ottawa and elsewhere in Canada are organized into Divisions, much like university faculties: Physics, Chemistry, Biology, Mechanical Engineering, Electrical Engineering and so on. The Industrial Research Assistance Program is the industrial support arm of NRC, having grown from a technical information service set up at NRC forty years ago.

You will see from Slide 1 that the IRAP Network stretches from coast to coast in Canada. We have over 200 professional scientists and engineers with industrial management experience working as Industrial Technology Advisors or as Project Managers, helping Canadian firms acquire and apply new technological expertise. The IRAP mandate, shown in Slide 2, is to "Help with Technology". We aim to add to a company's technical competence by facilitating its access to the best possible sources of technical expertise and, where appropriate, by supporting the personnel costs of development projects carrying high technical risk. Our resources, shown in Slide 3, connect all the major sources of technological development in Canada - and abroad - with our client community, Canadian industry.

IRAP is composed internally of two networks: the Field Network and the Laboratory Network. Slide 4 shows a breakdown of the Field Network's 160 Industrial Technology Advisors. As you see, only 60 are direct employees of the National Research Council, while the remainder are employees of Provincial Research Organizations, other research institutes and member firms of the Association of Consulting Engineers of Canada. IRAP has a contractual agreement with each of these bodies whereby varying numbers of their employees work full-time or part-time for IRAP as Industrial Technology Advisors. By engaging these organizations directly in IRAP's industrial support activities, we have strengthened their links with industry and added significantly to our own technological base.

Slide 5 shows the substantial growth of the IRAP Field Network over the past five years. This expansion of our personnel and our regional office locations, together with our continuing creativity in program delivery, reflects IRAP's policy of constantly enlarging the scope and effectiveness of our outreach to industry. Support to industry via the IRAP Field Network has increased from 5.5 million dollars spent on 766 projects in 1981-82 to expenditures of 19.3 million dollars on over four thousand projects in 1985-86. This support may take the form of a few thousand dollars provided to help a firm hire a student, access a special laboratory or acquire the services of a consultant for a short period to assist them in finding the technical solution to a problem. It may also take the form of a more substantial contribution to a longer term project for which funds of up to $30,000 dollars a year may be provided for up to three years. This type of funding is very popular and is typically used to help an individual who has a bright idea and who wants to work in a basement or garage or small workshop for a year or two to try it out and to prove the concept before embarking on a major business enterprise. All projects administered by the Field Network are offered only to small firms, that is, those with less than two hundred employees. Within these projects, access is very often provided for the firm to technical experts located within publicly-funded laboratories, although such a linkage is not mandatory.

IRAP's other arm, the Laboratory Network, has a more specific mandate to deliver publicly-funded research to the private sector for commercialization. The LabNet therefore only assists companies with projects in which there is a substantial transfer of technology from a government or university laboratory. Thus, a major element of the LabNet's role is developing familiarity with the activities of such laboratories and awareness of their emerging technologies.

Slide 6 shows a breakdown of professional staff associated with the IRAP Laboratory Network. The 28 project managers who are direct employees of the National Research Council are divided into 4 groups: I will describe the functions of these groups in more detail a little later. The 17 project managers who are employees of other federal government departments handle projects in which the technology has originated in laboratories of their own departments. Within Canadian universities, IRAP funds Technology Transfer Officers who are employees of the universities, tasked with identifying new technology within the university which is ripe for commercialization, locating appropriate industrial partners, and managing the resulting collaboration. IRAP has stepped in to provide funding for these functions in the early stages where there is some risk, little funding available from other sources, and insufficient revenue in the form of royalties and licensing fees for the function to be self-supporting. It is an experiment which seems to be working.

Some of the history of the IRAP Laboratory Network is shown in slide 7, from its beginnings in 1975 as PILP, the Program for Industry/Laboratory Projects. As you see from the many changes introduced over these 11 years, our program has been far from static, and has always been ready to implement new elements to improve service to our clientele. Originally established to transfer to industry technology developed in NRC laboratories, the program now transfers technology originating in any publicly-funded laboratory in Canada or overseas. In the early days, the program offered 100% of project R&D costs to a company and later, in 1982, adopted the contribution mode in which only a percentage of project costs is paid to companies. Although this contribution was originally fairly high, typically 90%, it has subsequently declined to its present day level of 50%. However, a major principle was involved in the change, namely that the intellectual properties developed during the course of the project now belong to the client company whereas in the contract mode they became the property of the Crown, and available to the company only under licence.

A major milestone occurred in 1983 when the federal government identified biotechnology as a strategic technology to be promoted in Canada and allocated IRAP specific funds for this purpose. Since most of the technology was resident in universities, IRAP needed to develop new operating principles, particularly with regard to shared ownership of intellectual properties between the client company and subcontracting university and to mutually agreeable arrangements respecting the university's wish to publish and the company's wish to maintain confidentiality. IRAP's success in finding a way through these hazards led it to expand its dealings with universities to all technologies in the following year.

The Laboratory Network's most recent expansion has been into the international arena, where we are easily able to extend our Canadian practices as regards transfer of technology from publicly-funded institutions. We are now also finding ways of facilitating the transfer of technology from overseas companies to our Canadian client companies without compromising our policy of supporting industry only within Canada. In addition, we have initiated specific agreements with individuals or organizations in foreign countries, for instance an agreement with an Israeli technology transfer agent who informs us of new technologies developed in his country which may be of value to Canadian industry.

Slides 8 and 9 show the distribution of IRAP Laboratory Network projects among industry sectors and by sources of technology for the year 1985-86 when we handled 366 projects with a budget of 39 million dollars. It is interesting to compare the breakdown of our technology sources with slide 10 which shows Canadian gross expenditures on research and development for calendar 1986. We see that projects funded by the IRAP Laboratory Network have not yet achieved the same distribution regarding source of technology as is found in expenditures on R&D. In particular, the universities, which account for close to one-third of expenditures in publicly-funded institutions, only account for one-sixth of our projects and represent a major untapped source of technology. In addition, many government laboratories have developed technology which has not been fully exploited in the marketplace. The IRAP Laboratory Network is organized so as to play a very specific role in assisting these publicly-funded laboratories effect technology transfer.

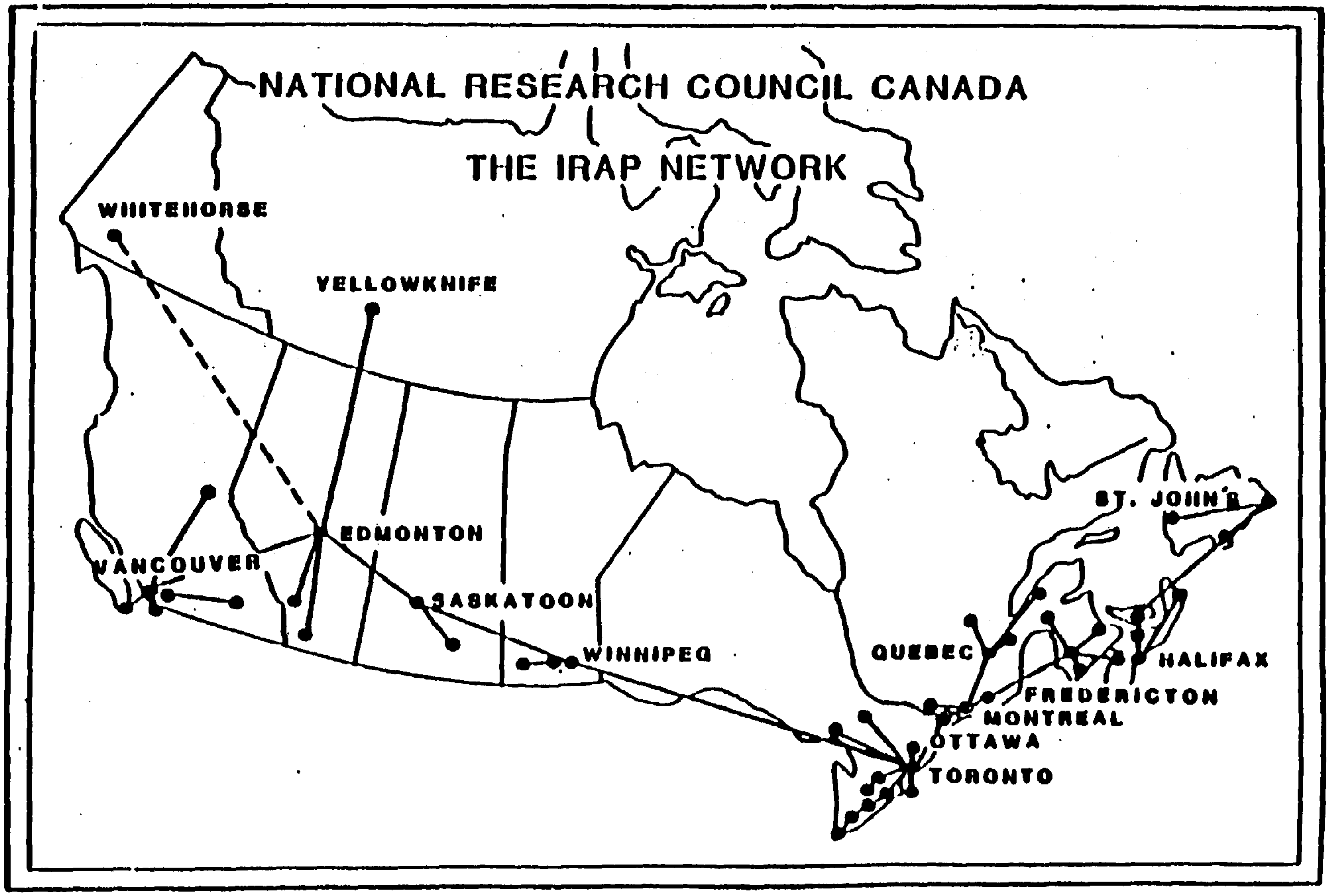
Looking back again at slide 6 we see that the National Research Council core group of the LabNet consists of four sub-groups. Three of these have a specific focus of technology which tends to be the focus of the IRAP-funded technology transfer projects they manage and of the networks of expertise with which they are most familiar. Each sub-group has a major responsibility for reinforcing mechanisms of technology transfer from certain sources, namely international sources, the National Research Council itself, other federal government departments, and the universities. IRAP supports the activities of the National Research Council's Industry Liaison Officers, who are located in each NRC Division. Within certain other federal government laboratories - Communications, Health & Welfare, Agriculture and Defence - the IRAP Laboratory Network provides a staff member for two or three days per week to help identify and commercialize interesting new technologies.

Within Canadian universities, as shown in Slide 11, IRAP has funded seven Technology Transfer Officers and is negotiating support of three more. We also maintain strong links with the councils which fund university research.

Our role in international technology transfer began with IRAP's presence at various trade shows outside Canada, where we take requests for technology and offers of technology from Canadian companies seeking collaboration or technical assistance from outside Canada. From these efforts have grown many collaborative projects and agreements with foreign countries and organizations.

In summary, IRAP looks for opportunities to help Canadian industry with technology from any source throughout the world. Slide 12 shows that we still have some way to go in persuading Canadian firms to undertake R&D and to pick up and apply new technology from any source in a timely enough fashion to be competitive. IRAP will continue to be the intermediary which encourages and eases mutually profitable collaboration between publicly-funded laboratories and private sector firms, particularly small, new companies with high growth potential. We welcome the opportunity of participating in this workshop and look forward to a significant involvement in any new initiatives arising from it leading to stronger ties between the technology bases of our two countries.

ML/sp
23 December 1986


NATIONAL RESEARCH COUNCIL CANADA
THE IRAP NETWORK
WHITEHORSE
YELLOWKNIFE
EDMONTON
VANCOUVER
SASKATOON
WINNIPEG
QUEBEC
ST. JOHN'S
HALIFAX
FREDERICTON
MONTREAL
OTTAWA
TORONTO

THE IRAP MANDATE

• SUPPORTING RISK	NOT	"INVESTING"
• PROVIDING TECHNICAL GUIDANCE	NOT	MANAGERIAL GUIDANCE
• DEVELOPING HUMAN ASSETS	NOT	FINANCIAL OR CAPITAL ASSETS
• SERVING WITH TECHNOLOGY	NOT	CONTROLLING TECHNOLOGY USE
• EXPLOITING PUBLIC LABORATORIES	NOT	STORING INFORMATION

THE RIGHT RESOURCES

IRAP INTERCONNECTS ALMOST ALL OF THE TECHNOLOGY SOURCES IN CANADA,BOTH LARGE AND SMALL,IN ONE POWERFUL TECHNOLOGY ASSISTANCE NETWORK

- FEDERAL LABORATORIES
- PROVINCIAL RESEARCH ORGANIZATIONS
- RESEARCH INSTITUTES
- TECHNOLOGY CENTRES
- UNIVERSITIES
- CONSULTING ENGINEERING FIRMS

1986/87

IRAP FIELD NETWORK

INDUSTRIAL TECHNOLOGY ADVISORS

			PYs
A. NATIONAL RESEARCH COUNCIL			
	Locations: NRC Offices (3)	11	
	PRO Offices (10)	27	
	Universities or Colleges(20)	22	
			60
B. PROVINCIAL RESEARCH ORGANIZATIONS (9)			61
C. SPECIALIZED CENTRES (19)			23
D. RESEARCH INSTITUTES (21)			-
E. ASSOCIATION OF CONSULTING ENGINEERS CANADA (16)			17
			161

JD/
21 July 86

IRAP FIELD NETWORK PROJECTS

1981/82 - 1985/86

	EXPENDITURES	PROJECTS
1981/82	$5-59M	766
1982/83	7-01M	1005
1983/84	11-31M	2384
1984/85	18-02M	4065
1985/86	19-30M	4333

NOTES

- ALL PROJECTS WITH SMALL (<200 EMPLOYEE) FIRMS
- APPROXIMATELY 34,000 SMALL MANUFACTURING FIRMS IN CANADA
- DURING 5 YR PERIOD, PERCENTAGE OF SMALL MANUFACTURING FIRMS GIVEN PROJECT ASSISTANCE INCREASED FROM 2% TO 10%

JHB/8-4-86

1986/87

IRAP - LABORATORY NETWORK

		PYs
A)	NATIONAL RESEARCH COUNCIL CANADA	
	- INTERNATIONAL TECHNOLOGY TRANSFER	6
	- INFORMATICS/ELECTRONICS (NRC/LIAISON)	9
	- BIOTECHNOLOGY AGR/FOOD (OGD LIAISON)	5
	- MATERIALS/ADVANCED MANUFACTURING (UNIVERSITIES LIAISON)	8
		[illegible]
B)	OTHER GOVERNMENT DEPARTMENTS	
	- PROJECT MANAGERS	17
C)	UNIVERSITIES	
	- TECHNOLOGY TRANSFER OFFICERS	6 (+3)

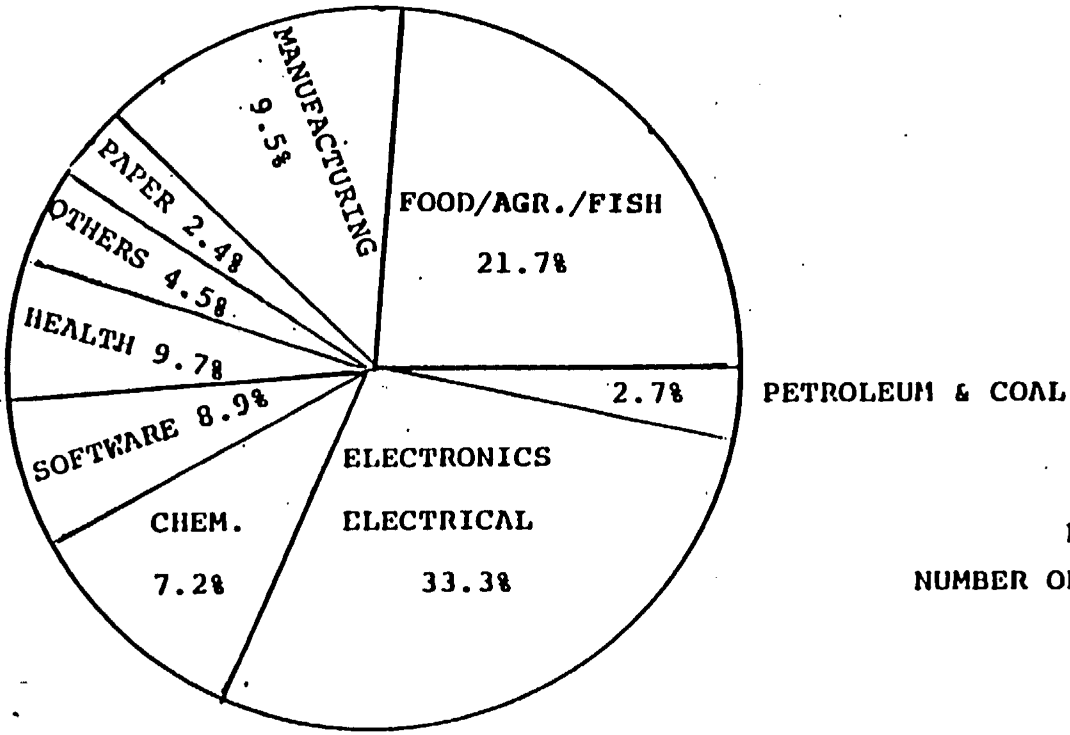
DEC. '86
ML/sp

EVOLUTION OF THE IRAP LABORATORY NETWORK

1975	- PILP PROGRAM ESTABLISHED	• PROJECTS CONTRACTED TO MEET NEEDS OF NRC LABORATORIES
1981	- PILP PROGRAM INCLUDES ALL GOV'T DEPARTMENTS - "COPI" PROGRAM TERMINATES	• NRC ADMINISTERS TECHNOLOGY TRANSFER ENLARGED BUDGET • PILP PROJECT SELECTION BY INTERDEPARTMENTAL COMMITTEE
1982	- PILP PROJECT "CONTRIBUTIONS" REPLACE CONTRACTS	• DIRECT BENEFITS TO LABORATORIES REMOVED • COMPANIES CONTRIBUTE TO PROJECT COSTS • COMPANIES OWN NEW TECHNOLOGY
1983	- PILP BIOTECHNOLOGY PROGRAM LAUNCHED	• TARGETED BUDGET WITH UNIVERSITY COLLABORATION EMPHASIZED
1984	- UNIVERSITIES BECOME TECHNOLOGY SOURCES - "INCUBATOR" BECOMES "CO-OP-TECH" AND EXTENDED TO OTHER GOV'T DEPARTMENTS	
1985	- PROVINCIAL RESEARCH ORGANIZATIONS BECOME TECHNOLOGY SOURCES - PILP & IRAP-P PROGRAMS MERGED into the IRAP Laboratory Network	• LAUNCHED INTERNATIONAL TECHNOLOGY TRANSFER ELEMENT
1986	- INTERNATIONAL COLLABORATION AGREEMENTS ON INDUSTRIAL R&D	

INDUSTRY SECTOR DISTRIBUTION OF FUNDING

1985-86



EXPENDITURE: $39,261,000

NUMBER OF PROJECTS : 366

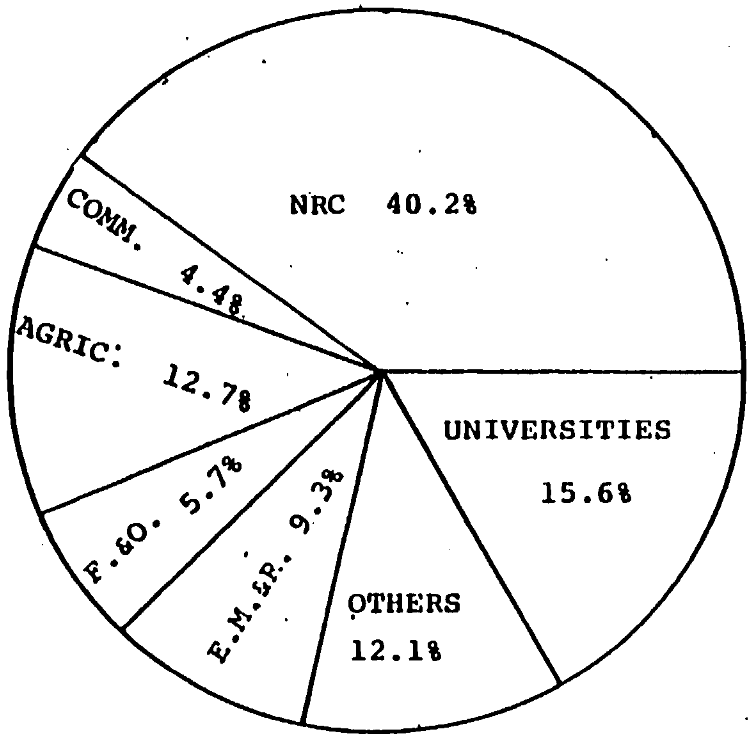
IRAP : LABORATORY NETWORK

HELPING WITH TECHNOLOGY

PROJECT TECHNOLOGY LINKAGES

BY NUMBER OF PROJECTS

1985-86



EXPENDITURES: $39,261,000

NUMBER OF PROJECTS: 366

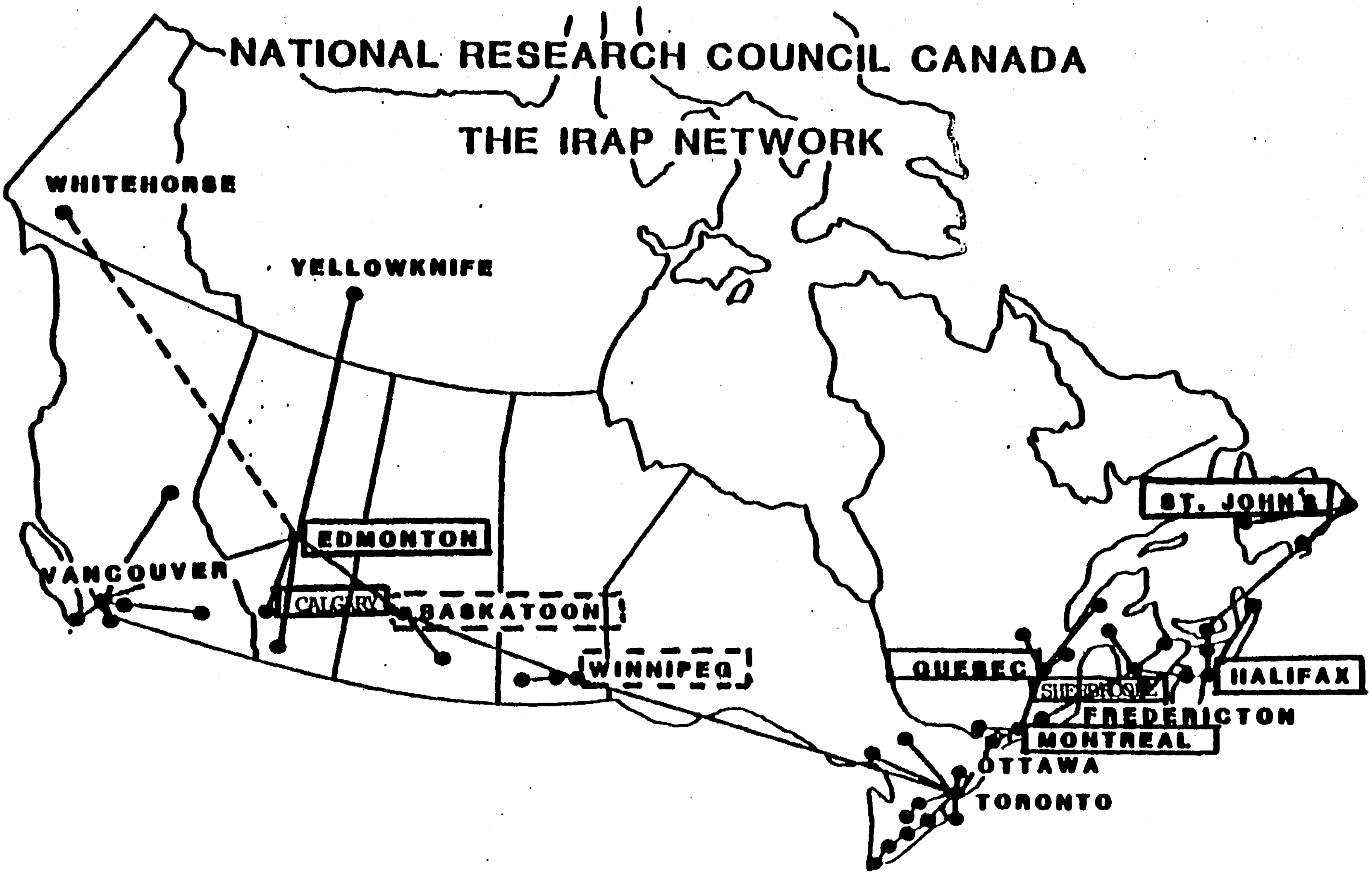
CANADIAN R & D PERFORMERS

NATURAL SCIENCES & ENGINEERING: GROSS EXPENDITURE ON R&D

ESTIMATE CALENDAR 1986 BY PERFORMERS

NRC (All Programs)	$ 435M
FEDERAL GOVERNMENT	$1,368M
PROVINCIAL GOVERNMENT	$ 120M
PRO'S	$ 91M
BUSINESS SECTOR	$3,528M
UNIVERSITIES	$1,150M*
OTHER	$ 85M
	$6,342M

*NSERC (1985/86) $ 312M


NATIONAL RESEARCH COUNCIL CANADA
THE IRAP NETWORK
WHITEHORSE
YELLOWKNIFE
EDMONTON
VANCOUVER
CALGARY
SASKATOON
WINNIPEG
QUEBEC
SHERBROOKE
FREDERICTON
MONTREAL
OTTAWA
TORONTO
HALIFAX
ST. JOHN'S

BUT.......

- 45,000 FIRMS STILL NEED HELP
- TECHNOLOGY USE LAGS IN CANADA
- FOREIGN TECHNOLOGY IS STILL UNEXPLOITED
- OVER 1,000 START-UP FIRMS PER YEAR NEED SPECIAL TREATMENT
- UNIVERSITY AND GOVERNMENT LABORATORIES ARE STILL MYSTERIES TO MOST FIRMS (AND VICE VERSA)
- INNOVATION MANAGEMENT NEEDS ENCOURAGEMENT

National Research Council Canada Conseil national de recherches Canada 1985

GERMAN/CANADIAN WORKSHOP
DECEMBER 2,3,4, 1986
UNIVERSITY OF WATERLOO

A B S T R A C T

Dr. Peter Tonn, head R&D Transfer office, industrial relations.

Transfer of Aerospace Technology to Industry by cooperation and personnel transfer - The DFVLR experience

As a sample case study for National Labs, DFVLR - German Aerospace Research and Testing Institute - is shown in it's historically based cooperation with aerospace and other industries. Industrial needs of the medium term future are shown to influence DFVLR's planning process and daily work. The ways of coordination are discussed. The positive consequences on staff motivation and consequently R&D results are explained. Finally, recently developed ways of cooperation with industries are listed.

Vortrag

Workshop CANADA

Transfer of Aerospace Technology to Industry by Cooperation and Personal Transfer

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The DFVLR experience

The difficulties of Technology transfer are generally known to this audience. They are visualized by these two slides (1, 2):

Being at the research side of the transfer, getting technology across is comparable to pushing an airplane with a string. experience has shown, that one of the more efficient ways to get an airplane moving is to pull it on the string, preferably joining efforts of all persons involved. This observation has already taken us to the topic, transfer by cooperation and personnel transfer.

This way of transferring technology, know-how, research results has been stressed lately as the most efficient and important way of transfer. But before going into the details of how it is done in our particular sample case, I should like to point out, that it has been always important and that it has been the real secret of success. Looking at agreements about patented licenses about blueprints for devices, about contract work one observes, that all these worked only if the persons involved cooperated and passed on the relevant know-how and training, within the contract or besides it. The ways are known: Discussion, common analysis of problems and solutions, common design of solutions to reach the final result, even limited or permanent presence of the industrial engineer in the scientists laboratory or of the researcher in the industrial environment.To which degree these ways are employed depends upon the character of the institutions involved and of the work to be done.

Before going into detail, let me introduce the institution I represent, and myself:

The main task of DFVLR is applied research mainly in the aerospace field, supplied by work in non-nuclear energy and some other interesting technologies, but the latter on a small scale. DFVLR is a member of a group of thirteen research laboratories, ranging in size from 4500 employees to approximately 250 The tasks of these laboratories are quite different, as can be seen from this slide (3). Part of them is doing basic research, as distant from any practical application as sub-nuclear particle research usually is; others like DFVLR work very close to industrial needs, in certain aspects even being similar to an "expanded laboratory desk" of industry. Yet, whenever transfer of research and development results is involved, all of them have developed recently very similar ways. Hence, DFVLR may stand as a sample for the more general case of these laboratories.

I am responsible for the transfer of research and development results to industry from the German Aerospace Research and Development Establishment, DFVLR.

The common characteristics of these "national" laboratories are:

- They work on major, long term tasks, which typically require either permanent staff and/or large facilities;

- their tasks are set in agreement with the nations needs, as defined by the appropriate departments, in Germany mostly the department of Research and Technology;

- they receive public funding for the major part of their work or for all of it;

- they stay clearly in a stage of development in which market success is still so far away that industry would not occupy yet their own laboraties with this work.

Comparing them with other research and development units one finds two groups:

One group which comprises Nuclear Research at Karlsruhe and at Jülich, GKSS Center near Hamburg, Mathematics and Data Processing Research near Bonn, Radiation and Environment Research near Munich and German Aerospace, works predominantely on projects close to application and hence has considerably more contact with industrial enterprises than the second group, whose scope of work is orientated more towards basic, general knowledge. Yet, the second group, when coming into contact with industry, has found the same ways to be efficient as the first group.

Comparing these units with other large scale research units (4), such as the universities, one finds marked differences. For one, they are different from the universities in size and endurance of tasks and the permanence of staff. They are different from the Max-Planck-Society in the size of facilities they operate and in closer relation to application of results. They are different from the Fraunhofer Gesellschaft in that they are less contract orientated and less subject to immediate control from industry by research money. In the particular circle of government, industry and science they play a very peculiar role in having cooperation with all three of them and being able to perform tasks which none of the others can do:

They can do larger science projects than the universities, at the same time go closer to it's application together with industrial partners, aiming at final application all of the time. Due to close relation to the government they can perform quasi governmental tasks like administration of official research and development programs etc. At the same time being subject to government steering regarding their programs, they can be and are used to fill research and development gaps.

DFVLR was founded formally in 1969, joining a large number of R&D institutions which have their roots as far back as 1907, when at Göttingen the famous Fluid Mechanics Research Institution of Ludwig Prandel was founded - a name which till today is proudly displayed by the Göttingen facility of DFVLR. Two other large units were the German Testing Center for Aircraft and the German Research Center for Aircraft, founded in 1912 and 1936 respectively. These together with several smaller institutions formed DFVLR. They were dispersed all over Germany, explaining the geographical structure which is shown in the map (5).

DFVLR works in the following fields:

- Airplane guidance and control and aircraft design are concentrated at Braunschweig.

- Fluid mechanics is located at Göttingen

- Remote sensing and telecommunication via satellite are concentrated at Oberpfaffenhofen; in addition there is located the German Space Operations Center, from which the spacelab was controlled during the D1-Shuttle mission, and there is the heart of our computer net joining all centers.

- Stuttgart concentrates on non-nuclear energy technology, in particular solar power and use of liquid hydrogene as an energy carrier; Stuttgart center is responsible for the rocket engine testing facility at Lampoldshausen.

- Cologne houses the space technology management, the materials in space research facilities and the Space Station User Support Center (under development); in addition it is the administrative center of DFVLR, and the home of DFVLR's work in flight and space medicine and biology.

- Quite dispersed are the materials and design research facilities of DFVLR, which are almost hidden in other programs, but due to their abilities form an asset of their own.

DFVLR has an annual budget of about 200 Million $, and there are almost 4000 employees of all levels. Aircraft orientated tasks make up for almost half of our program while space orientated activities today make up for 35 %, with a strong tendency to grow; non-nuclear energy and new technologies take up 20 % of our work. Roughly 25 % of our budget stems from government (15 %) and industry (10 %) contracts. Besides the main programs there are a few activities with a particular high technology transfer potential: Deep diving medicine, vehicle technology and vehicle dynamics simulation, transportation systems analysis, robotics, materials treatment by high powered lasers, data processing, combustion technology, household energy supply, noise control and last not least the management of a research program towards the improvement of work conditions, environment and health with a total budget of more than a hundred million dollars.

Our organizational structure is characterized by 6 research departments plus several supporting and administrative departments, which do have R&D interests of their own. The organizational layer beneath that has 45 research institutes and divisions. It is obvious, that an organization as diverified as this cannot be operated and controlled if it does not have very strong connections with the users of the results produced, connections on all levels and of many kinds. In the following parts of my paper I give a general view of the typical connections and then will comment a few selected examples of more recent ways of cooperations with high efficiency.

The workprogram of DFVLR and the institutional development is influenced strongly by the shown in slide 6. The two groups with the strongest influence on DFVLR programs are the government departments and the national industry. Due to the close connection of DFVLR's work with year to year programs there are contacts with these on all levels, from the supervisory board at the very top down to the single engineer or scientist; on the government side they exchange plans and information with the relevant departments, from the secretary down to the officers responsible for single government R&D, transport or economic programs. The same situation is given on the industry side on which contacts range from national associations of industry down to engineers and scientist in laboratories and pre-production R&D. Looking somewhat closer at these contacts we of course find different levels of importance and scope, according to the hierarchically level of the person or body involved. At the top, there is one institutionalized planning process in the supervisory board, which decides about the long range corner stones of the program. Members of the supervisory board come from government, science and industry, each of them providing one third of the membership. It is obvious, that these members come from the departments or industries interested in aerospace. This guaranties a very efficient control of the general direction in line with needs of government and industry, which turn are very closely interconnected too, by common programs, often financed by government. Going down through the hierarchic levels the exchange of information and agreement about plans becomes ever more detailed and ever smaller, down to the scientists desk who with his colleague in industry communicates about practical details of how to solve the common problem.

The "scientific community" influences the basic research program of DFVLR - which today makes up for a mere 15 % of total work - in the usual ways, that is acceptance of publications, invitations to conferences etc., which in turn determine which scientific analysis or development is regarded as qualified and important. Secondly, they influence the institutional setting of DFVLR by being present in the regular five yearly reviews of the R&D institutes of DFVLR, which influence the future development of every single DFVLR institute. And of course, thirdly there is the every day contact between scientist on how to solve given problems.

To sum up, DFVLR has very decentralized ways of contacts with the outside world; these contacts are various, very close and make up for a large part of the motivation of DFVLR personnel. The institutes are very independent in regard to details, but they settle these details in accordance with the plans which they found in mutual consent - more or less, of course - of all parties involved. Given these various variant contacts, there is a strong role of bottom up planning, which on one side yields a strong motivation to fill programs, but on the other side can cause a serious problem for overall control.

This informal flow of program adjustments and the informal flow of results used by this way of behavior used to affect the work process of DFVLR as well as the image and reputation of DFVLR. Despite the fact, that there were important contributions to industry's needs, nobody took notice of them, very often these contributions were even forgotten or denied, partly because at an early stage industry used to take up parallel work which of course and rightfully was counted as an industry result, than. This has led in the last half decade to a marked change in DFVLR's way of handling contacts. This change was helped by the fact, that at about the same time research money available for industry and national research labs in Germany got short enough to forbid any parallel work towards the same goal, thus requiring mutual agreement on plans and work split. DFVLR was able, by several different means, to gain more control over their publications and more control over the transfer of results in general. These are: Keep proof of the transfer of results; to publish about transfers and, last not least, working under contracts and formal cooperations, defining every party's work and settling in advance the use of results. All this was set under the overall goals to

- assure the actual use of R&D results, to make the use of results known to the general public or at least those bodies influencing DFVLR's financial and reputational status and

- finally to improve returns from work to supply the basic funding received from government.

This goal of directing research and development towards transferable results and actual transfer of results is comprised under the idea of R&D transfer. We do have an office of R&D transfer, which decides the "old" task of technology transfer, makes known to institutes and scientists this way of thinking, aids them in actual design of projects and negotiation of contracts and finally develops the internal rules to follow from the experience gained. But the R&D transfer office covers only part of the field:

For one thing DFVLR institutes always have been very good and decided about finding their own projects and settling their contracts with third parties - if not all the time at the best of all conceivable conditions. In this, they have been supported for a long time by a very able and helpful administration. On the other hand DFVLR about four years ago has introduced a set of formal indicators, which is shown in slide (7). The first - volume of formal contracts - and last - personnel transfer to industry - so far have stayed in the background; but the second one - volume-of-return-from-contracts etc. - has shown marked effects from the very beginning as soon as it was introduced as an indicator of institutes' or departments' success in 1982. In slide (8) it is shown how the financial power of DFVLR from third party revenue instead of basic financing has increased during the last seven years. At the same time, almost unnoticed, the percentage of contracts, the percentage of formal cooperations and projects has increased at least twofold, whilst the so called basic research has been reduced to a mere 15 %. The way these formal indicators work can be seen on slide (7) again. There are incentives for managers and incentives for individuals. At the moment incentives for managers are far better, at least the tangible ones. The financial budgets and the personnel budgets of institutes always have been coupled to the success of the institute in a very general way. When introducing the volume-of-return indicator, this has been strengthened first after the first year towards a slight improvement in financial budgets upon request, if an institute more than filled its plan. Lately there has been introduced a fairly strict coupling, making any additional budget over the so called basic budget of institutes dependent upon their success in contracting successfully. It is to be expected, that the volume of formal contracts without additional returns will be worked into this systems in a few years, subject to a further improvement in the program control of DFVLR.

In order to help the personnel transfer to industry about three years ago a special "Junior Scientist Program" was introduced, in which the institutes could hire young scientists for at the longest three years outside their regular personnel budget, provided they could find financing; to help cooperation with industry at the same time, their easiest way is to find an industrial partner who pays half of the salary under a cooperative agreement. Then DFVLR will pay the other half from the technology transfer budget, thus making available an additional junior scientist to the institute with no additional cost.

The "cash" incentives for individuals are quite meager. This is due to the fact, that DFLVR is subject to official regulations regarding salaries, which do not permit payment of additional premiums etc. outside very narrowly set limits. So the only additional incentive is participation in royalties, if a persons patent carries licence income for DFVLR.

There is a second incentive, which in the slide I called "projects of interest and personal reward" which justifies a little bit of discussion.DFVLR often has been asked and it has been a permanent question for DFVLR management and employees if a program orientation as detailed as DFVLR's permits enough creativity for scientists or the other way around, if program orientation like this doesn't affect the quality of research. There has been a long discussion within DFVLR, that has not brought an answer or even one common opinion, but it has given everybody at least a common opinion about the problem at stake. To our knowledge there has never been research into this with qualified results. So we can only report the opinion of most of our scientist and engineers who deny that the program orientation of their work would affect the quality of the R&D. This positive attitude is important for cooperation with industry. People working in applied research and having this attitude usually do not fear the contact with industry; rather they draw motivation from positive contacts and from the idea of potential application of their results. To see one's work as an identified or at least identifiable contribution of a process or some component of some product often is more important than a positive reception of an publication or a presentation within a scientific colloquium.

This does not mean, that cooperation between DFVLR scientists and engineers and industry is free of any tension. The main drawback of cooperations towards an industrial application is restraint on publications. Being close to application means being close to competition, which in turn means, that there automatically are restraints on cooperating with other partners, be it in industry, be it in science. Yet another cause of tension are the different attitudes in defining primary goals: The scientist searches for scientifically clean and concise solution while the engineer in some industrial enterprise has to find a solution that works for a marketable product which brings quite different ideas about time needed and time available, about resources to be assigned to either a thorough and clean solution or towards a "quick and dirty" solution that works too.

Summing this up, we at DFVLR emphasize the positive effect that mutual understanding helps to reach a new and better process or product, and each side's contribution. One indicator for this is, that short term exchange of personnel besides the junior scientist training program mentioned above, is practiced fairly often, if the fringe penalties are not too high. We at DFVLR believe that these personal attitudes of our scientists and engineers to a large extent explain the fact, that DFVLR, despite very often repeated attempts to withdraw research and research money in favour of industry laboratories has kept its position as an independent research unit in the aerospace scene in Germany.

To illustrate what has been said so far I'll finally talk about a few examples of cooperation practiced by DFVLR and other government laboratories.

We have already talked about the junior scientist sponsorship program. The second example, cooperation with government and industry on helicopter development, is typical of the long-term cooperation without exchange of funds and without concise formal agreements. BO 105 of Messerschmidt Bölkow Blohm (MBB) is one of the few genuine European small helicopters. One of these has been refitted to be a flying testbed at DFVLR. Using this flying testbed we have been working on a program called ACTHOR/HESTOR since 1983. The technical scope of this program is:

Helicopter blades typically are controlled with a fixed mechanic device forcing them into different angles of attack during the full circle. It has been known for a long time, that the angles of attack possible with these devices are not optimal and cause a lot of additional noise and unnecessary vibration as well as loss of efficiency. So it has been agreed upon to have a program to control this angle of attack more delicately according to momentary position and to any relevant changes in flows. This is called technically "higher harmonic blade control".

The program toward this goal began in 1983 together with MBB and Hamburger Flugzeugwerke, HFW, first trying the concept in windtunnel experiments. After designing appropriate open and close loop controllers and matching actuators, appropriate hardware will be employed as single elements first in the inflight simulator, after which finally the full system will be designed, incorporated and tested. The close cooperation between the partners is shown in slide (9) and so far has been very successful.

This is typical of aerospace work. Slide (10) shows the present background to this. DFVLR, MBB and Dornier Aerospace as well as other smaller aerospace enterprises are represented by their programm circles, partially overlapping. The overlapping sections of the program circles indicate the fields of cooperation - so for instance the project just mentioned is contained in the field in which the medium range aircraft R&D program of DFVLR and the three R&D programs of MBB overlap. All the programs mentioned are contained in one large national informal agreement, the socalled Memorandum of the Association of German Aerospace Industry of 1985. This, and many other programs, are strongly influenced of course by the general goals of the relevant Departments of Research and Technology, of Defence and of Transportation.

The same principle goes for our space orientated work, for which at the time being there is a lot of work on the way to define the European and matching national programs. The programs, by the way, have at least been kept defined to such a degree all of the time, that useful work in the fields of interest to DFVLR has been possible.

Quite a different example of scientific and R&D cooperation and dissemination of results is practiced under the heading of "Study Group Flow with Separation". To explain the technical background: Smooth flows, preferably laminar have the highest efficiency and hence are the state sought for in design. Yet, brute reality demonstrates to many flows which may start smoothly but show separation very soon. These important flows, be it on modern aircraft - not only fighter aircraft - be it on automobiles, be it in machinery like turbines, pipes etc. are extremely difficult to compute and design. Consequently in 1979 the study group was formed, slide (11) giving DFVLR the role of a secretary responsible for organization and very often for initiative. The best way to describe DFVLR's role is to explain it as working like a catalyst, bringing agents - people - together and giving them the forum to interact. This study group is organized - very similar to DFVLR's matrix organization - in project groups, responsible for better design methods for different aircraft elements, be it helicopter rotors, be it fuselages, and in expert groups with special knowledge, be it on physics, be it on numerical simulation. They interact by themselves and have their programs approved in the Program Commitee - the Program Commitee receives not only these bottom up programs, but as well top down programs which are designed by the Program Management. The Study Group as such is guided by a curatorium, which advises on major goals and is responsible to make the needs of the study group known and accepted. All this work is done under the side condition of no exchange of funds and its results are applied not only in aircraft industry, but as well in the automobile industry, in turbines and in shipbuilding or in processing technology. The total volume entering annually is between 100 and 150 manyears research effort, of which 50 are delivered by DFVLR in the project groups. To a certain extent this effort is sponsored by government money.

As opposed to this still some what informal and voluntary approach, there recently has been launched a new design for government sponsored R&D cooperation between science and industry. It was invented by the Department of Research and Technology and has been labeled "Verbundforschung" (Joint research). The general goal behind it is to direct basic research more directly at application needs of industry. A typical "Verbundprojekt" (slide (12) is designed for a time span from 5 to 10 years, and comprises several partners from science and industry. The workload towards a common defined goal in the primary stages is mainly on the side of the research institutions, while in the later stages it shifts more and more into the industrial pre-production laboratories. The common goal, defined at the beginning, could be to design aluminium alloys of high strength at high temperatures. The basic physics of this are known and leaving basic research alone would probably lead to alloys with practical industrial potentials sometime in the future. Now the idea is, that by avoiding unpromising sidepaths and by concentrating on the promising main road these alloys with practical usefulness will be designed earlier. Instead of applying the usual detailed steering by the department of Research and Technology, one plans to rely upon the steering interests of the later user, industry, and hence ties research institutions and interested industrial enterprises together by providing them a common financial support. This support does not, in the original conception of Verbundforschung, cover all costs but only 50 % of project. The reasoning behind this is, that on the industry side there should be enough interest in getting these alloys faster to justify an own financial effort; on the science side the reasoning was, that at least the national laboratories did a lot of "useless" basic research, which could be directed towards more useful purposes, like these in "Verbundforschung". It was proven, though very quickly, that there were no such "gaps of uselessness", and since all science partners have received financial supports up to 100 % of their effort.

This new type of projects has been accepted very well all over the national laboratory scene and has brought to them new, additional activity. Very quickly this idea has developed into larger efforts, getting together groups who do not plan only a single common project like the one sketched but plan to cover whole fields of research in this manner, thus establishing sort of a national program. Examples from DFVLR are the Study Group Turbo Machinery, the TECLAS effort easily identified as aiming at technical lasers, and the TECFLAM activity, doing a 17 million dollar research program on technical combustion processes for a beginning.

There is no need to discuss details of sponsored research here, which has been taken up during the last half decade by all of the national laboratories to different extents. But there is a very nice example how close cooperation with industry can become, if there is actual industry interest for application. The example I want to mention is the DFVLR work in robotics. Originally, DFVLR felt a future demand was felt to for robots which could operate in space or in the deep sea to replace deep sea divers, the common characteristic being that those would find an environment partially or totally unknown to them, other than in a machine shop. About ten years ago, work was taken up to develop ways of feeding back sensor signals into the controlling software of the robot employing at first a very simple mechanical sensor. This first sensor, to elaborate more about the technical side of the project, was a simple mechanical device, feeling mechanical resistance in six dimensions (lateral resistance and momentum resistance in three dimensions each). From the first intermediate goal to make the robot stop once it felt resistance work went on to have it feel the precise location of a hole into which to place a pin, then to operate hand grinders on irregular surfaces, to mount complicated mechanical devices like automobile engine oil pumps and so on. Much work has to be done to speed up the real time operation and from there has developed a fully new insight into teach-in of robots. Today this robot is able to cut seams from elastic material. The awkward way of programming a robot by pressing single keys on a keyboard or by writing software is gone as well and is done much easier by "taking the robots hand" and guiding it over the path of work. It is possible to change a basic path once found etc. etc.. The latest application envisioned is to have an experimental robot on the next German spacelab mission D2 and to try it at handling experiments, thus following DFVLR's policy to aim at the utilization of manned space flight and at the same time to try to replace man in manned space flight as much as possible, transferring appropriate tasks to robots and machinery.

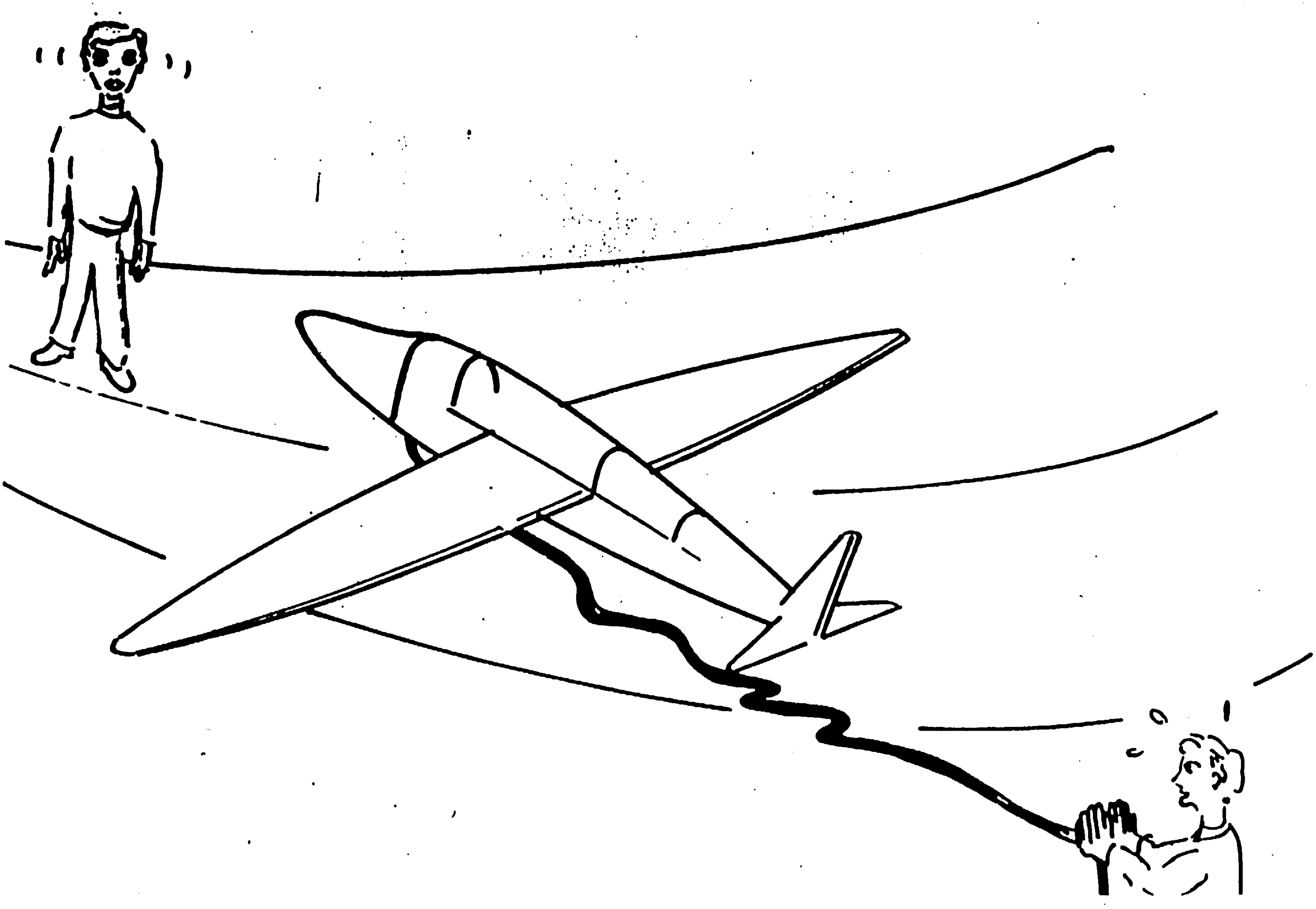
After that somewhat enthusiastic technical description, let me mention that during these past ten years the cooperation with industry has been the main drive behind designing this robot to the present state of development. All forms have been used: Licensing of patents, cooperation with firms buying the licensed product, developing new sensors and new software for automobile production application on research contract base, having sponsored junior scientists from several industries etc. etc.. We feel, that this cooperation with industry has brought out a robot with space potential in high quality much quicker and much cheaper than if it had been done without these cooperations.

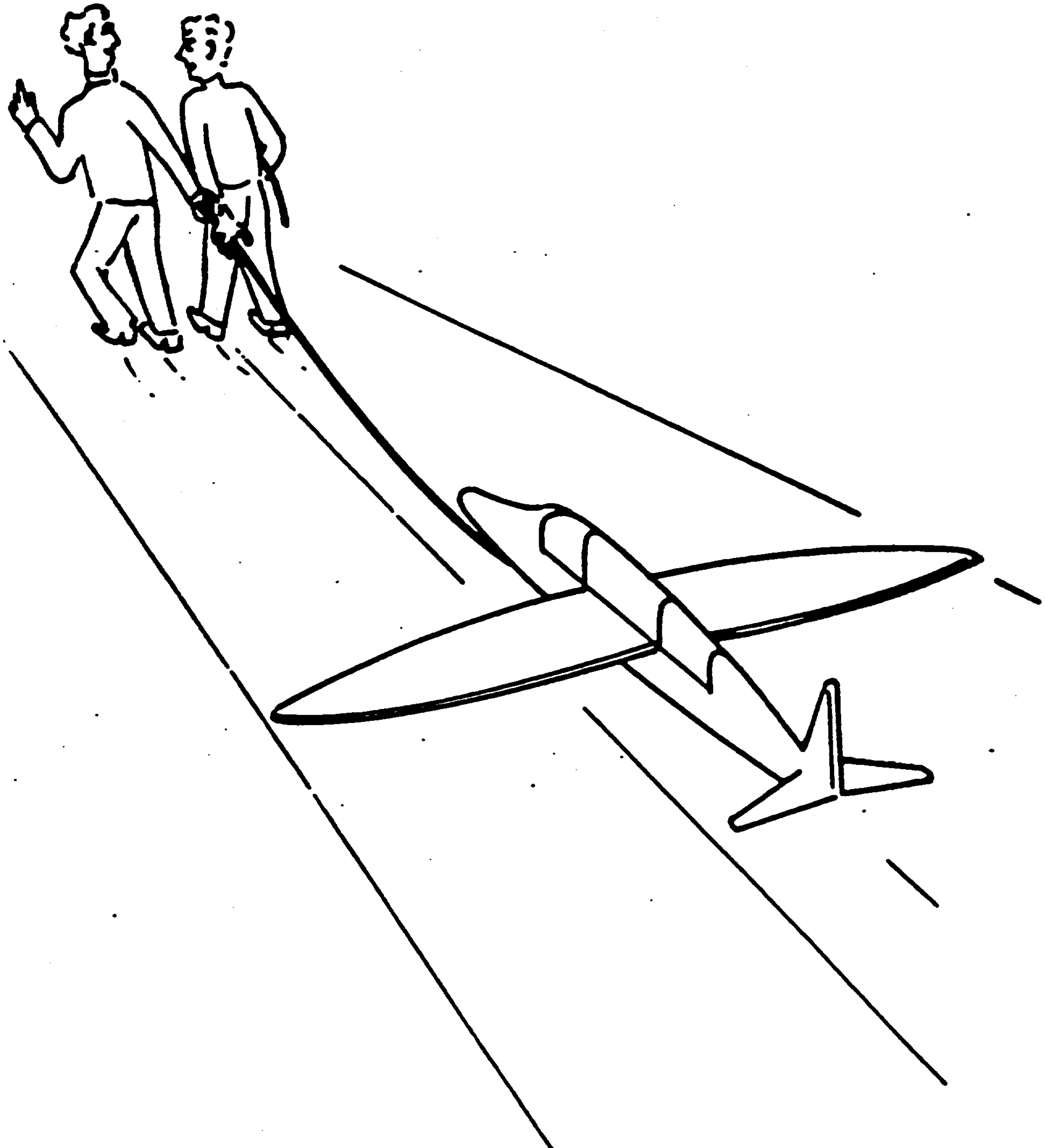
I believe to have shown, that there are many productive ways of cooperation between science and industry in which people, exchange of information between people and even exchange of people are involved. DFVLR as such at the time being has more than 250 partners in industry with a total annual contract volume of 20 million dollars, slide (13); the actual volume of cooperation, though, is much higher than this income figure. One third of the enterprises are smaller ones of up to 1000 employees; the experience of cooperation with them is at least as good as the experience with larger enterprises. We do base our cooperation on the initiative and drive of the institutes and the scientists and engineers which puts them right into the first row of acquiring new projects and we try to follow the close cooperation and feed back scheme shown in slide (14).

To say a few words on technology transfer - the spin off activities from our abilities, we have formed a few special units within DFVLR, for instance the consulting unit for composite materials, application laboratory for industrial high power lasers and several more. Overmore we operate a technology transfer office in the disguise of the R&D transfer office and we do have a patent licensing office besides. I do hope I have given you an impression on how cooperation with industry is handled and is experienced in my institution and want to thank you for your attention.

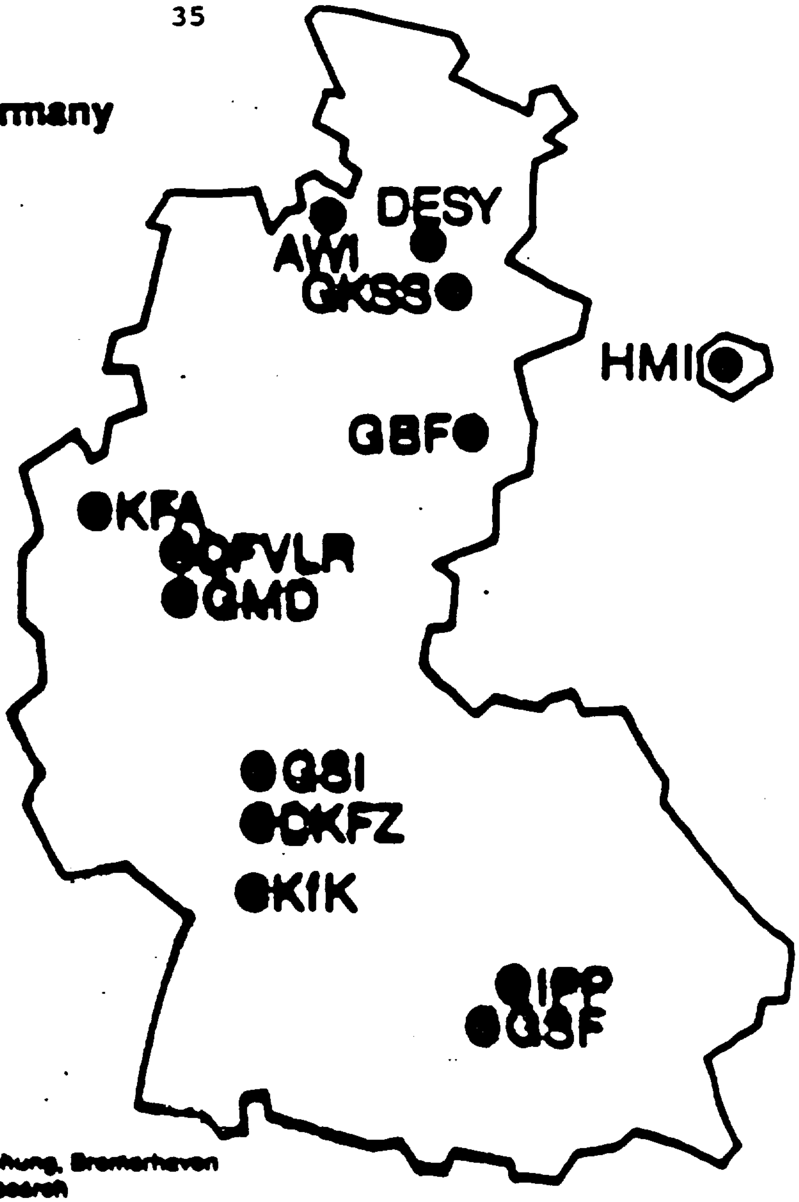
Slides 15 ff give an overview of German National Laboratories which is not covered in the paper. Courtesy of AGF

(1)



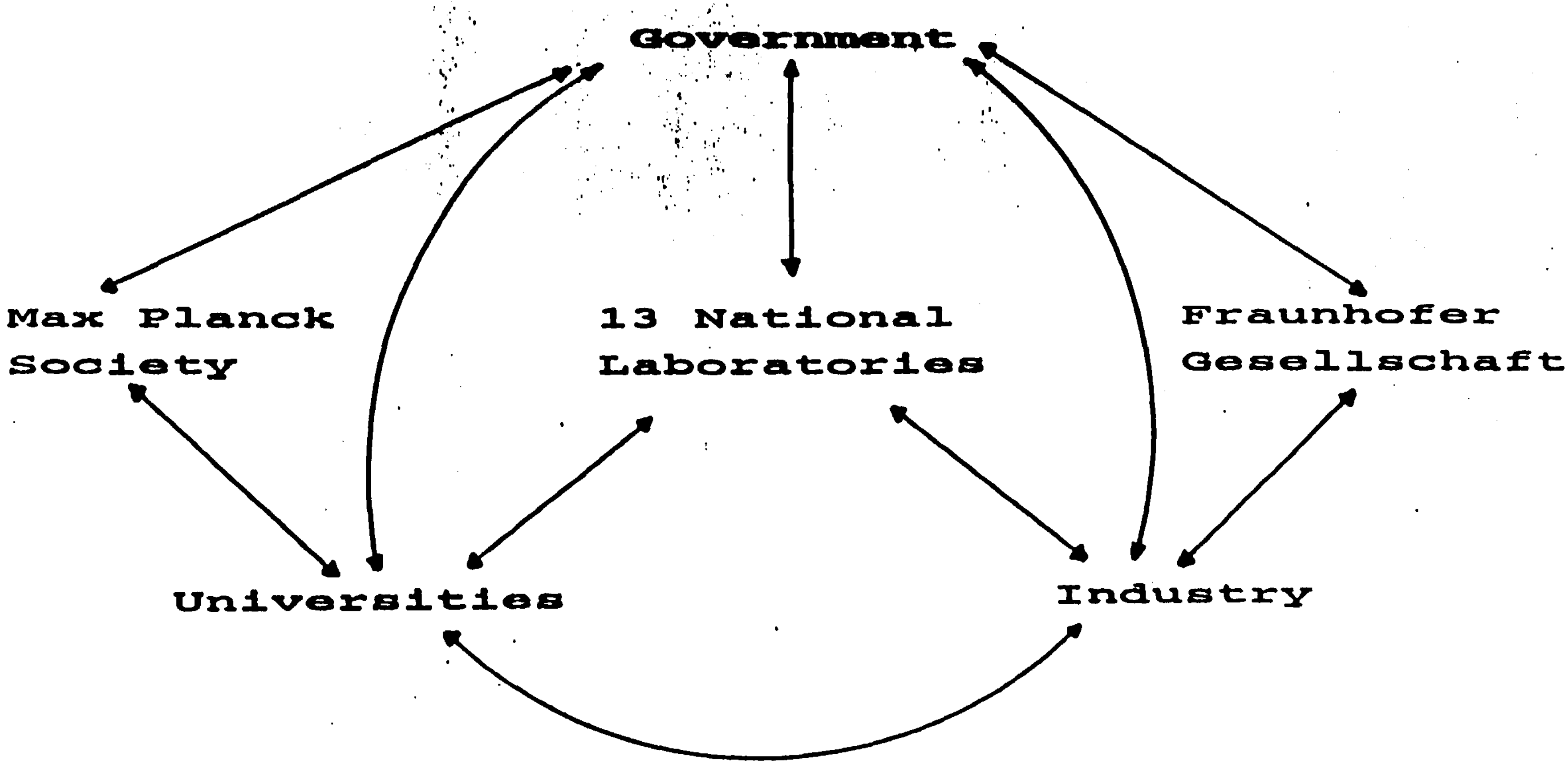


National Research Centers in the Federal Republic of Germany



AWI	Alfred Wegener-Institut für Polarforschung, Bremerhaven Alfred-Wegener Institute for Polar Research
DESY	Deutsches Elektronen-Synchrotron, Hamburg German Electron Synchrotron
DFVLR	Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Köln German Aerospace Research Establishment
DKFZ	Deutsches Krebsforschungszentrum, Heidelberg German Center for Cancer Research
GBF	Gesellschaft für Biotechnologische Forschung, Braunschweig National Research Center for Biotechnological Research
GKSS	GKSS-Forschungszentrum Geesthacht, Geesthacht GKSS-Research Center Geesthacht
GMD	Gesellschaft für Mathematik und Datenverarbeitung, Bonn National Research Center for Mathematics and Data Processing
GSF	Gesellschaft für Strahlen- und Umweltforschung, Neuherberg bei München National Research Center for Radiation and Environmental Research
GSI	Gesellschaft für Schwerionenforschung, Darmstadt National Research Center for Heavy Ion Research
HMI	Hahn-Meitner-Institut für Kernforschung Berlin Hahn-Meitner Institute for Nuclear Research
IPP	Max Planck-Institut für Plasmaphysik, Garching bei München Max Planck-Institute for Plasma Physics
KFA	Kernforschungsanlage Jülich, Jülich Nuclear Research Center Jülich

"Environment of National Laboratories (AGF)"

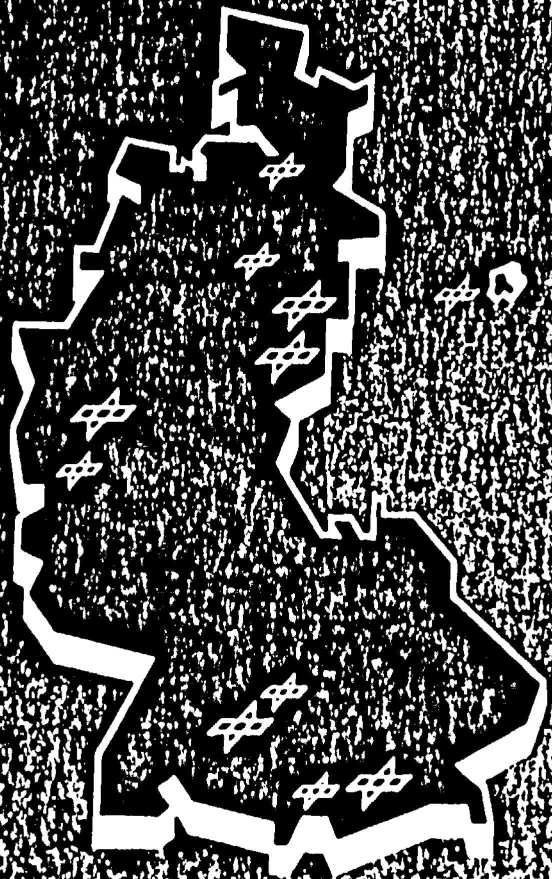


DFVLR

DFVLR Locations

5 research centers with
6 local branches:

- Braunschweig
  - Trauen
- Göttingen
  - Berlin
- Köln-Porz
  - Hamburg
  - Bonn
- Stuttgart
  - Lampoldshausen
- Oberpfaffenhofen
  - Weilheim



DFVLR
German Aerospace

Coordination of DFVLR work with external bodies

Government Departments	DFVLR	Industry
secretary	supervisory board (delegates from government, industry, science) ↔	- national associations
	executive board	- enterprises board
↔	department institute scientist	↔
officer		engineer/scientist

↕

"Scientific community"

In general: Contacts are decentralized and various; close

Institutes are independent in regard to details, subject to program developed in mutual consent.

DFVLR

Motivation of R&D transfer in general

Formal indicators

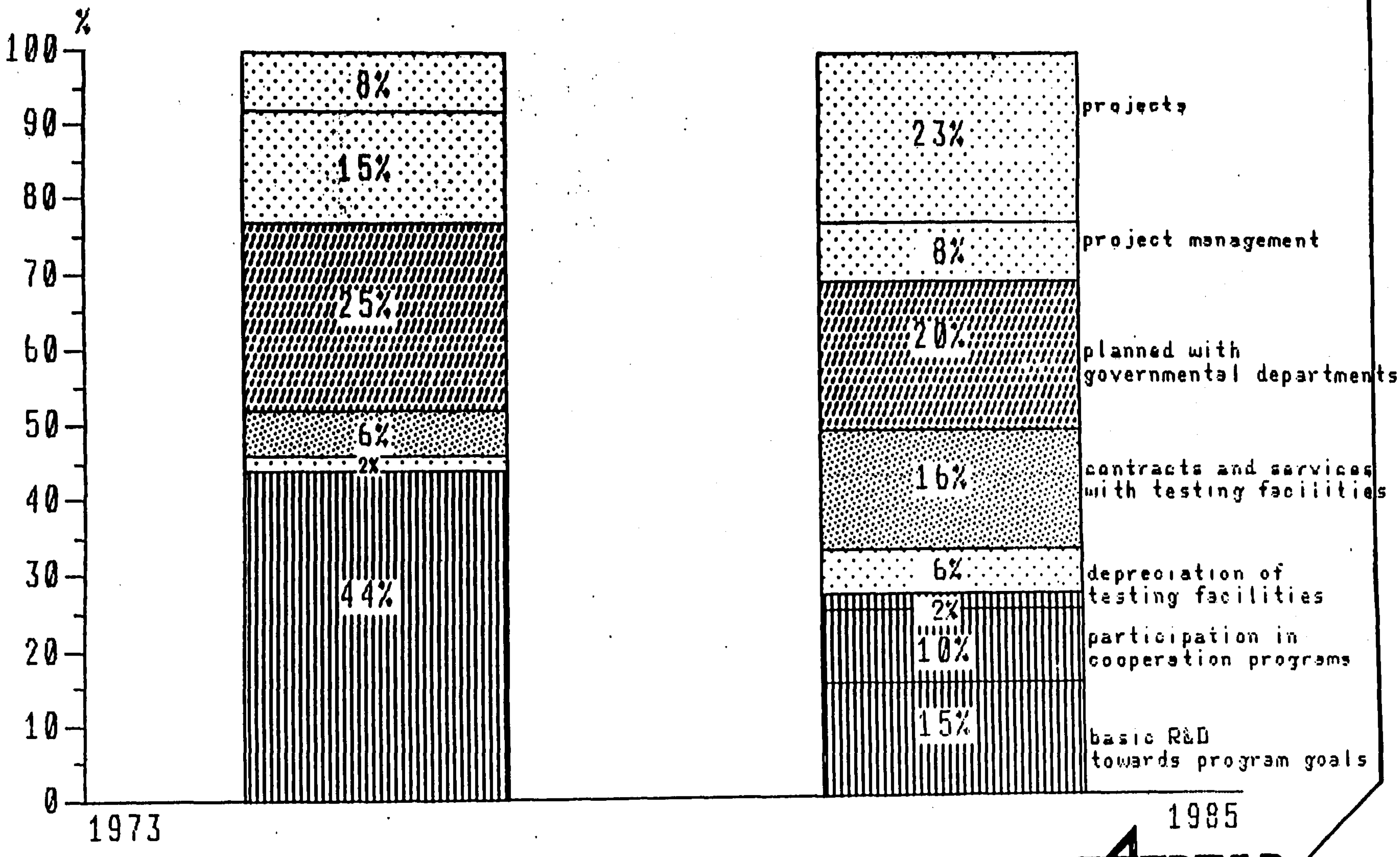
- volume of formal contracts
- volume of return *
- personnel transfer to industry

Incentives for managers

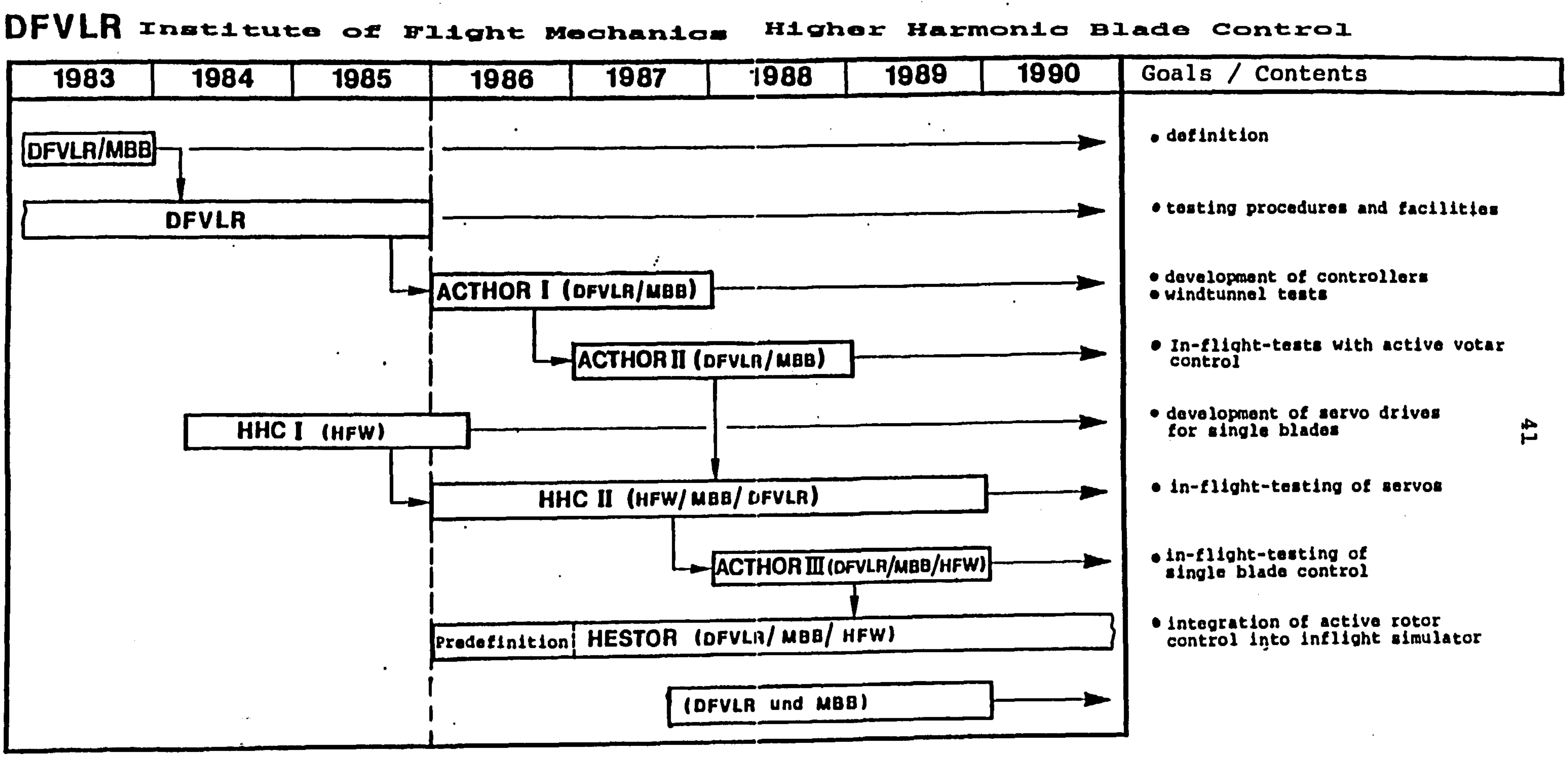
- financial budgets *) coupled to returns
- personnel *) coupled to returns
- junior scientist program

Incentives for individuals
- potential revenue from licenses
- projects of interest and personal reward

Change in split between basic R&D and pr::jects
1973 - 1985



Example of program schedule



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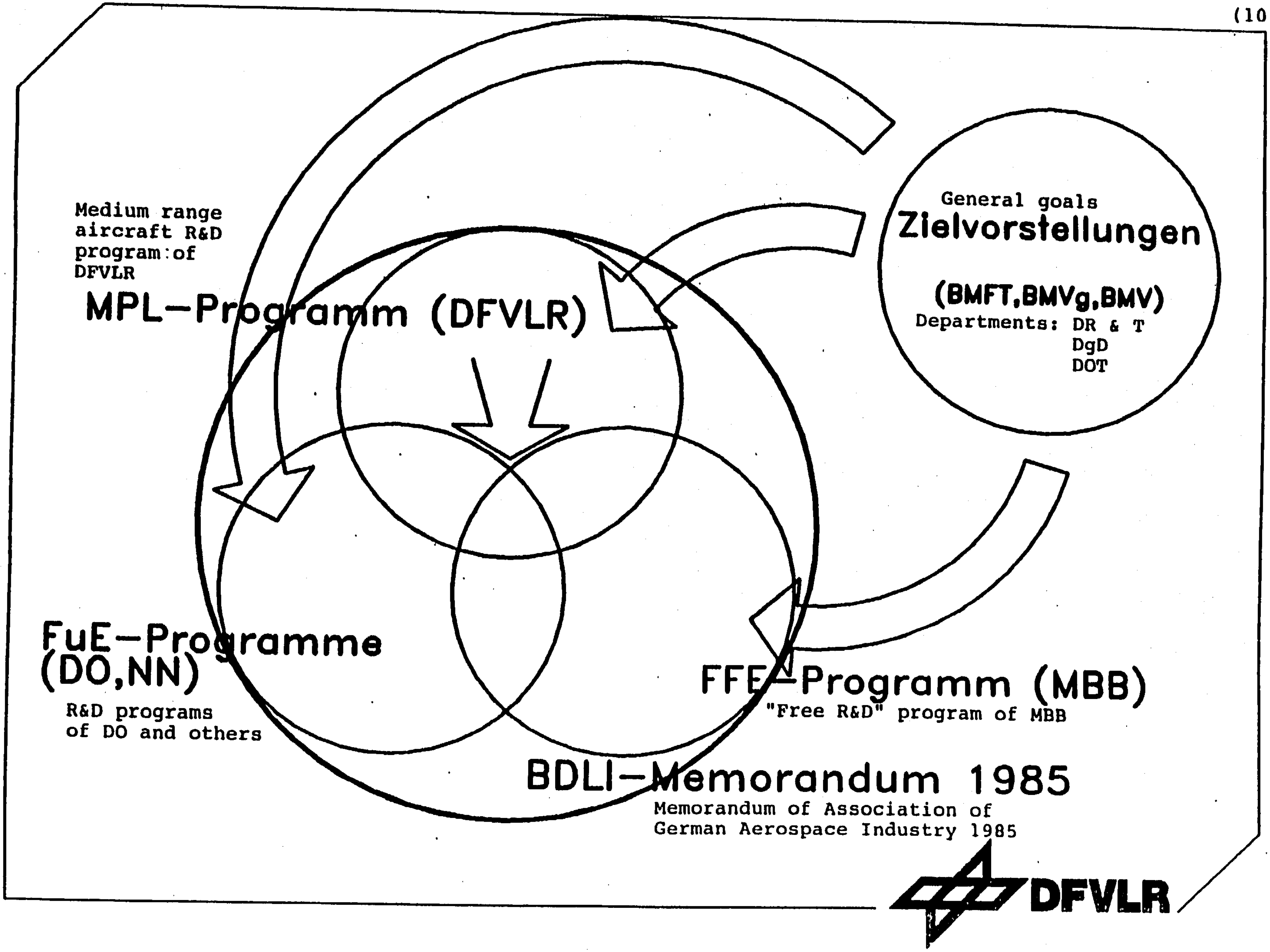
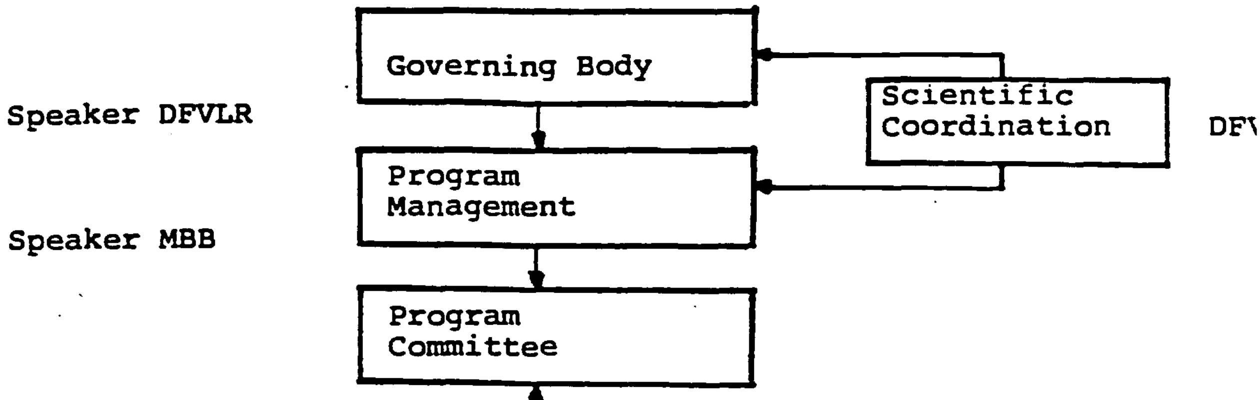


Medium range aircraft R&D program of DFVLR
MPL-Programm (DFVLR)
General goals
Zielvorstellungen
(BMFT,BMVg,BMV)
Departments: DR & T
DgD
DOT
FuE-Programme (DO,NN)
R&D programs of DO and others
FFE-Programm (MBB)
"Free R&D" program of MBB
BDLI-Memorandum 1985
Memorandum of Association of German Aerospace Industry 1985
DFVLR

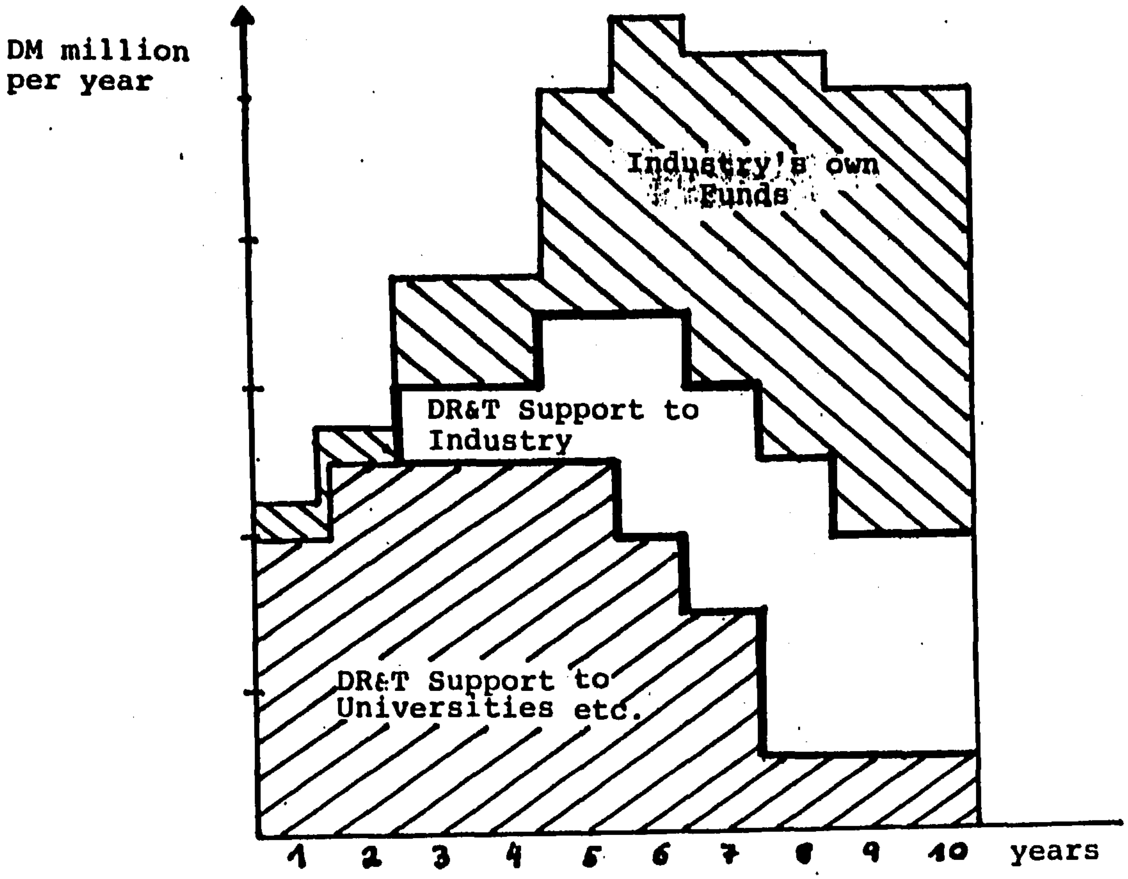
Organigram

Study Group "Flows with Separation"



"Observation
onsultation")

Project Groups / Expert Groups	High Aspect Ratio Wings	Low Aspect Ratio Wings	Rotary Wings	Blunt Bodies/ Fuselages	Laminari- zation of Wing Flows
Physical Base					
Mathematical Base					
Numerical Simulation					
Measurement Engineering					
Facilities					



Funding Flow Chart of a "Joint Research Project" (Example)

DFVLR

DFVLR partners

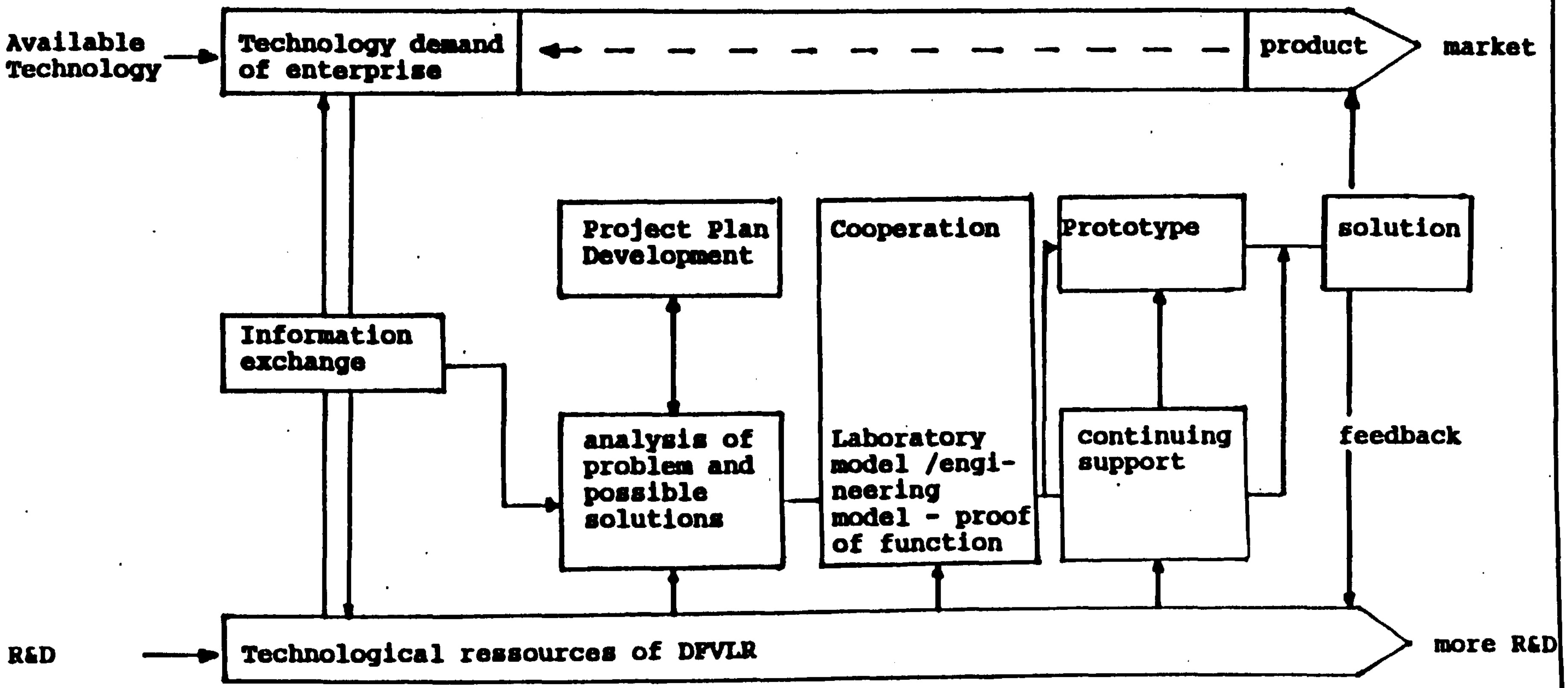
	national	international
Industry	200	50
other (universities, scientific institutions of all kinds etc.)	180	170
Total	380	220

30 % of national partners are enterprises of up to 1000 employees.

50 % of relations with industrial partners are formal contracts/cooperative agreements, partly based on patented know-how.

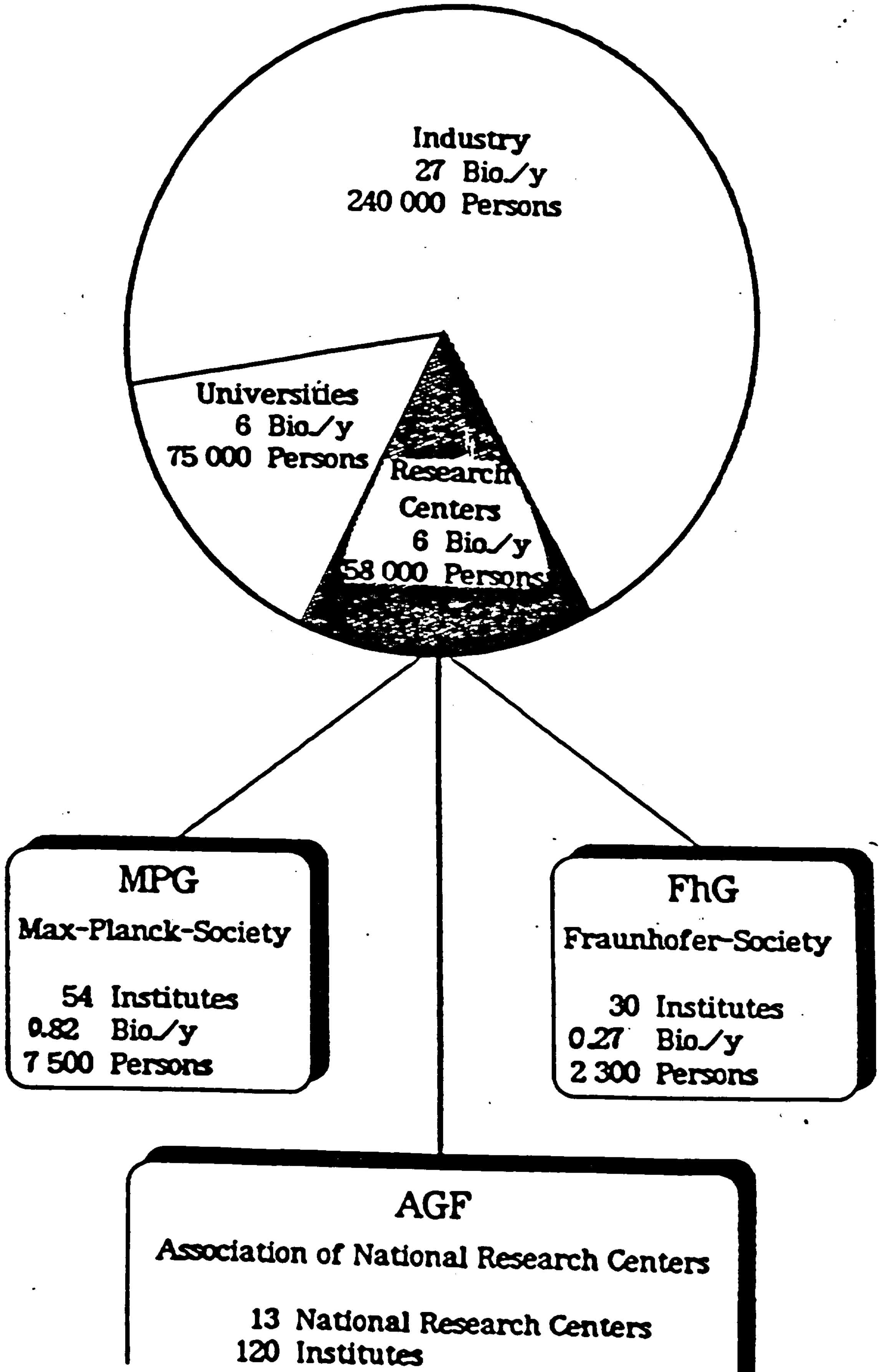
DFVLR

STEPS OF R&D TRANSFER AT DFVLR



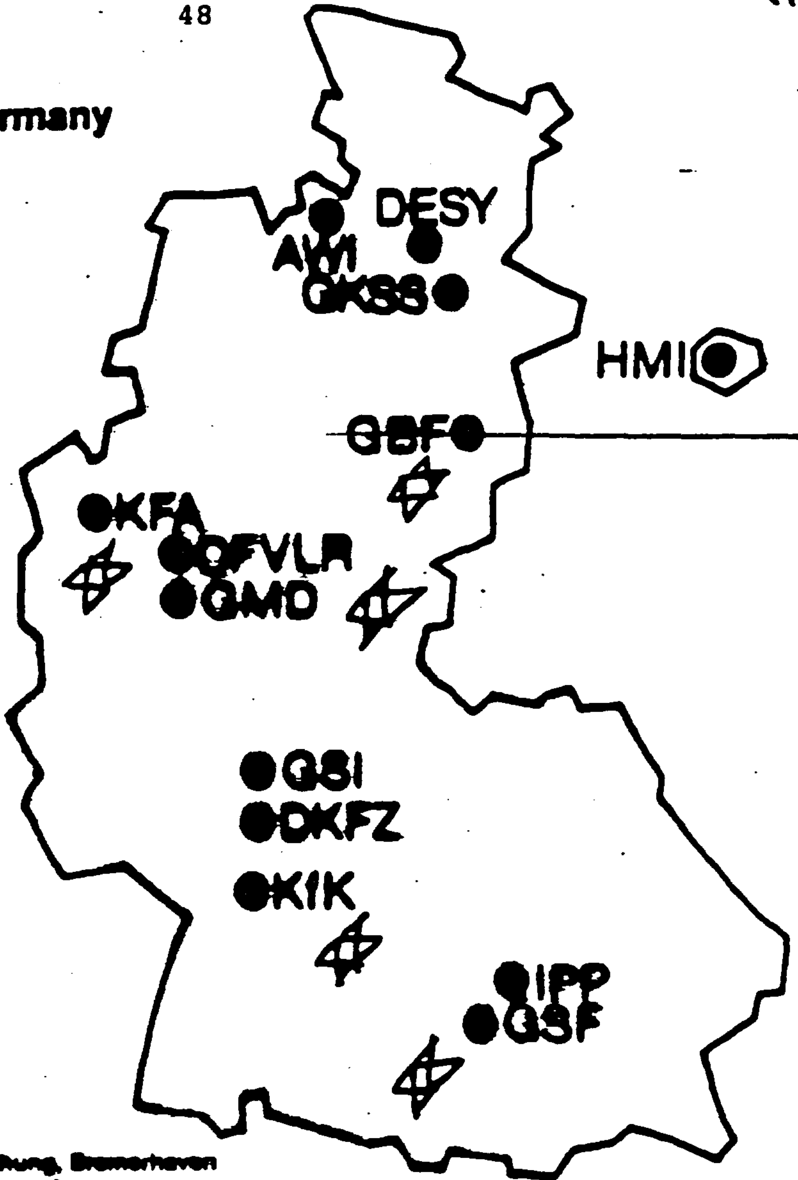
DFVLR

Research in the Federal Republic of Germany



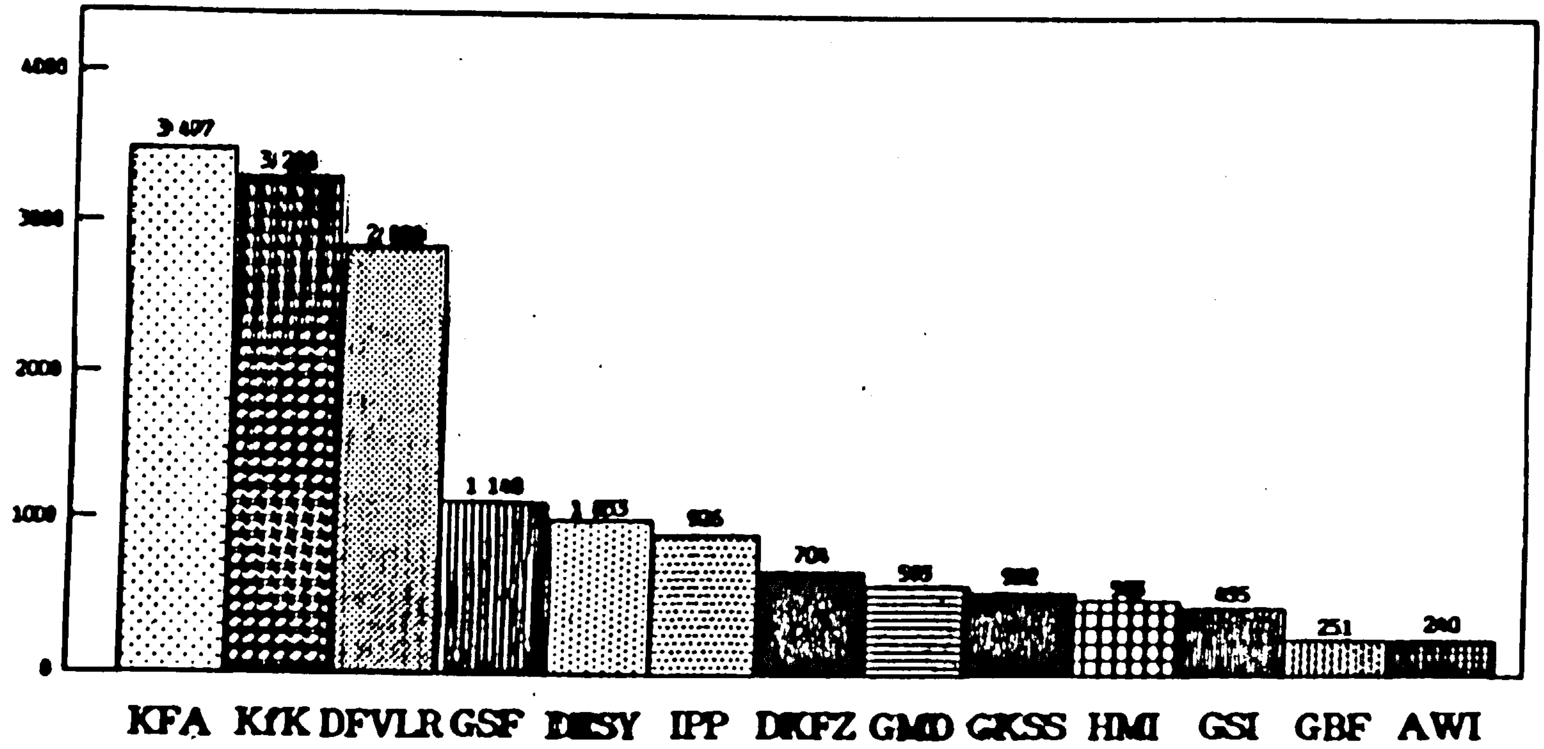
(16)

National Research Centers in the Federal Republic of Germany

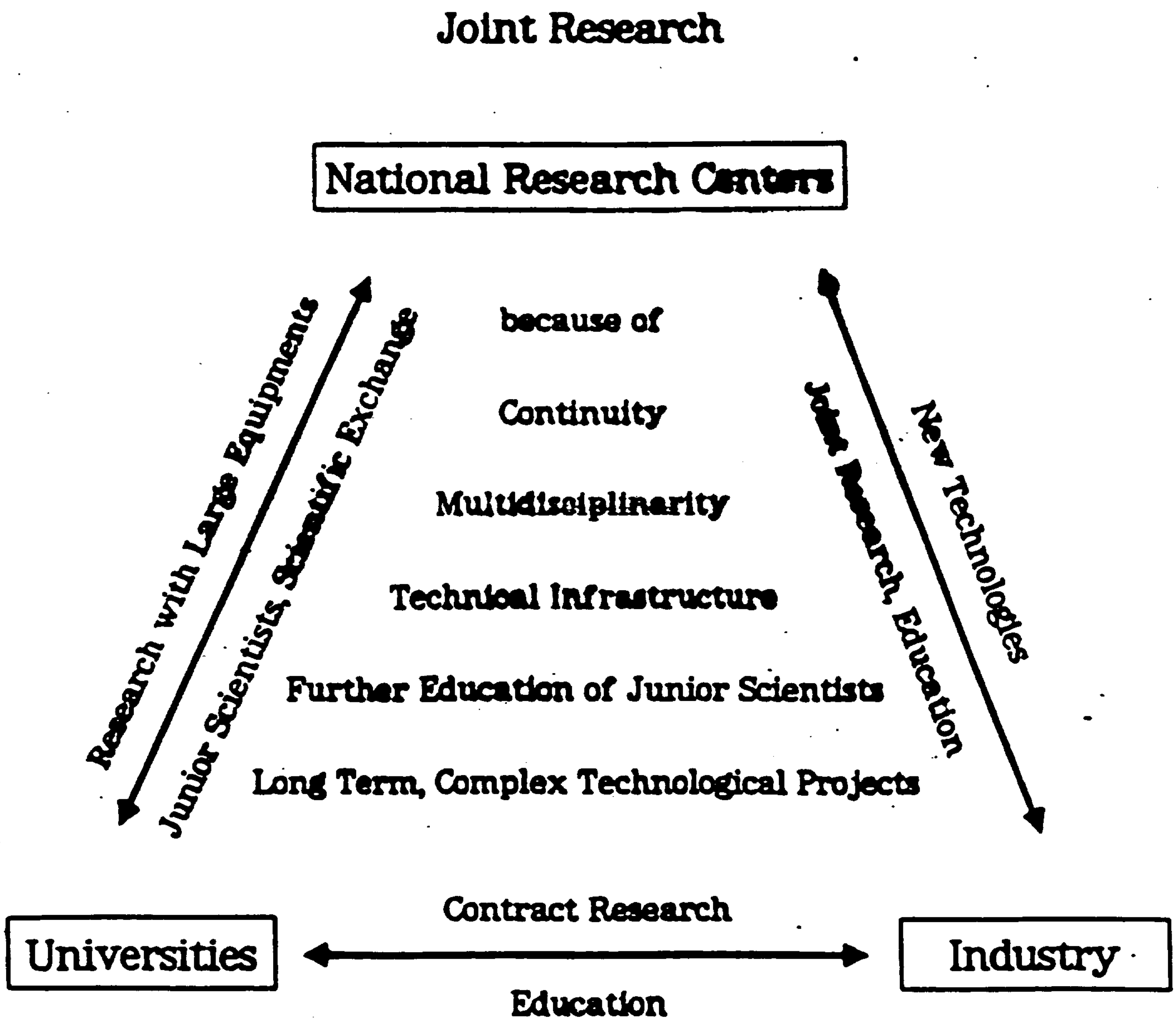


AWI	Alfred Wegener-Institut für Polarforschung, Bremerhaven Alfred-Wegener Institute for Polar Research
DESY	Deutsches Elektronen-Synchrotron, Hamburg German Electron Synchrotron
DFVLR	Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Köln German Aerospace Research Establishment
DKFZ	Deutsches Krebsforschungszentrum, Heidelberg German Center for Cancer Research
GBF	Gesellschaft für Biotechnologische Forschung, Braunschweig National Research Center for Biotechnological Research
GKSS	GKSS-Forschungszentrum Geesthacht, Geesthacht GKSS-Research Center Geesthacht
GMD	Gesellschaft für Mathematik und Datenverarbeitung, Bonn National Research Center for Mathematics and Data Processing
GSF	Gesellschaft für Strahlen- und Umweltforschung, Neuherberg bei München National Research Center for Radiation and Environmental Research
GSI	Gesellschaft für Schwerionenforschung, Darmstadt National Research Center for Heavy Ion Research
HMI	Hahn-Meitner-Institut für Kernforschung Berlin Hahn-Meitner Institute for Nuclear Research
IPP	Max Planck-Institut für Plasmaphysik, Garching bei München Max Planck-Institute for Plasma Physics
KFA	Kernforschungsanlage Jülich, Jülich Nuclear Research Center Jülich

National Research Centers: Number of Employees in



Triangle of Cooperation



Essentials of National Research Centers

1. **Tasks**

In National Science and Engineering

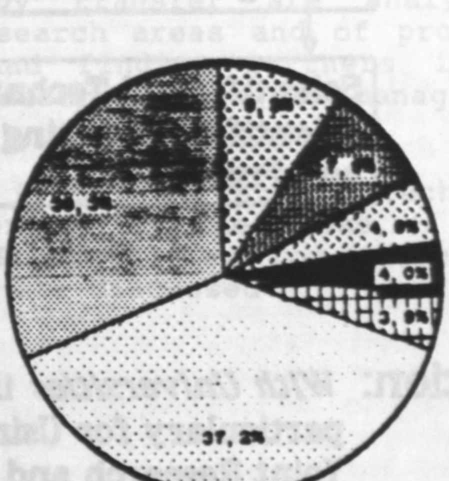
Technological Projects
Program Research
Basic Research in Specific Areas
Development, Construction and Operation of Large Equipments
Long Term, Risky, Public Interest

2. **Infrastructure**

Well Developed and Specialized for Complex Tasks

Accelerators
Research Reactors
Wind Channels
Rocket Testing Devices
Animal Labs Biotechnological Devices
Special Maintenance Facilities

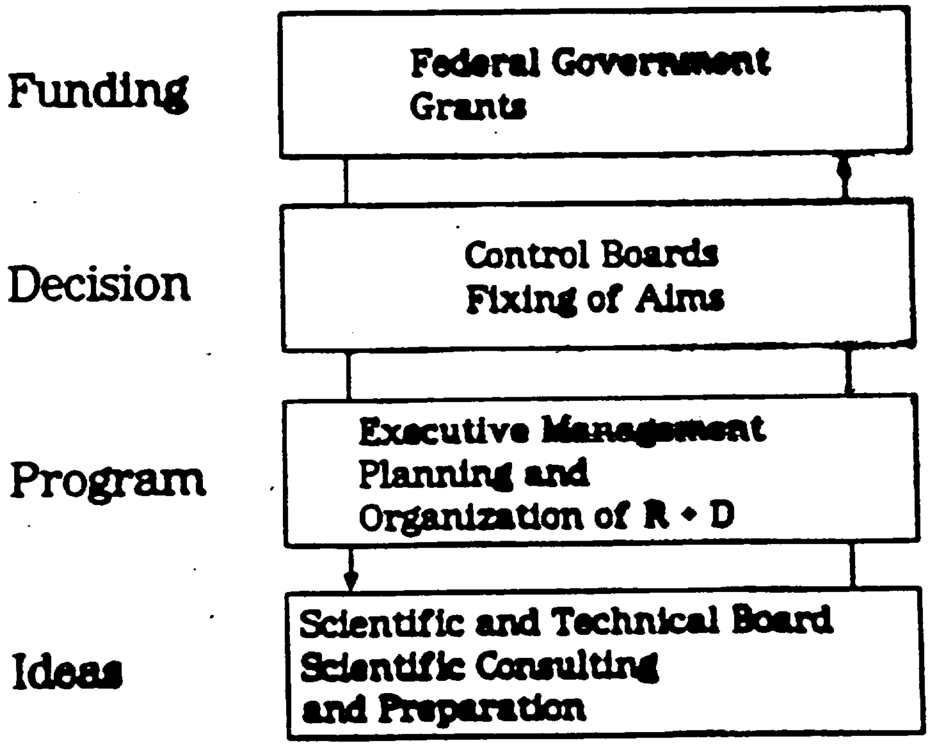
3. **Interdisciplinarity**



164 other academic professions
155 Biologists, Zoologists, Agriculturalists, Botanists
198 Lawyers, Economists, Management Scientists
316 Mathematicians, Computer Scientists
363 Chemists
1 209 Engineers
1 484 Physicists

Essentials of National Research Centers

Research Planning: Global Steering and Principle of Reverse Current



Cooperation: *With Universities* in Basic Research particulary for Using the Large Equipments Yoint Research and Education.

With Industry on big Technological Projects and by Technology-Transfer

GERMAN/CANADIAN WORKSHOP
DECEMBER 2,3,4, 1986
UNIVERSITY OF WATERLOO

COMMERCIALIZATION OF THE RESULTS OF PUBLICLY FUNDED RESEARCH

A B S T R A C T

Dr. J. Wüst (Germany)

The Tools of Technology Transfer in National Research Centres as illustrated by the example of the Karlsruhe Nuclear Research Centre.

The contribution to the first Canadian-German symposium contained a brief description of the history of the national research centres, their cooperation with industry, and the present situation of intensified technology transfer, especially also to small and medium sized firms. The basic approaches used in transferring technology to industry were discussed.

The contribution is a more detailed description of the tools of technology transfer used in practice and an evaluation of the success achieved and the problems encountered. The four major areas of technology transfer are analyzed: development of industry-related research areas and of project ideas; marketing research results and finding partners in industry; ways of cooperation with industries; project management and problems of organization.

Examples are given from a variety of technical fields together with a general overview of the areas of activity of national research centers. Possibilities for cooperation among Canadian and German partners are discussed.

Tools of Technology Transfer in National Research Centers as Described by the Example of the Karlsruhe Nuclear Research Center

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This description of the technology transfer activities of the Karlsruhe Nuclear Research Center is a sequel to my paper presented at the first Canadian-German Workshop in Berlin. On that occasion, I gave an account of the historic development of the German national research centers and their cooperation with big industries and of the present situation of increased technology transfer, especially also to small and medium-sized enterprises.

My report today will contain a more detailed description of the practical approaches used as well as an evaluation of the success and the problems encountered in practice. Let me begin by outlining the general scenario of technology transfer with all its fundamental possibilities.

The Technology Transfer Scenario of German National Research Centers

Fig. 1 shows the scenario of technology transfer activities, subdivided into sources of technology, types of technology packages to be transferred, methods of transfer, and target groups. "Technology" in this connection generally means the knowledge associated with the design, construction and operation of scientific and technical systems. This knowledge is generated in the R&D program as part of a main activity set up autonomously by the national research centers. Also the results of plant operation constitute an important source of technology. In addition, there are training programs disseminating knowledge about methods and facts. All these areas of activity are long-term programs. In order to be able to transfer technology to industry as quickly as possible, which is particularly important in cooperation with small and medium-sized enterprises, we concentrate on the spinoff field in this connection. This allows us to handle all sorts of projects without any technical or scientific constraints and, to a certain extent, also free from the bureaucratic restrictions normally encountered in large-scale programs. I will come back to that point later. As is shown in Fig. 1, technology is transmitted as a technical system, in the heads of the staff, or in other types of information. The method of transfer is based on various contractual formats, from cooperation agreements up to, very important, informal contacts established to initiate communication between a research center and industry on the broadest possible scale. The "classical" method of documentation and publication of the results for the benefit of users is no longer sufficient in our era of short innovation cycles of industrial products. In most cases, we cooperate with partners on the basis of exclusive contracts. Most of our partners are small and medium-sized enterprises; the size distribution is shown in Fig. 2. However, also cooperation with big industries is necessary, because there are developments which cannot be commercialized by working with small firms. Cases in point are the development of superconductors for high-field magnets, topics of complex technology transfer projects executed outside the R&D program. Target groups of technology transfer, other than industries, may be the public sector or the research sector.

A technology transfer program for the specific exploitation of spinoffs as an independent main activity is a special model case in national research in the Federal Republic of Germany, which exists only at the Karlsruhe Nuclear Research Center. Incidentally, it should be added that each of the 13 German national research centers has its own history and specific activities. It is not easy, therefore, to describe in general terms the technology transfer from big science research in the Federal Republic of Germany. All German national research centers have in common that they have greatly expanded their cooperation with industry over the past few years, most of them quite successfully. Yet, there are specific differences between the national research centers more involved in basic scientific research and those more engaged in technical application and product design.

The Karlsruhe technology transfer program for spinoff development is to make available to industry all facilities of the research center while, at the same time, drawing a clear dividing line to the R&D program in order to maintain the freedom in defining those research and development activities as far as possible. Yet, there are major repercussions on the R&D program of the technology transfer program, which may even lead to the initiation of new major R&D activities as a consequence of information fed back from industry. Fig. 3 shows these flows of information resulting especially from specific cooperation agreements with industries of any size and also in a broad upstream technical or scientific discipline. This situation is desirable especially in the national research centers working in the nuclear field, as those centers are undergoing a change of duties as a result of many nuclear programs in the Federal Republic of Germany being phased out. This situation implies a number of advantages, by releasing capacities, as well as disadvantages, for management must be afraid of the newly won capacities being either split off or subjected to excessive inroads by industry.

Cooperation with Small and Medium-sized Enterprises

The technology transfer program for small and medium-sized enterprises also opens up projects on a smaller scale and extending over a medium term. This is shown in Fig. 4. The smaller the technology packages to be transferred, the smaller will also be the partner company, and the greater must be the internal flexibility of the respective research center. This must be taken into account in the contractual formats of cooperation shown in Fig. 4, which range from joint companies founded with industry, whenever large systems are involved, up to smaller research or consulting contracts.

Let me briefly comment on the importance of contract research. In the Federal Republic of Germany there are special contract research institutions, such as the Fraunhofer-Gesellschaft, which is only partly financed by the state, or the Battelle Institute, which exists on contract research financed by industry. As cooperation between the national research centers and industry is being expanded on the basis of contract research, this involves the danger of creating competition with those institutes, thus limiting their possibilities. It is for this reason that we carry out contract research only if specific know-how exists at the Karlsruhe Nuclear Research Center which is not available at those institutions.

Division of Labor between the German National Research Centers and the other Research Institutes in the Federal Republic of Germany

On the basis of their specific capabilities, the national research centers (Fig. 5) handle long-term, complex research and development projects of supraregional and overriding economic importance, respectively, which are associated with major technical and economic risks. These projects involve high expenditures for planning and management and, as a rule, also require interdisciplinary cooperation. For our smaller technology transfer projects we make use of those characteristics while, at the same time, adapting them to the needs of small and medium-sized enterprises.

The Max-Planck-Gesellschaft devotes its activities mainly to fundamental research. The Fraunhofer-Gesellschaft conducts applied research, especially on behalf of third parties. The research institutions run by the federal government and the state governments were created to support the objectives pursued by specific ministries.

Research at the universities is conducted on the basis of the principle of unity of research and teaching. Teaching and scientific aspects are the main priorities. As far as technology transfer is concerned, the universities often suffer from lack of funds for research, from being split up into too many small institutes, from administrative problems in running projects with industry which exceed the framework of one institute (which is the rule in the present high-tech era), and they also suffer because of their fundamental research-orientedness and remoteness from industry, respectively.

Industrial firms handle their own research and development projects associated with less risk and serving to develop new products and new technologies for in-house fabrication and also to improve current industrial fabrication processes.

These definitions show the specific position of the national research centers. They cooperate closely with the other institutions, especially the universities and extra-university research establishments. A number of scientists at the national research centers at the same time hold professorships at universities. Reasonable division of labor can produce synergistic effects in this complementary R&D association. We also try to exploit the possibilities of this network of cooperation for the benefit of specific projects in our technology transfer program at Karlsruhe. In our opinion, the national research centers play a special role in transferring technology to industry in our present age of complex, interconnected technologies. The systemic approaches and the global contacts existing at the national research centers not only allow comprehensive support to be given to industry, but also (as we have learned particularly in the fields of nuclear technology and environmental technology) can bridge the chasms between the natural sciences and the humanities. Only if the obvious dichotomy of these two sectors in our society is overcome by an integrating approach it will be possible to have a healthy technical development.

The characteristics of the national research centers also qualify them for international cooperation, a topic of special interest at this workshop. International connections are a sound basis for this cooperation; the national research centers of the Federal Republic of Germany cooperate with some 1000 research institutions all over the world. As one example I would like to show the network of connections existing in our Karlsruhe development of the fast breeder reactor (Fig. 6).

Duties and Organization of the Technology Transfer Program of the Karlsruhe Nuclear Research Center (KfK)

The responsibility for the execution of the technology transfer program lies with the Technology Transfer Coordination Unit, a staff department directly reporting to the Chief Executive Officer (Fig. 7). The four main activities of that unit are shown in Fig. 8. It is the central point of contact for industry looking for problem solutions at KfK. Its specific activities are these:

- Finding and developing project ideas.
- Finding partners in industry.
- Working out contracts with partners in industry.
- Project management.

In discharging these duties, the unit cooperates closely with the existing administrative departments: Patents and Licenses (one of the purposes of the technology transfer program is to generate as many joint patents as possible with the industrial partners), Sales (services and contract research), Public Relations (general marketing). These activities are largely identical with those of a "product" responsibility in most large firms, working in product development, marketing and sales.

"Product-related" research areas are identified or expanded as a basis for technology transfer projects at Karlsruhe (Fig. 9). These lines of research, which are already quite close to industry without, so far, having been covered under specific agreements, constitute the best basis for specific projects to be executed quickly.

If one traces the route of an innovation from the basic idea up to commercial placement of a new product or process, as shown in Fig. 10, one finds in the width of the dark form in this figure the type of technical and administrative activities within the technology transfer projects. It is mainly prototypes which are built and demonstrated in cooperation with industrial partners. In line with the possibilities available to a national research center, work may also extend into fundamental research, where those ideas are developed further, either in cooperation with other partners, but sometimes also without any partners, which have a sufficiently high probability of leading to specific products. One important point is the willingness of a research institution to see a development through the marketing stage in order to broaden the possible uses, e.g., by application programs conducted in cooperation with the first few customers, and thus enable the commercial partners to quickly enlarge their markets. This close interaction with the market is particularly necessary in the light of today's short product life cycles. Continuous interaction with the market is necessary and should even extend back to the possibility to quickly work out fundamental problems, should they arise.

Project teams work on projects (Fig. 11) with the special objective to get a development as smoothly as possible over the threshold between the research institution and an industrial firm. This requires highly flexible personnel able to develop projects to a level of maturity which allows the respective partner to market it with his own forces as quickly as possible. Scientists often do not accept this role of merely rendering contributory services. The teams working on such projects are best composed of staff members with the appropriate managerial skills, often mixed with members of the partner firms. Inventor remunerations are paid for patents and also for know-how in order to boost motivation. Unfortunately, the pay scheme in public service does not allow us to pay adequately for the higher performance of the staff members cooperating with industry, which, we feel, would be very necessary. Although the government is prepared to improve the situation, not very much has so far happened in practice.

Examples of Technology Transfer Projects

The areas of activity of KfK are shown in Fig. 12. They range from nuclear technology as the original field of work (at present represented in the R&D program to the tune of some 50%) to more recent topics, such as microengineering for the fabrication of micromechanical structures by means of X-ray depth lithography.

Let me, by a way of example, quote the "SPECTRAN" process photometer family. Roughly ten years ago, the first patents were applied for as a result of work on the development of measuring equipment to be used in assaying for traces of special gases for a method of uranium enrichment. The partner in that case was, and still is, a firm which, at that time, had problems with its original line of products. Cooperation initially was focused on new technical systems, which should be patentable as far as possible and should be applicable in process measurement for assaying for traces of liquids and gases and in environmental applications for emission control and work station checkups. After the basic systems had been developed in the first few years, most of the activities were focused on application work meant to demonstrate to process industries (such as large chemical firms or power plants) various possibilities of application. A whole family of equipment gradually evolved. In addition, so much know-how in the field of this measuring technology was generated at the Nuclear Research Center that we are now able to set up our own technology transfer laboratory in this field of measurement in order to exploit various spinoff ideas. This technology transfer laboratory is to report directly to the Technology Transfer Coordination Unit, which would mean that it would also have technical responsibility as a development department in addition to its coordination functions. Like all technology transfer work, this is also very much tailored to the persons involved and will be built up around staff members with the appropriate commercial leanings.

While this family of measuring gear is an example of an activity very closely related to industry and to the market, I would like to discuss fundamental research in the next example which, at the same time, involves specific products. I am talking about a fundamental activity devoted to the development of amorphous materials, so-called amorphous metals, as new materials. Because of their specific properties (such as hardness, magnetic properties, thermal conductivity, wear resistance), many applications are foreseen for these materials. For this reason we, together with a partner, are trying to develop an economic method of producing forms out of these bulk materials. In order to be able to make new products available to the partner as early as possible, a program of laboratory equipment for investigating amorphous materials, so-called melt-spinning apparatus, has been established. At the same time, through their contacts with the United States of America, our scientists are supporting the setup of a distribution agency for North America to enable the partner company to distribute a new product line worldwide already at the present state of development. This has been made possible by our contacts with research institutions in USA.

Another example of our cooperation with the Karlsruhe Technology Park as a breeding ground of new enterprises is a fault detection system for pipelines. A company developing such an "intelligent pig" was founded at Karlsruhe. The unit detects cracks and corroded spots inside pipelines. On the basis of our knowledge of materials development for nuclear applications and our capabilities in the fields of complex electronics and sensing systems, together with the operating experience of the partner firm, a prototype was developed in just two years, which is currently being tested in cooperation with a pipeline operator. I would like to draw your attention to one method at this point, which allows fast commercialization. We include some first customers and users in a cooperative scheme as early as possible with the consequence that the application know-how directs development in the appropriate directions. Often, development projects are fraught with the problem of being completed without any contacts to customers and, when they are to be marketed, suddenly develop operational problems. The triangular cooperation of the first user - partner company for development and marketing - research institution has been most helpful in this respect. Such first users can often be called in, sometimes also with financial contributions, if they are highly interested in a solution to a problem and in a product for which no vendor had existed before.

These examples allow me to draw attention to the importance of regional cooperation in order to achieve synergistic effects.

Regional Cooperation

Fig. 13 shows the cooperation of the Karlsruhe Nuclear Research Center with industry and other research institutions in the Karlsruhe region. Here we see our Nuclear Research Center as a technology pole which, thanks to its communication links with other institutions in the region and beyond, allows developments to be launched which can only be carried out by division of labor in an integrated system. Of course, this does not mean that developments originating from universities, the Fraunhofer-Gesellschaft, the polytechnical schools (Steinbeis Foundation) must always be processed through a national research center. What it means is continuous, daily, close communication for the common development of ideas, especially together with local industries, in order to get complex products into practical application as quickly as possible. For the same reason we have established expert discussions, also beyond the Karlsruhe region, for which some 200 guests from all these institutions and our Research Center meet roughly once every six months in order to maintain contacts in certain areas. Even more important is the fact that "the doors are open" in all institutes every day, thus allowing private talks to be organized.

Thanks to its geographic location in the central Upper Rhine region, close to the French border, the Karlsruhe region is a natural place for launching important schemes of cooperation across the borders, which is one of the objectives of the European Community. Also associations with the municipal authorities, the state ministries at Stuttgart, the capital of the state of Baden-Württemberg, and the Association of German National Research Centers (AGF) in Bonn are being intensified. In the same connection, participation in the funding programs of the European Communities is important to note.

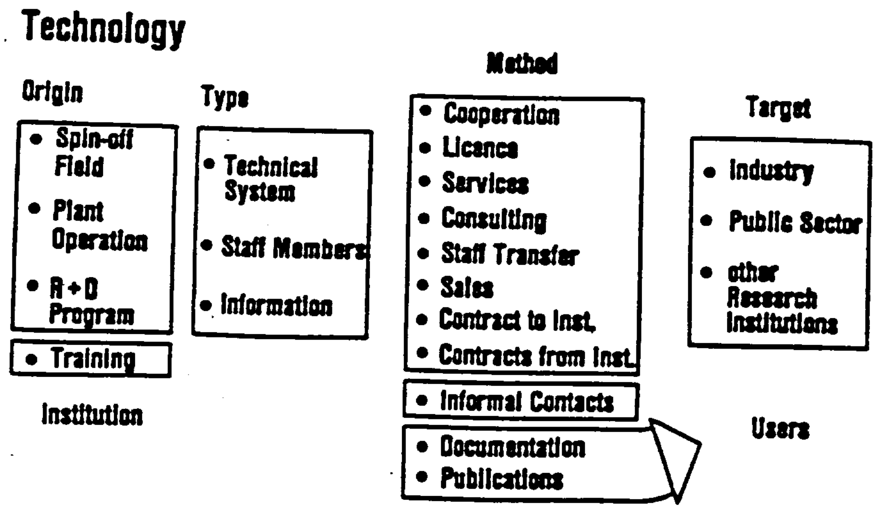


Fig. 1 Technology transfer paths

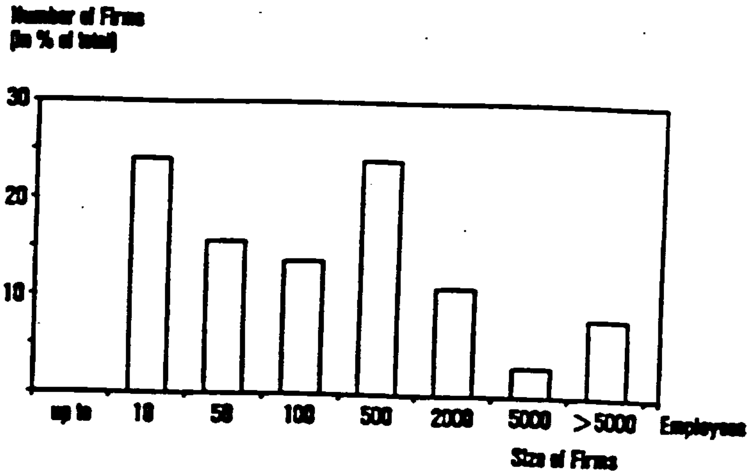


Fig. 2 Industrial partners in the KfK TT-Programme

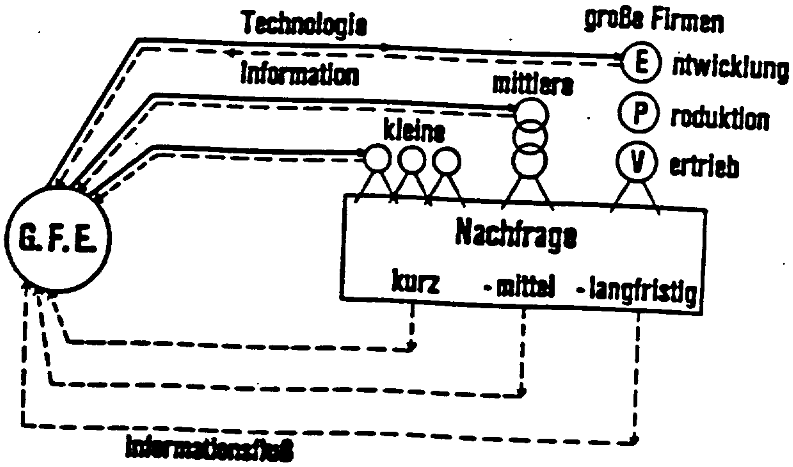


Fig. 3 Communication of a national research centre with industry and the market

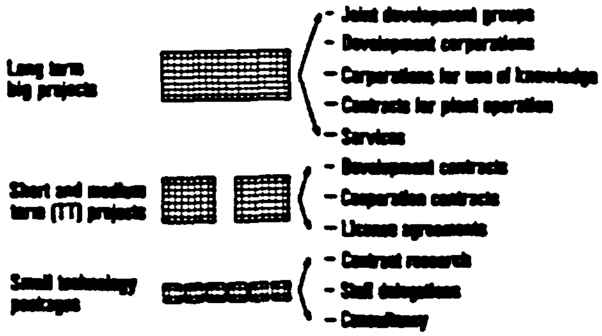


Fig. 4 Projects and types of cooperation between KfK and industry

- Thinking in systems and cosmopolitan attitude
- Interlinking with many national and international research institutes
- Capability of cooperating with national industry and medium sized firms
- Network of national research establishments (AGF)
- From basic research to prototypes
- Technical-scientific multidisciplinarity
- Technology poles in the regional ambient

Fig. 5 Specific advantages offered by national research establishments

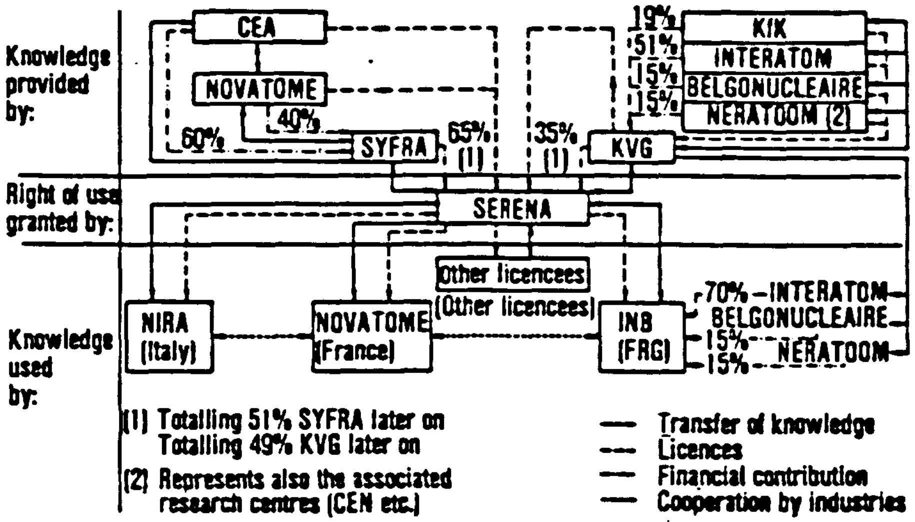


Fig. 6 Fast breeder reactor cooperation in Europe (without GB)

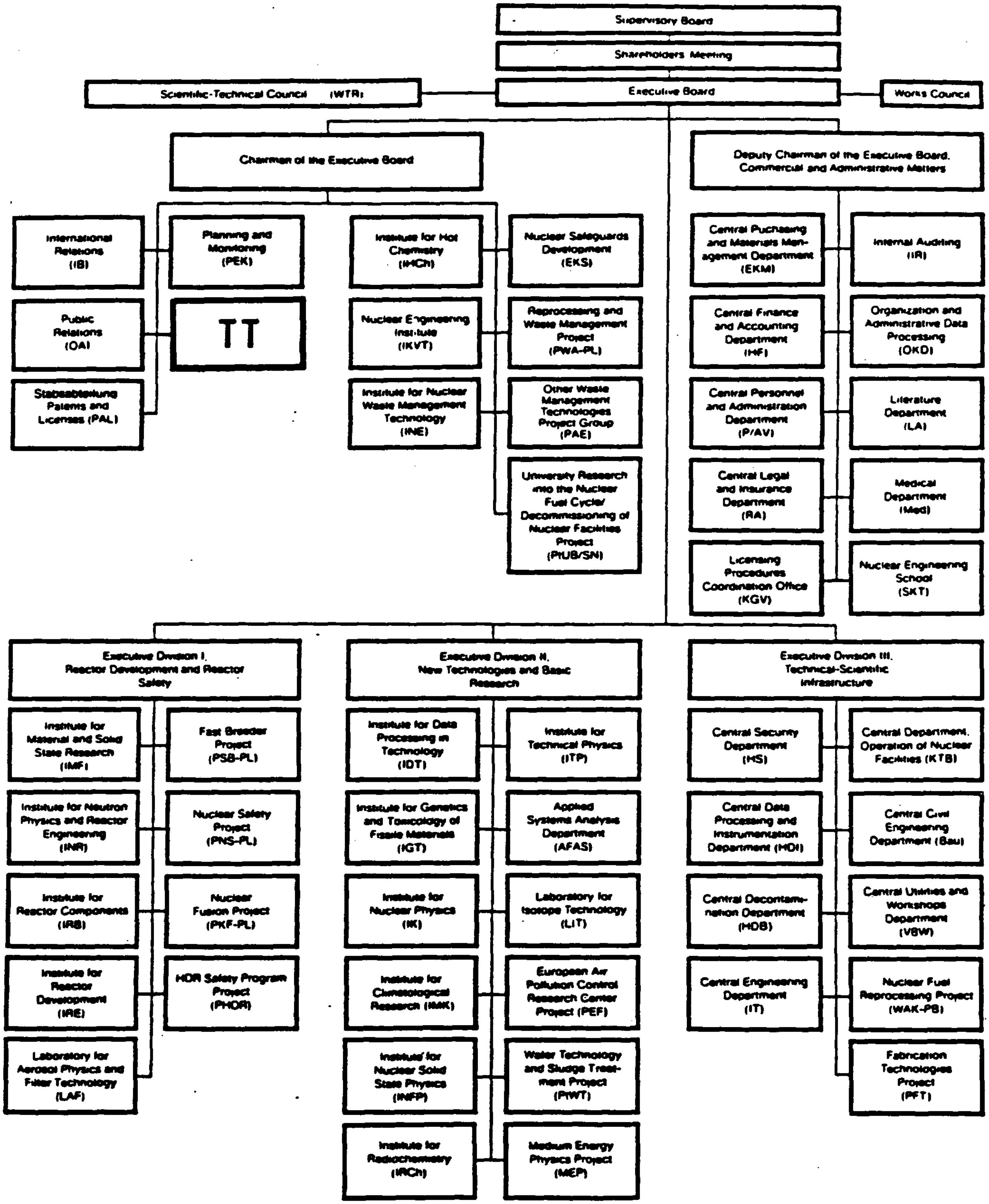
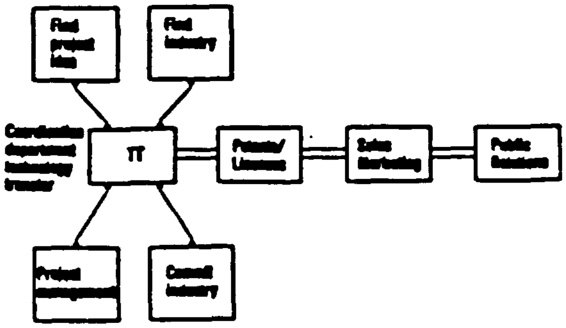
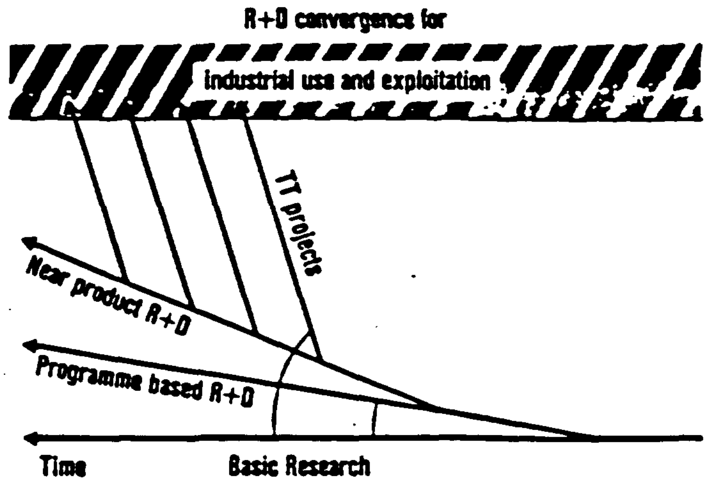


Fig. 7 Organizational structure



<u>Fig. 8</u> TT tasks and KfK departments involved



<u>Fig. 9</u> R + D convergence for industrial use and exploitation

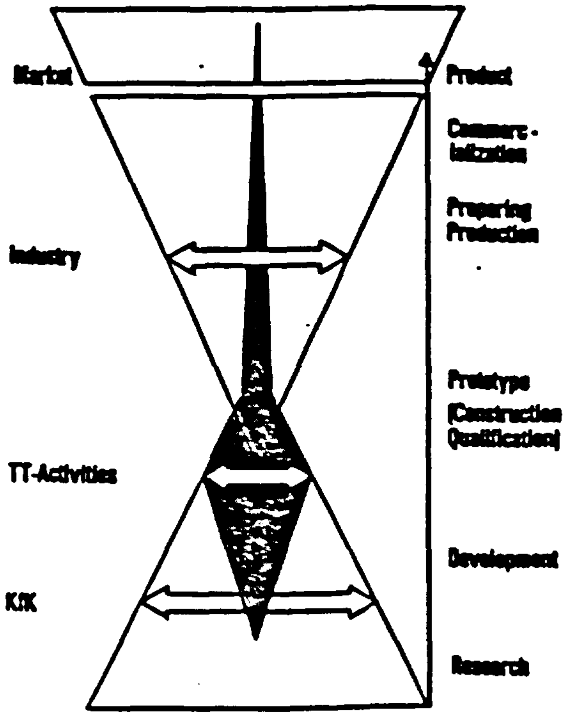


Fig. 10 Scheme of technology transfer

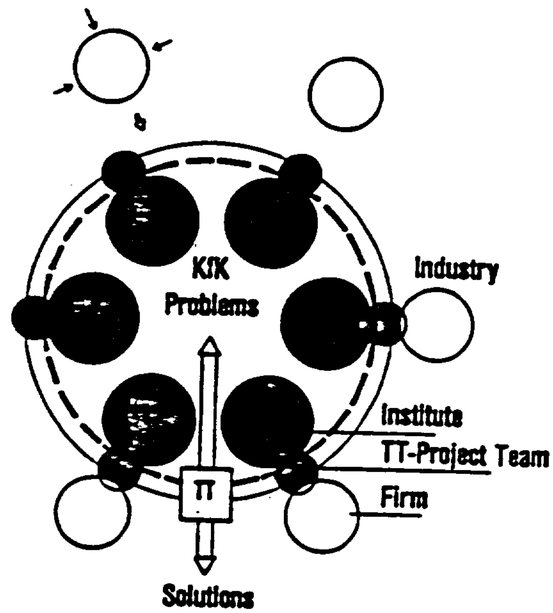


Fig. 11 TT cooperation KfK - industry

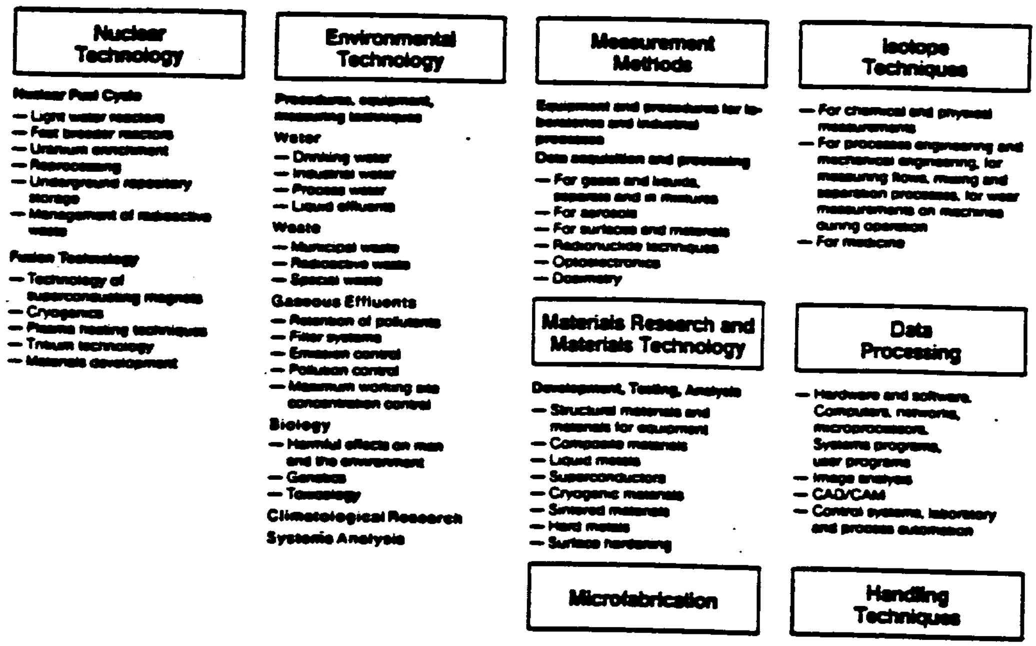


Fig. 12 Scientific and technical keypoints of KfK as sources of spin-off projects

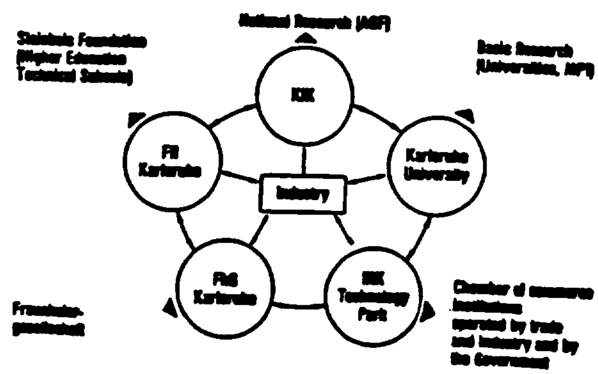


Fig. 13 New technologies by regional cooperation (technology poles)

GERMAN/CANADIAN WORKSHOP
DECEMBER 2-4, 1986
UNIVERSITY OF WATERLOO

TECHNOLOGY TRANSFER AT THE CANADA CENTRE FOR MINERAL AND ENERGY TECHNOLOGY

J.Kuryllowicz
Director, Office of Technology Transfer
Canada Centre for Mineral and Energy Technology
Energy, Mines and Resources Canada

WHAT IS CANMET

The Canada Centre for Mineral and Energy Technology (CANMET), is the R&D arm of the federal government department of Energy, Mines and Resources. It was established in 1907 as the Mines Branch, and renamed in 1974 to reflect its expanding mandate. The five main divisions cover mining, mineral sciences, physical metallurgy, coal, and energy.

CANMET'S MISSION

CANMET's mission is "To enhance the role and contribution of minerals and energy in the Canadian economy by means of mission-oriented research and development in mining, mineral processing and utilization of metals, industrial minerals and fuels."

Because of its mission, CANMET is organized along the lines of industrial sectors, rather than scientific disciplines. Implementation of technology by industry has always been a primary concern, and interaction with clients has always been close. Much of CANMET's research takes place in the field, or requires other forms of industry cooperation, such as the provision of samples or operating data.

CANMET'S CLIENTS

CANMET's primary clients are the mining, mineral processing, coal, oil and gas, primary metal, and metal fabricating industries. These industry sectors are of great importance to the Canadian economy, contributing some 10% to Canada's Gross National Product. These sectors have an even greater relative impact on Canada's exports, transportation system, and certain regions.

TECHNOLOGY FOCUS

CANMET's mission is to raise the level of technology within our client industries, and not simply to advance state-of-the-art. Therefore the source of new technology is not the essential consideration - CANMET engages in the diffusion of new technology from private and public sources, either domestic or foreign, as appropriate. Some CANMET projects consist not of pure R&D, but of bringing together the best expertise extant in industry, universities, and government.

For example, two of our most successful recent projects, an Open Pit Slope Manual and a software package called Simulated Processing of Ore and Coal, brought together the expertise of numerous organizations within and outside Canada. In fact, the Manual involved very little original research. Both projects achieved commercial success and international recognition, succeeding where other, higher cost attempts failed to achieve results.

One current project on Diesel Exhaust Filters, which is receiving financial support from the National Research Council for the prototype testing stage, grew out of a joint effort of CANMET, the United States Bureau of Mines, the Ontario Ministry of Labour, seven Canadian mining companies, an American ceramic manufacturer, a small Canadian equipment manufacturer, and several mining diesel equipment suppliers. A recently completed project on ceramics with Almax Industries Ltd., which won the silver Canada Excellence Award, called on the expertise of both Queen's University and CANMET, and a break-through project on in-place bioleaching of uranium with Denison Mines involved CANMET and the universities of Dalhousie, Queen's and Laurentian.

NATURE OF PROJECTS

CANMET projects fall into one of three categories: policy, protection, and productivity. Policy projects are those driven by the policy requirements of the government, such as the need for estimates of potentially recoverable reserves of "strategic" mineral products. Protection projects deal with technology for the public good, such as that affecting health, safety, and the environment. CANMET has no regulatory responsibilities, but does consider relevant regulatory agencies as its clients, and provides standard and certification services. Productivity projects tend to be long term, generic in focus, but some short term, company specific work is undertaken on cost recovery. Most projects are cooperative with several public and private sector participants.

At any one time, the allocation of effort and resources among the different types of projects reflects the policies of the government of the day and perceptions of industry needs. CANMET is strongly influenced by its clientele, both through formal mechanisms, such as our industry advisory committee (National Advisory Committee on Mining and Metallurgical Research), and less formally through ad-hoc project steering committees, meetings with industry associations, and the continuous interaction between researchers and their colleagues in industry and universities.

The nature of R&D and technology transfer methods is also adjusted to suit the structure of the client industry. The approach varies with the number of companies, the size of individual companies, and their technical sophistication.

TECHNOLOGY TRANSFER AT CANMET

The transfer of technology has always been important in CANMET. Recognizing the varied levels of commercialization skills and knowledge among researchers, and the growing complexity of the process, CANMET created the Office of Technology Transfer in 1981 to serve as a central source of advice for the laboratories.

OFFICE OF TECHNOLOGY TRANSFER (OTT)

Technology transfer is the main, though not only, mandate of this office. The prime responsibility for technology transfer still rests with the laboratories, and OTT is involved in only some technology transfer activities. Approximately half of OTT projects is initiated by the laboratories, and the other half by industry requests for assistance.

OTT activities are varied and include: advice on a commercialization strategy, intellectual property management, market studies, state-of-the-art reviews, search for partners, and accessing other government programs, such as that of the National Research Council.

OTT is also responsible for two other, though related, activities: project evaluation and engineering and economic evaluation.

Project evaluation, usually initiated after a major milestone or the completion of an R&D project, is done by an independent, outside party. This evaluation is not an audit in the accounting or bureaucratic sense. Rather it looks for the real impact of the research results: did anyone in industry apply the technology, did the application result in cost savings or increased revenue, are there potential users who did not apply the technology and why, etc. The results of such an evaluation not only document CANMET's achievements, but also guide CANMET in the design of future projects and technology transfer activities, and can point out unrealized opportunities.

Engineering and economic evaluation is an important part of R&D and technology transfer. It is an iterative activity. A back-of-the-envelope flow diagram and cost estimate in the first phases of research can help focus effort on weak points in the technology and are essential for a go/no go decision. As research advances, estimates can become progressively more accurate. For such an evaluation to be useful, it is essential to have a good grasp of the market, identifying the technical and economic parameters of alternative technologies and the operations of potential clients. Knowing the market, it is easier to convince potential partners and to identify when such an approach should be made. Resources are not wasted on peripheral questions and unprofitable avenues can be identified early.

TECHNOLOGY TRANSFER METHODS

Technology transfer is most successful and efficient when it is built into an R&D project from initiation. Transfer can take many forms, depending on the nature of the technology and the nature of the client industry:

personal contact through visits or phone calls
- most frequent
- cheap and effective
- most applicable when the technology is an incremental improvement to existing technology
- can reach only a small number of potential users

hard products such as reports, articles, manuals or software
- most applicable for the transfer of information or data, although software and manuals can contain know-how
- can be targeted at a specific audience
- is complementary to other transfer methods
- provides a permanent record, which is particularly important where all applications cannot be foreseen
- may require special skills to prepare
- may require ongoing maintenance

education through conferences, seminars or workshops
- can reach large audience
- require significant preparation

demonstration through mobile pilot plants or laboratories
- necessary when technology is difficult to describe in words
- excellent for reaching a technically unsophisticated audience or to overcome scepticism

further development through field tests, pilot plants, or prototype construction and testing.
- necessary when the technology is a significant change from state-of-the-art

CONCLUSION

With the creation of the Office of Technology Transfer, the transfer process has become more visible and the collective experience can now be shared, analyzed, and applied to improving the process. The future, a world of budgetary restraint and need for proof of results, will mean an increased emphasis on efficient and effective transfer, commercialization, and implementation. The lesson learned from our experience is that technology transfer is most successful when it is integrated into the R&D planning process. It cannot be tacked on at the end of technical success in the laboratory.

To achieve such integration, the level of skill, knowledge, and awareness of technology transfer must be raised throughout the laboratories. Of course, we must be flexible and respond to the unplannned, unexpected success, which can be expected in a research setting. Emphasis on cooperation must also increase, and I welcome this opportunity to exchange ideas with our colleagues from Germany.

CANADA
CENTRE
FOR
MINERAL
AND
ENERGY TECHNOLOGY

CENTRE
CANADIEN
DE LA
TECHNOLOGIE
DES MINÉRAUX
ET
DE L'ÉNERGIE

CANMET

CANMET

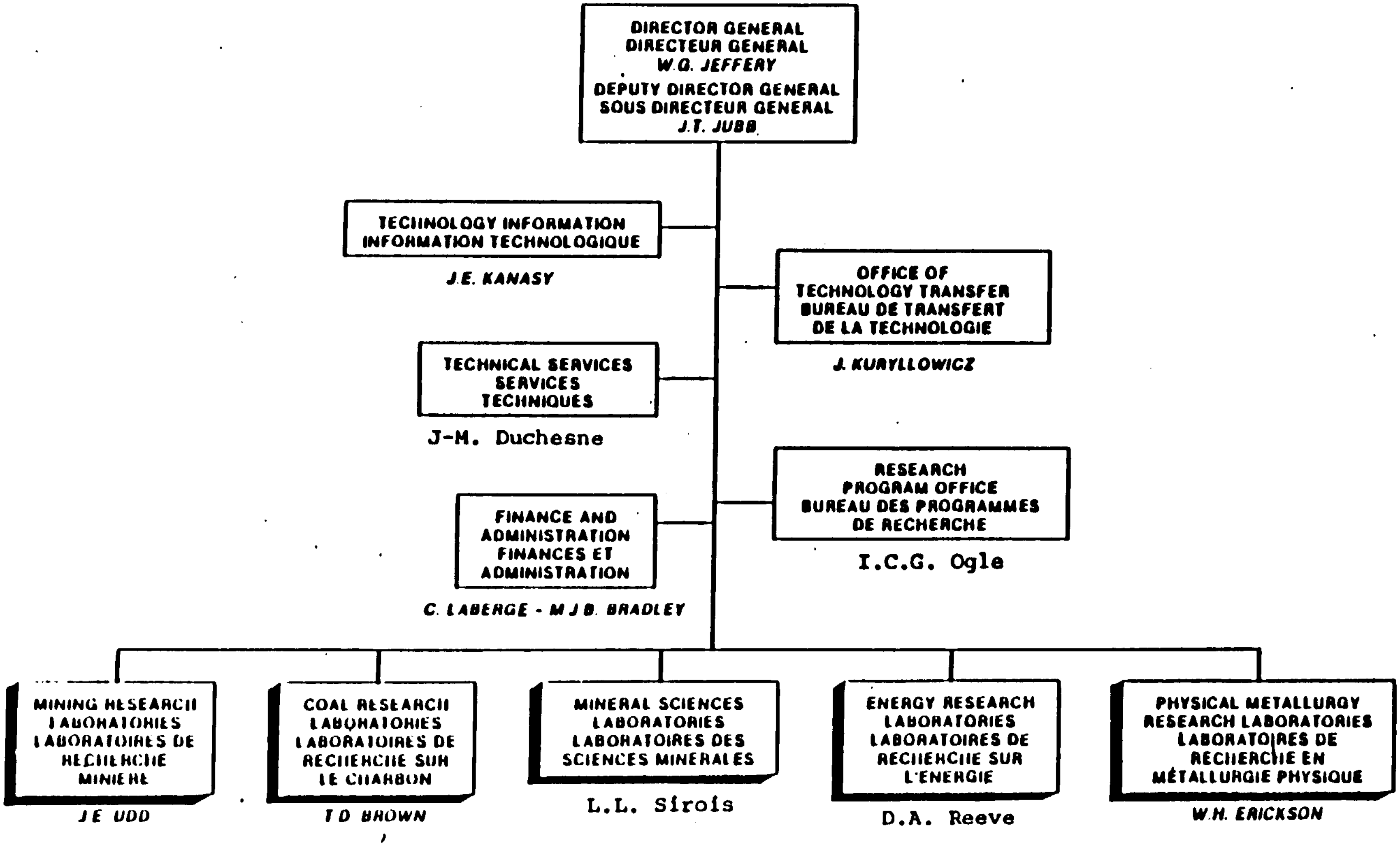
MISSION

To enhance the role and contribution of minerals and energy in the Canadian economy by means of mission-oriented research and development in mining, mineral processing and utilization of metals, industrial minerals and fuels.

RESPONSABILITÉS

Dans le cadre de son mandat, faire ressortir le rôle des minéraux et de l'énergie et leur contribution à l'économie canadienne au moyen de la recherche et du développement thématiques en matière d'exploitation minière, de traitement des minéraux et d'utilisation des métaux, des minéraux industriels et des combustibles.

CANMET


DIRECTOR GENERAL
DIRECTEUR GENERAL
W.G. JEFFERY
DEPUTY DIRECTOR GENERAL
SOUS DIRECTEUR GENERAL
J.T. JUBB
TECHNOLOGY INFORMATION
INFORMATION TECHNOLOGIQUE
J.E. KANASY
OFFICE OF TECHNOLOGY TRANSFER
BUREAU DE TRANSFERT DE LA TECHNOLOGIE
J. KURYLLOWICZ
TECHNICAL SERVICES
SERVICES TECHNIQUES
J-M. Duchesne
RESEARCH PROGRAM OFFICE
BUREAU DES PROGRAMMES DE RECHERCHE
I.C.G. Ogle
FINANCE AND ADMINISTRATION
FINANCES ET ADMINISTRATION
C. LABERGE - M J B. BRADLEY
MINING RESEARCH LABORATORIES
LABORATOIRES DE RECHERCHE MINIERE
J E UDD
COAL RESEARCH LABORATORIES
LABORATOIRES DE RECHERCHE SUR LE CHARBON
T D BROWN
MINERAL SCIENCES LABORATORIES
LABORATOIRES DES SCIENCES MINERALES
L.L. Sirois
ENERGY RESEARCH LABORATORIES
LABORATOIRES DE RECHERCHE SUR L'ENERGIE
D.A. Reeve
PHYSICAL METALLURGY RESEARCH LABORATORIES
LABORATOIRES DE RECHERCHE EN MÉTALLURGIE PHYSIQUE
W.H. ERICKSON

I	II	III	IV	V	VI
Exploration	Production of raw materials	Beneficiation of raw materials	Extraction and production of metals. Processing of non-metallic minerals. Processing and conversion of fuels.	Fabrication of materials with specific composition and structure	Properties and uses of materials for industrial application
Prospecting	Mining	Processing Milling Cleaning Petroleum refining	Smelting Refining Upgrading	Semi-fabrication Casting Rolling Forming	Utilization Corrosion Wear Toughness

MINERAL AND ENERGY SCIENCE AND TECHNOLOGY

←——————————————→

←——→ **GEOLOGICAL SCIENCES**

←——→ **MATERIALS SCIENCE**

CANMET
MINERAL AND ENERGY R&D

POLICY R&D

- TO SUPPORT POLICY DECISIONS, REGULATIONS, SPECIFICATIONS, TECHNOLOGY EVALUATIONS, RESOURCE ASSESSMENTS

PROTECTION TECHNOLOGY

- QUALITY OF LIFE
- HEALTH AND SAFETY
- ENVIRONMENT
- INTEGRITY OF STRUCTURES

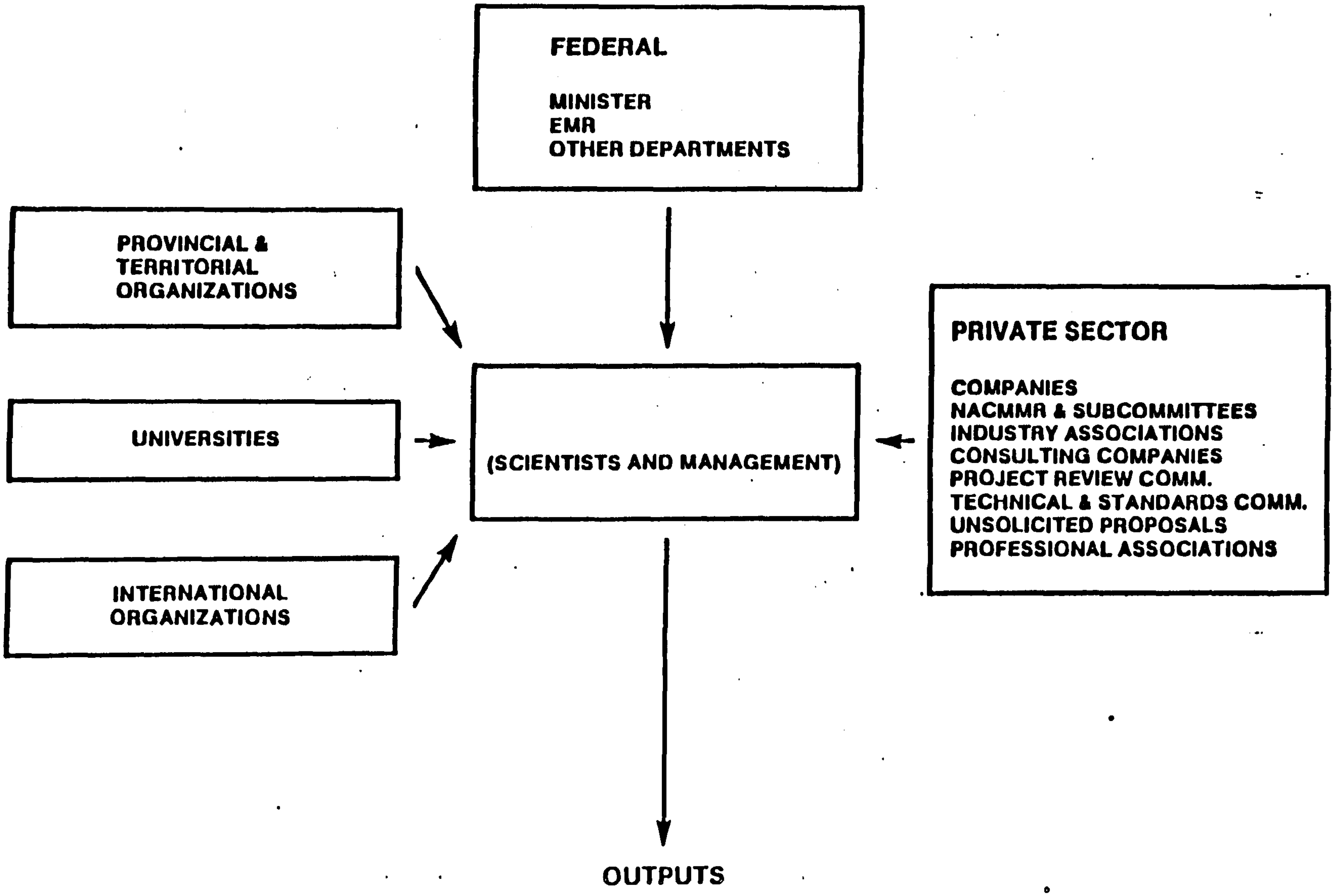
PRODUCTIVITY TECHNOLOGY

- HIGHER RISK (MEDIUM AND LONGER TERM - NATIONAL TECHNOLOGY BASE)
- LOWER RISK (SHORTER TERM - DISAGGREGATED INDUSTRIES)
- TECHNOLOGY DEVELOPMENT
- NATIONAL FACILITIES

TECHNOLOGY TRANSFER

- RESEARCH RESULTS TO AGENCIES AND INDUSTRY

CANMET INPUTS



OFFICE OF TECHNOLOGY TRANSFER

1. TECHNOLOGY TRANSFER
2. PROJECT EVALUATION
3. ENGINEERING & ECONOMIC EVALUATION

TRANSFER METHODS

- -PERSONAL CONTACT
- -PRODUCTS
- -EDUCATION
- -DEMONSTRATION
- -DEVELOPMENT

GERMAN/CANADIAN WORKSHOP
DECEMBER 2,3,4, 1986
UNIVERSITY OF WATERLOO

COMMERCIALIZATION OF THE RESULTS OF PUBLICLY FUNDED RESEARCH

A B S T R A C T

Mr. H.W. Baumans, Ing.
Centre de Recherche Industrielle du Quebec

Provincial Research Organizations are involved to varying degrees in technology transfer to industry and subsequent commercial application of the results of their work. The Centre de Recherche Industrielle du Quebec (CRIQ) is active in all three principal phases of the process: supply of technical and industrial information, conduct of R&D projects under contract to industry and the commercialization of in-house research results. Various aspects of these activities will be presented, with a discussion of the problems and difficulties encountered.

GERMAN/CANADIAN WORKSHOP
December 2 - 3 - 4, 1986
University of Waterloo

Commercializing Results of Research from Provincial Research Organization

Hans W. Baumans, Dipl.- Ing.

Most of the provinces of Canada - that is eight out of ten - have created their own R&D organizations, between roughly the first World War and 1970. While their mandates differ in detail, their principal vocation is to further the economic development of the respective province. The "Centre de Recherche Industrielle du Québec" is one of these PRO'S. CRIQ was created by an act of the provincial legislature which stipulates the specific mandate:

- research in applied science carried out either in its own laboratories or in those of other research centers;

- the perfecting of industrial or scientific products, processes and equipment;

- the gathering and diffusion of technological and industrial information and data.

This is an exceedingly broad mandate, which has had to be refined considerably over the years in order to fit the available resources and the needs of the industrial clientele. Choices have had to be made concerning the technical disciplines covered as well as regional presence. Today, CRIQ operates two laboratories:

- in Quebec City, operations cover the fields of materials sciences, heavy mechanical engineering and manufacturing technology;

- In Montreal, activities are centered on automated production, product development and electronics.

CRIQ is a Crown corporation, not a government department. A Board of Directors composed of industry representatives and members of the scientific community reports through the minister of industry and commerce to the National Assembly. Two vice-presidents responsible for the laboratories in Quebec and Montreal and the director of the technical information division report to the president of the corporation. The technical information division is a separate entity since it carries out a specific part of the mandate.

In 1984/85, CRIQ operated on a total budget of 24 million dollars. Of this amount, 9 million dollars was income from contracts, while 15 million dollars originated as a subsidy from the Government of Quebec. CRIQ's contract revenue is growing at a rate of almost twenty percent per year; however, total financial autonomy is not at present an objective.

The day-to-day activities may be divided into the following broad categories:

- the provision of scientific, technical and industrial information and data to manufacturing firms on a subscription or ad-hoc basis;
- technical counseling and trouble-shooting services;
- test and evaluation services, excluding routine tests available from commercial laboratories;
- contract research and development, including the desing and development of new products for the manufacturing industry of Quebec;
- a modest volume of in-house projects for technology acquisition purposes and the preparation of future unsolicited proposals.

Since most major corporations have highly structured product development activities and well-equipped R&D laboratories, the principal clients of CRIQ are the SME'S, the "Small and Medium - Sized Enterprises" frequently mentioned in government statistics and policy statements.

Since the basic vocation of CRIQ is in the domain of economic development, in particular to stimulate the growth of the manufacturing industry, effective technology transfer is a direct measure of success.

Each of the three sectors of the mandate involves a degree of technology transfer. The supply of technical information and industrial data involves a rudimentary tansfer of technology, since the skills and know-how of CRIQ information analysts will make accessible data from data banks, state-of-the-art reports, patent information, and technical articles which the client Company would be unable to obtain without this assistance. This is particularly true for firms outside the major metropolitain areas.

An important percentage of CRIQ's activities involves the development of new products under contract for industrial customers. The success of these projects depends in large measure on the effectiveness of the technology transfer, which in turn depends on contributions from both partners involved. In this connection, the technological level of the receiving organization and the attitudes of the personnel involved are crucially important. The technology transfer process must begin very early in the project, by the active participation of Company personnel in the early technical choices, the selection of components, processes and materials, etc., in order to develop an in-depth understanding of the problems involved and to appreciate potential future production problems. This on-going familiarization with techniques, components and equipment establishes excellent communication channels at the working level and goes a long way towards a smooth transfer of the final results of the project with a minimum of organizational confrontation. Frequently, personnel of the client Company work in our laboratories for prolonged periods, on the assembly and test of the prototype of a new equipment.

Thus, when the final drawings and data of the new product are released to the Company at the end of the contract, there are people at the receiving end thoroughly familiar with the new equipment or machine and in an excellent position to draw maximum advantage of the results of the development project.

A certain volume of R&D work at CRIQ is internally funded; the projects originate in technical ideas advanced by members of the R&D team, or are created as a result of problems identified in the course of work for industry for which an industrial sponsor has been found.

Results of these R&D projects are commercialized depending on the nature of the subject, according to one of two basic approaches: in the first, the idea is developed analytically, by simulation or by preliminary models to the stage of proving the feasibility of the idea. Wherever possible, we apply for patents or other forms of protection. Through CRIQ's team of commercial agents, we try to identify companies potentially interested in the technology; in other cases, the techniques developped may be integrated into an industrial project proposed by a customer; a supplementary agreement is then concluded to arrange a license for this application, without affecting CRIQ's rights in the intellectual property and without precluding the application of the technology to other non-competitive fields.

Typical examples of cases treated in this fashion are a novel type of adaptive filters, a new type of compander for audio signal and techniques of speech compression.

In the second approach, the idea involves a new product rather than a technique. In many cases, it is necessary to develop the product to a level where its features and advantages can be demonstrated in order to interest and convince potential investors. Again, we seek patent protection for the contemplated application and the market areas of interest. As early as possible, we try to interest a financial backer. In the choice of an eventual licensee, we place particular importance on the marketing capacity of the partner company since the commercial success of a technical product depends to an enormous degree on the credibility of the company marketing the product and much less on the technical excellence of the product. Of course, we insure that adequate economic benefits accure to the province by requiring a high Quebec content in the final product.

Recent examples of this approach are a rotary press for the extraction of water from sludges and slurries, and an equipment to eliminate co-channel interference from TV signals.

R&D is not the only avenue to new products, and it is perfectly impossible to develop all the required technology in Canada. The acquisition of technology via a license, possibly from overseas, is an important option for a Company. It may be advantageous for the Company to avail itself of the skills and experience in technology transfer available at CRIQ before concluding a license agreement.

In the area of technology transfer from third parties, CRIQ has concluded agreements with Quebec universities in order to commercialize ideas generated in the university laboratories. This program has not been very successful to-date; professors either commercialize their inventions themselves, by-passing sometimes the university, or the inventions are too far removed from the range of interest of industry to be commercially viable.

One area of technology transfer CRIQ has completely abandoned is the attempt to commercialize the ideas of individual inventors. After nine years of operation, it was found that the yield was too low to justify continued involvement.

After fifteen years, we are convinced that technology transfer from a public R&D organization is not an easy matter, and that there is no single method to achieve success in all cases.

UNIVERSITY OF WATERLOO

COMMERCIAL DEVELOPMENT OFFICE

PRESENTATION

TO

GERMAN/CANADIAN WORKSHOP

WEDNESDAY, DECEMBER 3, 1986

ROBERT B. NALLY
COMMERCIAL DEVELOPMENT OFFICER

CANADIAN R&D ENVIRONMENT

o INDIGENOUS R&D LIMITED TO A FEW MAJOR CORPORATIONS AND UNIVERSITIES

o NEED TO CAPITALIZE ON UNIVERSITY RESEARCH BREAKTHROUGHS AND EXPENDITURES

o ONTARIO GOVERNMENT SET UP IDEA CORPORATION (CROWN CORPORATION EQUITY FUND) TO MEET PRE-COMMERCIAL, HIGH RISK, START-UP FUNDING NEEDS.

o IDEA CORPORATION INITIATED COMMERCIAL DEVELOPMENT OFFICER $3M PROGRAM IN LATE 1984 ON 10 ONTARIO UNIVERSITY CAMPUSES

UNIVERSITY OF WATERLOO

- LOCATED 1 HOUR WEST OF TORONTO, ONTARIO
- 22K STUDENTS, 775 FACULTY
- 6 FACULTIES: ENGINEERING, MATHEMATICS, ARTS, SCIENCE, ENVIRONMENTAL STUDIES, HUMAN KINETICS & LEISURE STUDIES
- LARGEST MATHEMATICS FACULTY IN WORLD
- SECOND LARGEST CO-OP UNIVERSITY IN NORTH AMERICA (9,000 STUDENTS)
- $30M (C) DIRECT RESEARCH EXPENDITURES ($8M CONTRACT, 50% INDUSTRY)
- IBM $20M+, DEC $25M EQUIPMENT GRANTS
- SOFTWARE ROYALTIES $1.5M+/YEAR NET TO UNIVERSITY
- POLICY ON OWNERSHIP: FACULTY OWN COMMERCIALIZATION RIGHTS

University of Waterloo

Waterloo, Ontario, Canada
N2L 3G1

Office of Research
Incorporating Waterloo
Research Institute
519/885-1211

Telex 069-55259

COMMERCIAL DEVELOPMENT OFFICE

A Commercial Development Office (CDO) funded by IDEA Corporation and operating out of the Office of Research was established March 1, 1985.

Purpose of CDO

To assist the University community in commercializing innovations by;

Identifying research spin-offs and other technology opportunities that may have significant commercial potential.

Developing an action plan in cooperation with Principal Researchers or Investigators to perform preliminary technology assessment/feasibility, patent search, market survey, competitive analysis, economic analysis, and overall commercial feasibility of the potential opportunity.

Assisting in proposal and business plan development to obtain funding investment for additional development of feasibility models/phototypes and commercialization plans.

Assisting in the exploration and selection of the optimum technology transfer and commercialization strategy.

Assisting in the sourcing of capital from various sources for commercialization.

Assisting in the sourcing of key management for new start-ups.

Providing ongoing management consultation, follow-up and support to ensure successful technology transfer and commercialization.

Contact: Robert B. Nally
Commercial Development Officer
University of Waterloo
Waterloo, Ontario N2L 3G1
Tel: (519) 888-4515 or 885-1211 ext.6619

January 1986

INTRODUCTION

- o COMMERCIAL DEVELOPMENT OFFICE (FUNDED FOR 3 YEARS BY IDEA CORPORATION) STARTED MARCH 1, 1985

- o CDO OPERATES OUT OF THE OFFICE OF RESEARCH REPORTING TO THE DEAN OF RESEARCH (DR. E. HOLMES)

- o - PURPOSE OF CDO FUNCTION:

    - o TO MORE EFFECTIVELY MANAGE THE TECHNOLOGY TRANSFER PROCESS IN THE AREA OF SPIN-OFF COMPANIES AND TECHNOLOGY LICENSING BASED ON UNIVERSITY RESEARCH ACHIEVEMENTS

    - o CDO IS A TECHNOLOGY MANAGEMENT FUNCTION TO MAXIMIZE INDUSTRY, UNIVERSITY AND SOCIETY BENEFITS FROM RESEARCH RESULTS AND MINIMIZE IMPACT ON UNIVERSITY COMMUNITY IN TECHNOLOGY TRANSFER AND COMMERCIALIZATION PROCESS

UNIVERSITY-INDUSTRY-SOCIETY INTERACTION AND TECHNOLOGY TRANSFER

- o MULTI-DIMENSIONAL TAKES MANY FORMS
- o RESEARCH PUBLICATIONS
- o STUDENT EDUCATION/GRADUATION, CO-OP
- o WORKSHOPS, SEMINARS, CONFERENCES
- o CONTRACT RESEARCH AND CONSULTING
- o BOOK PUBLISHING
- o INSTITUTES AND CENTRES
- o INDUSTRIAL/COMMERCIAL ASSOCIATIONS, TASK FORCES, ADVISORY BOARDS AND COMMITTEE PARTICIPATION

o SPIN-OFF COMPANIES	CDO OFFICE
o PATENT, KNOW HOW, COPYRIGHT LICENSING	MANDATE

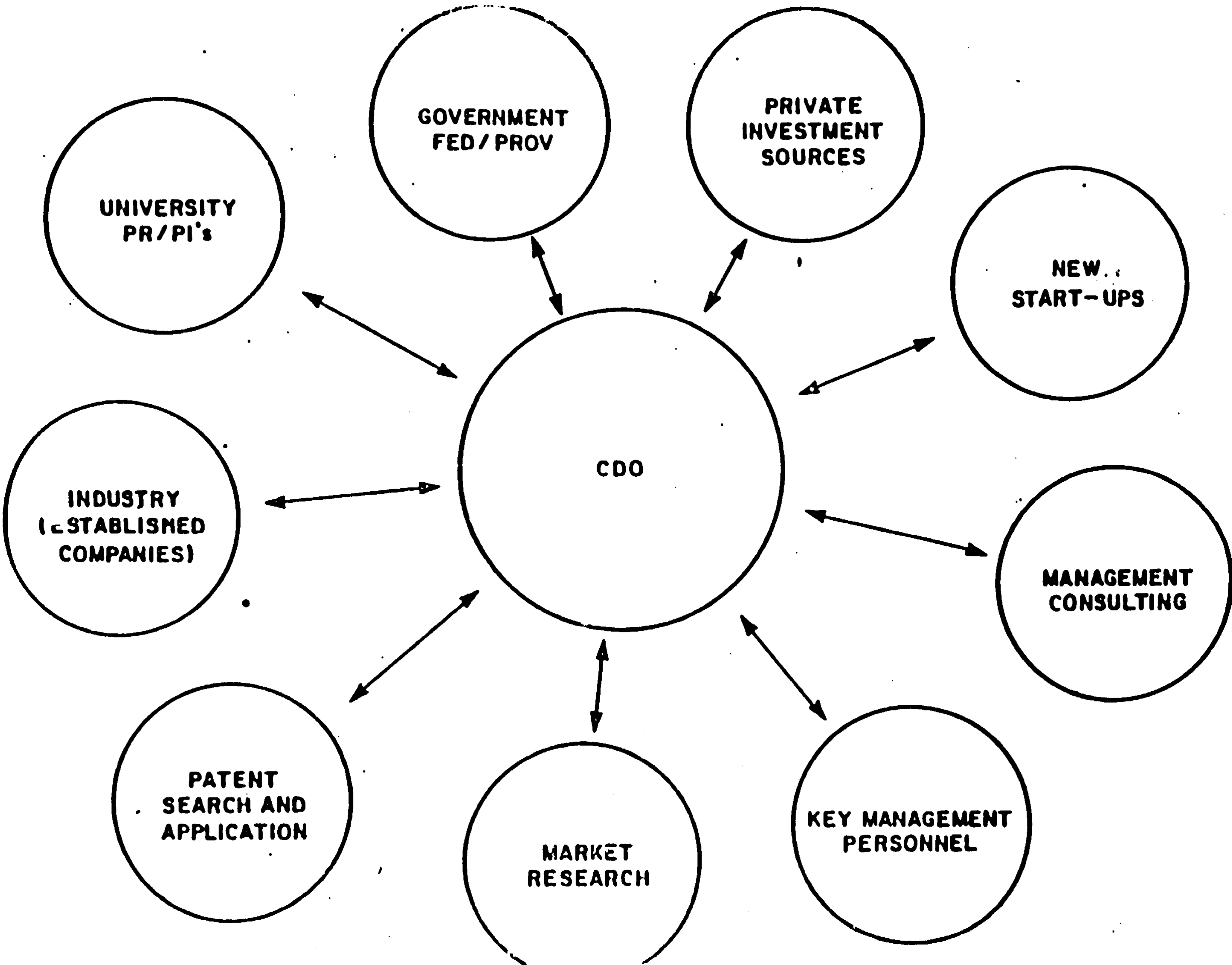
CDO'S OPERATIONAL FUNCTION:

TO PACKAGE TECHNOLOGY FOR SUCCESSFUL TRANSFER AND COMMERCIALIZATION

1. FEASIBILITY ANALYSIS (ENGINEERING, MANUFACTURING, DISTRIBUTION, REGULATORY)
2. MARKET RESEARCH
3. COMPETITIVE ANALYSIS
4. ECONOMIC ANALYSIS
5. FINANCIAL ANALYSIS
6. DEFINE/CLARIFY OWNERSHIP
7. PROVE/DEMONSTRATE FEASIBILITY/REDUCE RISK
8. SECURE AND DEFEND INTELLECTUAL PROPERTY PROTECTION
9. DEVELOP TECHNOLOGY TRANSFER COMMERCIALIZATION STRATEGY
10. PREPARE PACKAGE
11. LICENSE PREPARATION AND NEGOTIATION
12. BUSINESS PLAN
13. ADVERTISING AND PROMOTION
14. IDENTIFY APPROPRIATE PRIVATE SECTOR PARTNERS/ENTREPRENEURS
15. SELL PACKAGE
16. OBTAIN PRIVATE SECTOR AND/OR GOVERNMENT FUNDING
17. PERFORM ONGOING TT&C AGREEMENT SUPPORT AND MAINTENANCE

CDO NETWORKING

- CDO IS A COMMUNITY ECONOMIC DEVELOPMENT FUNCTION HENCE NEEDS EXTENSIVE "COMMUNITY" SUPPORT
- PRIVATE SECTOR INVESTMENT SOURCES
- FINANCIAL INSTITUTIONS
- GOVERNMENT FEDERAL AND PROVINCIAL
- LAWYERS, ACCOUNTANTS, ADVERTISING AND PROMOTION, DISTRIBUTERS, MARKET RESEARCH CONSULTANTS, SUPPLIERS
- BOARDS OF DIRECTORS
- SENIOR MANAGEMENT TALENT (CEO, GM, PRESIDENT, V.P. MARKETING)


UNIVERSITY PR/PI's
GOVERNMENT FED/PROV
PRIVATE INVESTMENT SOURCES
NEW START-UPS
INDUSTRY (ESTABLISHED COMPANIES)
CDO
MANAGEMENT CONSULTING
PATENT SEARCH AND APPLICATION
MARKET RESEARCH
KEY MANAGEMENT PERSONNEL

SAMPLES OF PROJECTS IN COMMERCIALIZATION PROCESS:

CURRENT SPIN-OFF COMPANIES UNDERWAY

WATLAN INC.	P.C. LOCAL AREA NETWORK WATSTAR	DOUG REID (CEO) & DR. PETER ROE, SYSTEMS DESIGN ENG.
WATERLOO ENGINEERING SOFTWARE	SPECIALIZED S/W PACKAGES	RICHARD MOORE (CEO) & ENGINEERING FACULTY TI
CRYPTECH SYSTEMS INC.	VOICE/DATA COMMUNICATIONS SECURITY (ENCRYPTION)	DR. SCOTT VANSTONE & & TEAM COMB & OPT. MATHEMATICS
TURBOTAK INC.	AIR POLLUTION CONTROL EQUIPMENT	DR. DON SPINK CHEMICAL ENGINEERING
CHINA-CAN TECHNOLOGIES INC.	PACIFIC RIM TECHNOLOGY MARKETING CONSORTIUM	ANDREW BARLOW (CEO) & FACULTY
MACHINE VISION & INTELLIGENCE INC.	QUALITY CONTROL INSPECTION SYSTEMS & ROBOTICS VISION	DR. ANDREW WONG & TEAM SYSTEMS DESIGN ENG.

CURRENT PATENT, KNOW HOW, COPYRIGHT COMMERCIALIZATION

PROJECTS UNDERWAY

JCMOS DRAM CELL (3 PATENTS)	DR. ABE ELMASRY DR. ALI ELDIN	ELECTRICAL ENGINEERING
MACHINE VISION & INTELLIGENCE (8 PATENTS)	DR. ANDREW WONG DR. MOHAMED KAMEL	SYSTEMS DESIGN ENG.
PUBLIC KEY ENCRYPTION VLSI SYSTEM (2 PATENTS)	DR. SCOTT VANSTONE DR. RON MULLIN IVAN ONYSZCHUK	MATHEMATICS COMBINATORICS & OPTIMIZATION
ORGANIC FOOD PRESERVATIVE	DR. JOHN THOMPSON DR. DUTCH DUMBROFF	BIOLOGY
MULTIPROCESSOR ARCHITECTURE (SYLVAN)	DR. FORBES BURKOWSKI & TEAM	COMPUTER SCIENCE

ISDN COMMUNICATIONS SYSTEM	DR. JOHN MARK	ELECTRICAL ENGINEERING
MICROWAVE INTEGRATED CAD S/W PACKAGE	DR. LEN CHOW	ELECTRICAL ENGINEERING
MUNICIPAL INCINERATOR DIOXIN ELIMINATION	DR. FRANK KARASEK	CHEMISTRY
BIOMASS LIQUIFICATION BY FLASH PYROLYSIS	DR. DON SCOTT	CHEMICAL ENGINEERING
FTIR CLUSTER ANALYSIS CELL	DR. TERRY GOUGH	CHEMISTRY
BOAT CONSTRUCTION TECHNIQUE	DR. MIKE ELMITT	ARCHITECTURE

NEW SPIN-OFF COMPANY POTENTIAL

- BIOTECHNOLOGY
- OPTOMETRY
- VLSI
- OXFORD ENGLISH DICTIONARY
- COMPONENT PART AUTOMATED STRUCTURAL ANALYSIS
- DATA PROCESSING S/W PACKAGES
- CONTROL SYSTEMS SOFTWARE

CDO FUNCTION BENEFITS TO UNIVERSITY - INDUSTRY - SOCIETY

- COMPLETE APPLICATION IN SOCIETY OF RESEARCH ACHIEVEMENTS
- PROVIDE COMMERCIALLY SUCCESSFUL SOLUTIONS TO PROBLEMS IN SOCIETY (ENVIRONMENTAL, QUALITY, PRODUCTIVITY)
- CONTRIBUTE TO NEW WEALTH AND EMPLOYMENT CREATION
- DEVELOP LONG TERM INDIGENOUS R&D AND BUSINESS MANAGEMENT CAPABILITY IN STRATEGICALLY KEY TECHNOLOGY SECTORS
- PROVIDE INCOME SOURCE FOR UNIVERSITY THROUGH ROYALTY AND EQUITY FEEDBACK
- OFF-LOAD UNIVERSITY MEMBERS IN TECHNOLOGY TRANSFER AND COMMERCIALIZATION PROCESS
- ASSIST ONTARIO/CANADIAN INDUSTRY IN ACQUIRING NEW TECHNOLOGIES, PRODUCTS AND MAINTAINING COMPETITIVENESS
- PROVIDE RISK INVESTMENT OPPORTUNITIES TO INVESTMENT COMMUNITY

GERMAN/CANADIAN WORKSHOP
DECEMBER 2,3,4, 1986

Dr. Klaus Landfried
Kaiserslautern/Germany

Co-operation Between Universities and Industry in Germany-Viewed from the Universities

The University I come from is a small to middle sized Technical University, founded in 1970 as part of a regional structural policy by the State government of Rhineland - Palatinate. At the moment student enrollment in all kinds of studies, postgraduate and doctoral studies included, is just above 7,000. Nine faculties have 130 professors and approximately 600 assistants, of which about one-half are paid by other than governmental funding.

Technical universities have always been looked down on a bit by the old, the traditional, the universal universities. This has begun to change very recently with the uprise of new technologies in the hierarchy of public values. In the history of academic life in Germany since the early 19th Century, we have had quite a few polarizations in this respect.

There was the great reformer of Prussian universities, Wilhelm von Humboldt, who sent German universities (which are by the way until today not only government-sponsored but in a very rigid way, government-directed like revenue-offices or even like an army, though there is always the never-ending debate on academic autonomy) - into splendid isolation, into the ivory-tower, as polarized by his brother Alexander, the great cosmopolitan who wrote in 1844 that:

> "Peoples hanging-back in industry in general, in the use of physics and technical chemistry, in the diligent selection of, and work on natural compounds, in which such a practice is not properly honoured by all social classes, will sink down from their national wealth. Even more so, when neighboring countries, in which there is a vivid exchange between science and the industrial arts are progressing, like in renewed energy of youth."

Since Germans tend to be rather thorough, we have had also the following polarizations: between basic and applied research, between truth and utility, thinking and doing, even science and engineering - the first item in these pairs, ranking always higher in the hierarchy of German academic values. Of course, all this is ideology, but also ideologies can be hardware in political terms, and in spite of a lot of technology transfer business still are to some extent.

Industry on the other hand eagerly searched for men of science in order to create a steady progress in products and techniques. Fortunately enough, creative inventors like Edison in the U.S.A., who made it the hard way outside of academia, were to be found also in Germany. The names of Benz, Daimler, Bosch, Borsig or Kurt Koerber - in the 20th Century - may symbolize that. But it is no surprise that industry very much welcomed the founding of the Kaiser Wilhelm-Society, later Max Planck-Society, where in specialized research institutes, top scientists work mainly on basic research.

Some universities too have tried rather soon to strengthen their ties with industry. Above all the technical universities which traditionally recruit their senior faculty staff from industrial firms with whom they have some co-operation in research. But this recruiting - with some notable exceptions - remains a one-way street. None of the faculties concerned have suffered in scientific reputation on account of their industrial liaisons. The TUs of Aachen, Stuttgart, Munich or Erlangen, most of them neighboured by big industrial names like Siemens or IBM or Daimler-Benz, may stand for all of them.

Then we had this dogfight - revolution of students - unrest of the late sixties and early seventies, their ideological fossiles still glowing at some places, accusing science to become the lackey of capitalist money. An absurd accusation when you look at the figures.

Let me now focus on our present situation by trying to press the whole world of co-operation into six hypotheses. But before I confront you with these rather general and abstract findings, I better tell you something about one of our practical projects at Kaiserslautern. A typical middle-sized iron-foundry doing also other kinds of working and processing of iron, eagerly looked for a new method to improve the surface of their products in terms of resistance against corrosion and in terms of level.

They cannot afford, of course, their own research or testing capacity. But they were not far - a 15 minute car ride - from our university which has a strong department of physics, and within this department a research team of basic research people dealing with the microstructure of metal surfaces (thin layer analysis) and with techniques of changing their qualities. And then a mechanism began to work which is very important for successful technology transfer: a working dinner was arranged and the outline of a co-operation project worked out, to be funded partly (40%) by a special MSE fund in the budget of the State Ministry for Economics. The project is now well underway due, above all, to the fact that the professor and his team and the foundry people understood and liked each other within a short time. The personal factor should not be underestimated in this respect. But understanding also means finding a common language, a difficult task, especially for scientists who must break up their special codes and translate and vulgarize the very core of their expertise.

Let me now present my hypotheses:

(1) All enterprise, even if in a traditional market section has to make use of high-tech innovations wherever it can in order to remain competitive. This needs intensive research within which the borderlines between basic and applied research and between traditional faculties can be drawn properly. But also universities have a good pay-off from co-operating with industry since they become more attractive for students and staff by a more practical orientation in research and teaching.

(2) If government and industry want to make use of academic research, if they want to keep research and the young talents needed within the universities, they have to take care of the proper outfit of the universities in terms of qualified staffing, equipment, and the financial means to sustain both. Governments always tend to be in a thrifty mood which may lead them to overlook real needs.

(3) Transfer of information and staff, co-operative projects in research and development and education should not be allowed to flow one way. Only if we can install systems of exchange, of real dialogue, above all the exchange of staff, technology-transfer will be successful. Whereas the transfer of information and co-operation in R&D run fairly well in

Germany already, continued education and co-operation in teaching are still in their very beginning. The exchange of staff so far works only one-way - from industry into universities.

(4) Co-operation between industry and universities should not be limited to research. It should be extended to teaching as well. We should also aim at co-operation among several universities in order to use possible synergetic effects. (What is now a very rare case).

(5) Universities should pay enough attention to social acceptance of their co-operation with industry. They should be open towards a broad spectre of industry with regard to size, branches and organizational forms. But also towards government institutions at the local, regional or federal level, and at last also towards the unions and their needs. The responsibility, of course, will always rest with the individual professor and his team, since personal trust is most important for any successful co-operation.

(6) Government, industry and universities alike have to be aware of the fact that only universities which are independent enough (and have the means to remain so) to select programs and projects of transfer themselves can be of long term use for society. We need a good balance of basic research (also in the sense that work in the labs is relieved from direct time pressure) and various forms of R&D in co-operation with industry.

This is not wishful thinking but many hurdles have to be taken, many problems have to be solved until this kind of co-operation will work well in Germany. So, at the moment we do have problems in the transfer-business in Germany, on three of which I shall now shortly elaborate.

Let me first put aside the ideological prejudices mentioned above, though they are still alive. Two of our problems have the same source: a set of traditional and ever growing bureaucratic regulations.

The First One: The structure of public salaries in Germany is such, that young talents in the fields of computer science and in the engineering disciplines can hardly be motivated to stay in university jobs after graduation. Salaries in industry range from 20% up to 50% higher than in the public service which does not allow for a leeway in terms of material incentives. This is bad for all parties in the co-operation field. We must soon develop new financial forms of incentives in order to stop the drain. The transfer of staff to and fro is also hampered by special regulations about retirement benefits and pensions and other silly and costly red tape.

The Second One: If a university manages to gain considerable revenues from co-operation projects, this sometimes leads officials in the Ministries of Finance (not in those for science and education, but they have to obey anyway) into temptation: to cut down regular funding or at least to stall the formation of free "overheads" which could be used by universities for motivational purposes. By the way, all fees charged by universities to third party customers have so far to be delivered directly to the Ministries of Finance. So we have to work with certain schemes of donations to evade the rules.

The Third Problem Just to be Mentioned: Though the number of students at universities will decrease considerably during the next decade (on account of the demographic development) for the moment most universities carry an "overload" which limits the capacity of time and equipment and staff available for co-operation with industry.

Let me now give you some more examples of what we are doing at Kaiserslauter University in the field of co-operation. Let me start with teaching, since the transfer of well trained people (with an incentive to continued education) remains the most effective channel of transfer. In their last two years before graduation (to Diploma) an increasing number of students (ranging from 10% to 20%, depending on the faculty) in the engineering sciences and in technical mathematics do their theses or other study work on some concrete enterprise problems arising mostly from some sort of co-operation with industry (in the range of up to 80 km or so). Secondly we have a special program of continued education in engineering mathematics which was developed in co-operation with firms like Audi, Volkswagen or Ford. This program is funded at equally 50% by the state and the federal government.

We also have seminars and workshops on a fairly regular basis in VLSI, AI and in the engineering faculties together with people from industry.

With regard to transfer-projects, there are many with MSE and quite a few bigger ones with big firms like Siemens, Volkswagen or Daimler-Benz. Some examples: There was a co-operation project with a MSE from the Kaiserslautern area, in which some of our engineers worked on the development of a new test method including the equipment to identify leaks in injection pumps. Another team worked on an electronic device in order to optimize the process of cooling and thawing in big refrigerating installations. A special software with a new macrolanguage was included in this project. The whole thing is now on the production line of that MSE. But let me add here that we do not normally care for the commercialization of the R&D results. At least so far. There are still more projects to tell about in biotechnology, in city and rural planning (together with city and country administrations), in chemistry, mathematics, physics, engineering and so on. Costs of projects may range from 5000DM at the lowest up to 4.5 Million DM, many of them partly financed by some sort of public funding.

Our small technology-transfer office (one business engineer with one-half time secretary) cannot monitor all projects under way, many of them deriving anyway from direct contacts between industry and research team. But we do provide and distribute (as do other universities) a catalogue comprising all research teams at our university willing to co-operate with industry with their main centres of research, equipment, with names, address and telephone numbers. This year the figure of co-operation projects in R&D may well reach 100.

ÉCOLE POLYTECHNIQUE:
A PARTNER FOR INDUSTRY

by:

Denis N. Beaudry
Director
Centre de Développement Technologique
ÉCOLE POLYTECHNIQUE DE MONTRÉAL

at:

UNIVERSITY OF WATERLOO

German/Canadian Workshop

"Commercialization of the results of publicly funded research"

December 3, 1986

It is with pride and also with a great deal of enthusiasm that I have accepted this kind invitation to participate in this workshop. My presentation will focus on

- information about École Polytechnique activities
- the role and structure of its industrial liaison office called le Centre de Développement Technologique
- examples of certain collaborations and technology transfer projects with industry
- our policy related to intellectual property and ownership of patents and software
- our experience with spin-off enterprises from our university
- our participation in an incubator program with the private sector and finally,
- a look at the benefits derived from our collaboration with the private sector.

École Polytechnique was created 113 years ago and is presently the second largest engineering school in Canada, both in terms of undergraduate and graduate students, after Waterloo and Toronto respectively.

It is a francophone institution but the majority of its personnel are bilingual or multilingual. Although its faculty has a French Canadian core, it comes from all over the world.

École Polytechnique is affiliated with the Université de Montréal. It has its own Board of Administrators, the majority of whom come from industry, and it has complete autonomy with regard to its budget. However, its academic programs are approved by the Université de Montréal which also grants its degrees at all levels.

Like most of the north american universities, its mission consists of training, conducting research and providing services to local, national and international communities.

We have almost 5 000 students, of which nearly 900 are at the post-graduate level. Our faculty is over 200 professors, out of which 140 are active in research as well as 125 full time researchers and research assistants. Our overall budget is 50 million dollars, of which 15 million is devoted to research and development.

Our institution has established technological development priorities: materials science and engineering, and, computer engineering, including computer-aided design. This means that for the next few years, available internal resources will be concentrated into these main fields.

École is also a partner in three multi-university research centers:

- CRIM for computer science and technology
- MERI for mineral exploration, and
- GCP for management of large projects.

We also favour the development of research centres, research groups and multi-disciplinary research laboratories. Our research activities extend into many fields and École provides special administrative and financial support to professors, researchers and students that are grouped together in major research units.

Like most modern universities, École Polytechnique has, as a prime objective, to transfer know-how and although technological transfer may take various forms, we favour cooperative training of our graduate students, scientific publications of results obtained from research contracts, continuing education and research contracts.

École Polytechnique has always had strong ties with industry. More than one-third of all engineers in Québec are graduates of the École and our Alumni Association is very active. Representatives from industry serve on the Board of Administrators and on many of its advisory committees. Oftentimes industry has sponsored special post-graduate courses at our School (e.g. in microelectronics, instrumentation and control, aeronautics, etc.) and we are providing a large number of intensive courses within our continuing education program.

As a matter of fact, our relations with private industry have become so important for the training of our students and for the development of our research activities, that we are presently seriously considering this type of activity in the establishment of our professors work load, in our budget distribution within our various departments and even in the "dossier de promotion" of our young professors. We, of course, are very conscious of the impact of such a potential policy on other institutions, however, we feel that nowadays, the development of a technological university can only benefit from a closer relationship with the private sector.

In this respect, one can only agree with former French President, Mr. Georges Pompidou who once said:

> "There are three ways to ruin yourself: gambling, women and technology. Gambling is the fastest. Women are the most pleasurable. Technology is the most certain."

These words reflected the failure of companies to grasp new technologies - and put them to work strategically and also reflected the inability of universities to find ways to transfer their technologies to the private sector.

In order to strenghten its links with industry, École Polytechnique created in 1971, le Centre de Développement Technologique (the C.D.T.) whose main role is:

- to prepare proposals for R-D
- to negociate R-D general agreements with various partners
- to administrate R-D contracts awarded to École Polytechnique including:
    - contract research
    - research agreements
    - specialized consulting
    - industrial and scientific testing
    - rental of apparatus and equipment.

- to administer École Polytechnique policy with regard to intellectual property including

    - agreements related to patents and software
    - licencing of technology

- to maintain a liaison with École Polytechnique spin-off enterprises and finally,

- to participate in the activities of an incubator program with the private sector.

Despite of a rather difficult economic situation in the last five years, the R-D contract activities have seen a steady growth and should attain four million dollars in 1987.

Private industry constitutes the main client of the C.D.T. In fact, nearly 60% of all contracts signed at École Polytechnique are with the private sector. Therefore, 18% of all research activities undertaken at École Polytechnique are done in collaboration with the private sector. This situation is most interesting when one considers that in the United States for instance, only 6% of all research is supported by the private sector, while it is even worse in Canada where only 4% of research activities is being supported by the private sector.

Our projects with private industry vary in size, in scope, in objective, in institutional and financial arrangements, in staffing and in success. Some of our activities involve all three sectors (university-government-industry), while others involve only two of them.

Some projects focus on advancing the frontiers of scientific knowledge, with only the most general objective of potential utility to industry or government in the future, while others seek improvement in the quality or productivity of specific industrial operations via application of existing engineering know-how. Some are of a problem solving nature, while others attempt to find uses for new technical knowledge.

One project with the private sector, which is of prime importance to our organization, is related to technology transfer and involves 10 partners, of which 7 are engineering consulting firms and 2 are electrical power utilities.

As many of you know, three of the top ten engineering consulting firms in the world are located in the Province of Québec, namely in Montréal. These consulting firms have grown and attained a world wide reputation in the design and construction of hydroelectric plants, including the huge Manic and James Bay developments.

In order to keep the edge on the worldwide market in this area, we have put together a multi-million dollar project, which we have named CASTOR, CASTOR being a French acronym for Conception Assistée par Ordinateur, or Computer aided design, but also happens to mean BEAVER or BIEBER, in languages which are more familiar to some of you.

These engineering consulting firms are often competitors for the same project. Needless to say, it took a lot of negociations, two years as a matter of fact, to convince these firms to contribute their money and knowledge to work on a project that generated results which would be common to all participants.

We are now in our second year for this project and we feel that these firms will be in a unique position to maintain a worldwide edge in the development of hydroelectric power plants because of new tools that will be available to them. This project constitutes a major technology transfer and it also supplies some most interesting research projects for our researchers and graduate students.

Technology transfer will be made easier if you have a clear policy of intellectual property, namely with regards to patents and software.

École Polytechnique has a policy which we feel is pragmatic, flexible and contains real incentives for its professors and researchers.

First, as in the majority of the universities in North America, École will retain its property rights on patents and software generated by its personnel.

Whenever École judges an invention to be of interest, such that we believe in its potential for technology transfer and in its financial and economic value with regards to commercialization, École will seek legal protection on the invention and will absorb the covering costs.

Simultaneously, École will sign an agreement with the inventors. This agreement will cover the following topics:

- Identification of means to further develop the technology of the invention and of means of financing this development.

- Establishment of the respective roles of École and of the inventors regarding commercialization and the search for industrial partners.

- Establishment of the type of administrative and legal services that École will provide, including the negociations related to the licensing of technology.

- Agreement is also reached on the nature of expenses to be incurred and on sharing of the NET INCOME between École and the inventors.

In this regard, École and the inventors will share evenly the first 50,000 $ of the NET INCOME. When the NET INCOME exceeds 50,000 $, sharing is then 40% for École and 60% for the inventors. When the NET INCOME exceeds 100,000 $, sharing is then 30% for École and 70% for the inventors.

Other matters, such as business plan, market research, venture capital and sources for funding the commercialization of the technology are discussed on an "ad hoc" basis and do not form part of the original agreement between École and the inventors.

I may add, concerning commercialization of new technologies, that École is maintaining a close relationship with Montréal Industrial Innovation Centre. This center is one of two innovation centers created by the Canadian government of few years ago, the other being right here at Waterloo to help universities in the commercialization of the results of publicly founded research.

We believe that spin-off companies are an excellent vehicule to transfer technologies and therefore, we support concretely the direct participation of our professors interested in the commercialization of their invention. The support we offer may be:

- incubation of some enterprises at École
- licensing of technologies to these spin-off companies
- undertaking joint R&D projects and
- providing "ad hoc" administrative and legal services.

École is, however, well aware of potential conflicts of interest for both its personnel and for the institution itself for which training of students remains the main objective. We do all we can to avoid embarrassing situations and for that reason, École has elected not to participate directly in the financing of these spin-off companies, as a shareholder or otherwise.

Since spin-off companies are not all the result of a high-tech project, École will give priority support to those spin-off companies that show the most potential in terms of economic spin-off and technology transfer.

Other types of spin-off companies such as consulting firms, service enterprises, and testing and analysis laboratories also generate employment and they receive a certain support from École.

We now have more than thirty enterprises which in recent years have spun-off from École. More than half of these enterprises are still active.

In order to better illustrate our interaction with spin-off enterprises, I will go over the relationship that École entertains with 9 of these companies.

In the first category, we have two enterprises which are incubating at École, that is Polyplasma Inc. and Polyceram Inc. École supplies floor space and laboratory facilities and participates in joint R&D projects.

In a second category, we have firms to whom École has licensed technology. These licences now constitute the only link between École and these spin-off enterprises.

We have Tektrend International, which is a blossoming company in the fabrication of accoustic correlation equipment, BGH-Multi-Applications Techniques Inc. which is extremely successful in urban planning where it develops software and turn-key packages and, Bionova Inc. which is active in the biomedical instrumentation field.

In another category, we have enterprises with whom École entertains close links by working jointly on R&D projects and/or by having licensed technology.

We have Air-Ins who purchased from École some testing equipment and who set-up testing laboratory facilities. It is interesting to note that the two professors involved in this spin-off enterprise each took a two-year unpaid leave of absence from École in order to start-up their company. This is rather unusual in our system!

We also have Schemacode International which has developed a software tool and Parinova that works in the domain of production processes related to solar energy.

At last but not the least, our "pièce de résistance", le Groupe Culi Inc. Two prominent students who, while they headed our student association (through a persistent lobbying campaign they masterminded) have reached an agreement with a major computer firm which entitled all engineering students in Québec to buy made-in-Québec microcomputers at a 60 percent discount from retail.

They graduated in spring 1985 and founded Le Groupe Culi. They put forward a software development program, that they feel should transform CULI into a software superstar by 1989, with 100 million dollars of annual revenue, 90 per cent from the United States.

Well, some people believe them. First, there is l'Agence québécoise de la valorisation industrielle de la recherche (AQVIR), that is a venture capital provincial government agency, which will finance about one third of this development program, that is 1 million dollars, through an interest-free loan. Each dollar from AQVIR will have to be matched by the private sector. To date CULI has been able to raise 1.2 million dollars from the private sector.

Their approach, called NOMOS, is expected to reach the market place in 1988, carrying an introductory price of about 10,000 $. It is designed to provide engineers and scientists with a variety of flexible software modules, permitting them to easily tailor microcomputer program to specific applications. They compare the modules to LEGO blocks which can easily be shifted around to create a different structure; programming approaches currently in use in the firm's target market do not permit anywhere near this degree of flexibility, they feel.

Well, we also believe in them at École. Last week, we signed with CULI a non-exclusive software-commercialization agreement. This will provide École with another pathway for software developed at École to find its way to the commercial market place.

If they are right, we will have a success story to tell the world ....

Another area in which we are presently active at École is in the establishment of a private incubator program. Dynamic industrial people have sought our help to establish an incubator program in an industrial environment. Amongs services that will be supplied to the start-up companies in incubation at this center, you will recognize the standard services of an incubator such as floor space, receptionist, answering service, access to computer librairies, database systems, shops, laboratories and testing equipment.

But more important is the access by these start-up companies to free consulting through partners who have decided to contribute some resources to the incubator program. Three major consulting firms in management and accounting, in legal services, and in marketing have each contributed 10,000 $ in cash and each 500 man-hours in consulting services. A local bank has contributed a 250,000 $ venture capital fund. Québec Department of Trade and Commerce has contributed 150,000 $ while Employment Canada will contribute nearly 300,000 $ over the next two years. École will be supplying technical consulting, training and laboratory services to industrials that will be accepted in this private incubator program. We believe that École will benefit from the incubator by first contribuing to the creation of new high-tech enterprises and also, by placing in incubation some of its own people (professors, researchers and students) who have technology to commercialize.

We strongly believe that the growth of our links and the projects undertaken with private industry has a great deal of benefits for our institution since:

- it contributes to the financing of our research activities
- it contributes to our research in terms of man-power
- it provides financial support to our students
- it permits us to procure equipment and software we could not have obtained otherwise
- it permits the establishment and financing of generic projects
- it contributes to the transfer of technology to the university and finally,
- it contributes to the economic growth of our country.

Thank you for your kind attention.

ÉCOLE POLYTECHNIQUE

ENGINEERING SCHOOL FOUNDED IN 1873

AFFILIATED TO UNIVERSITÉ DE MONTRÉAL

ÉCOLE POLYTECHNIQUE DE MONTRÉAL

MAIN OBJECTIVES

- Student education
- Advancement of knowledge
- Relations with the industrial community

ÉCOLE POLYTECHNIQUE DE MONTRÉAL

• HUMAN RESOURCES

STUDENTS:	Under-graduate		3 850
	Post-graduate (Master)		725
	Post-graduate (Ph.D.)		160
		TOTAL:	4 735

PROFESSORS:	~215
RESEARCHERS:	~125
OTHER PERSONNEL:	~450

• FINANCIAL RESOURCES

OVERALL BUDGET:		55 000 000 $
RESEARCH BUDGET:		
A) Grants		10 100 000 $
B) Contracts (C.D.T.)		3 600 000 $
C) Internal funds		1 250 000 $
	TOTAL:	14 950 000 $

126

ÉCOLE POLYTECHNIQUE DE MONTRÉAL

TECHNOLOGICAL DEVELOPMENT PRIORITIES

- Two major themes
  - → material engineering
  - → computer engineering

- Major inter-institutionnal collaborations
  - — Computer Research Institute of Montreal
  - — Mineral Exploration Research Institute
  - — International Centre for research and training in major projects management

ÉCOLE POLYTECHNIQUE DE MONTRÉAL

MAJOR RESEARCH UNITS

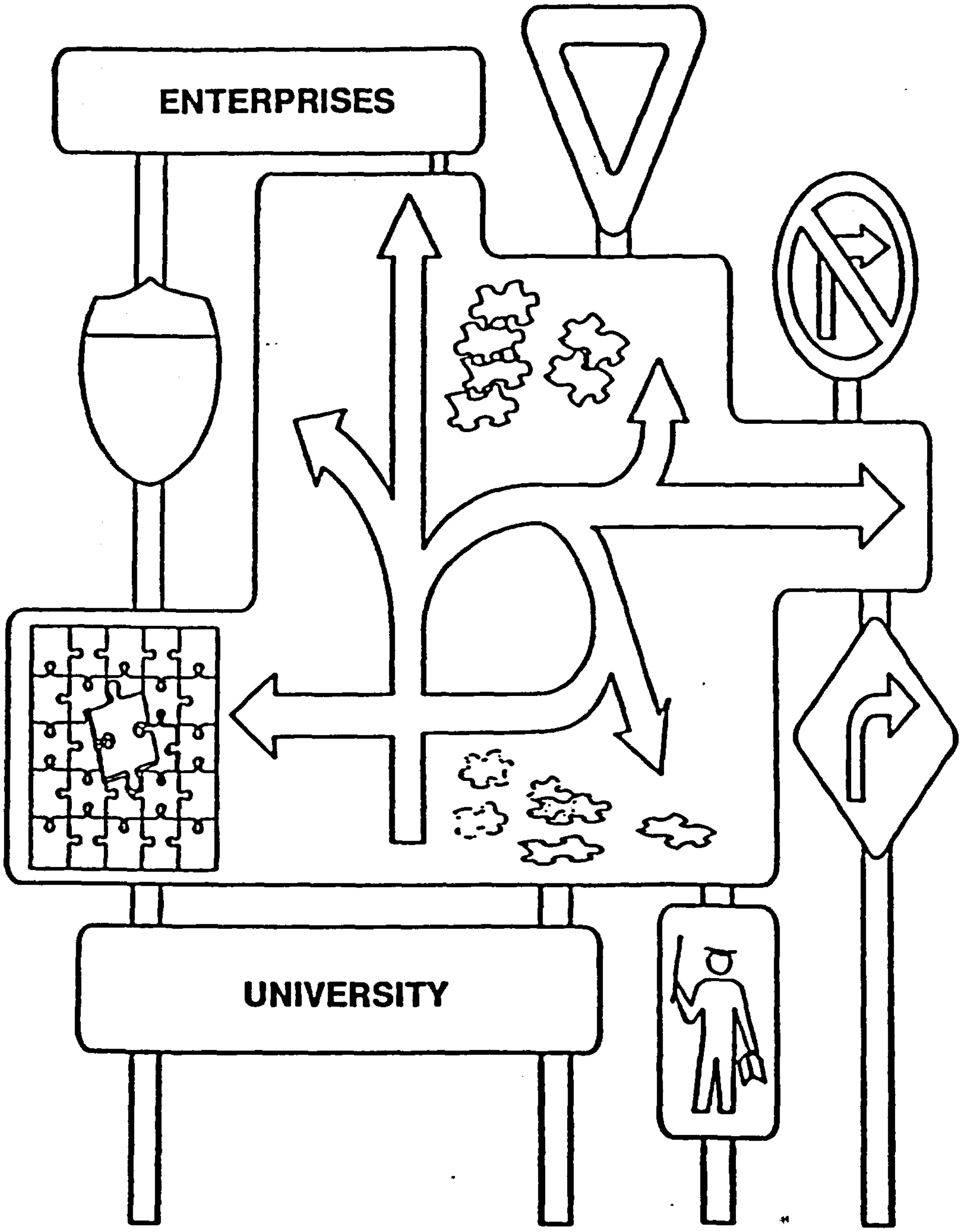
- Northern Research Engineering
- Thermochemical Calculations Research Center
- Thin film physics and engineering
- Polymer engineering
- Plastics and composites
- Ergonomics/Biomechanics
- Biomedical Engineering Institute
- Nuclear analysis and energy engineering
- Hydraulic developments
- Microscopic analysis of materials
- CAD/CAM — Robotics
- Neutron activation analysis
- Mechanical component analysis

ÉCOLE POLYTECHNIQUE DE MONTRÉAL

TECHNOLOGY TRANSFER

- GRADUATE STUDENTS
- SCIENTIFIC PUBLICATIONS/TECHNICAL CONFERENCES
- RESEARCH CONTRACTS/CONSULTING/EXPERTISE
- LICENSING/SPIN-OFF ENTERPRISES
- SHORT COURSES/CONTINUING EDUCATION
- PROFESSORIAL CHAIRS
- INDUSTRIAL EXPERIENCE FOR PROFESSORS
- COOPERATIVE GRADUATE STUDENTS PROJECTS
- ENTERPRISE INCUBATION CENTERS

COLLABORATION POLYTECHNIQUE-ENTERPRISES



"There are three ways to ruin yourself: gambling, women and technology. Gambling is the fastest. Women are the most pleasurable. Technology is the most certain".

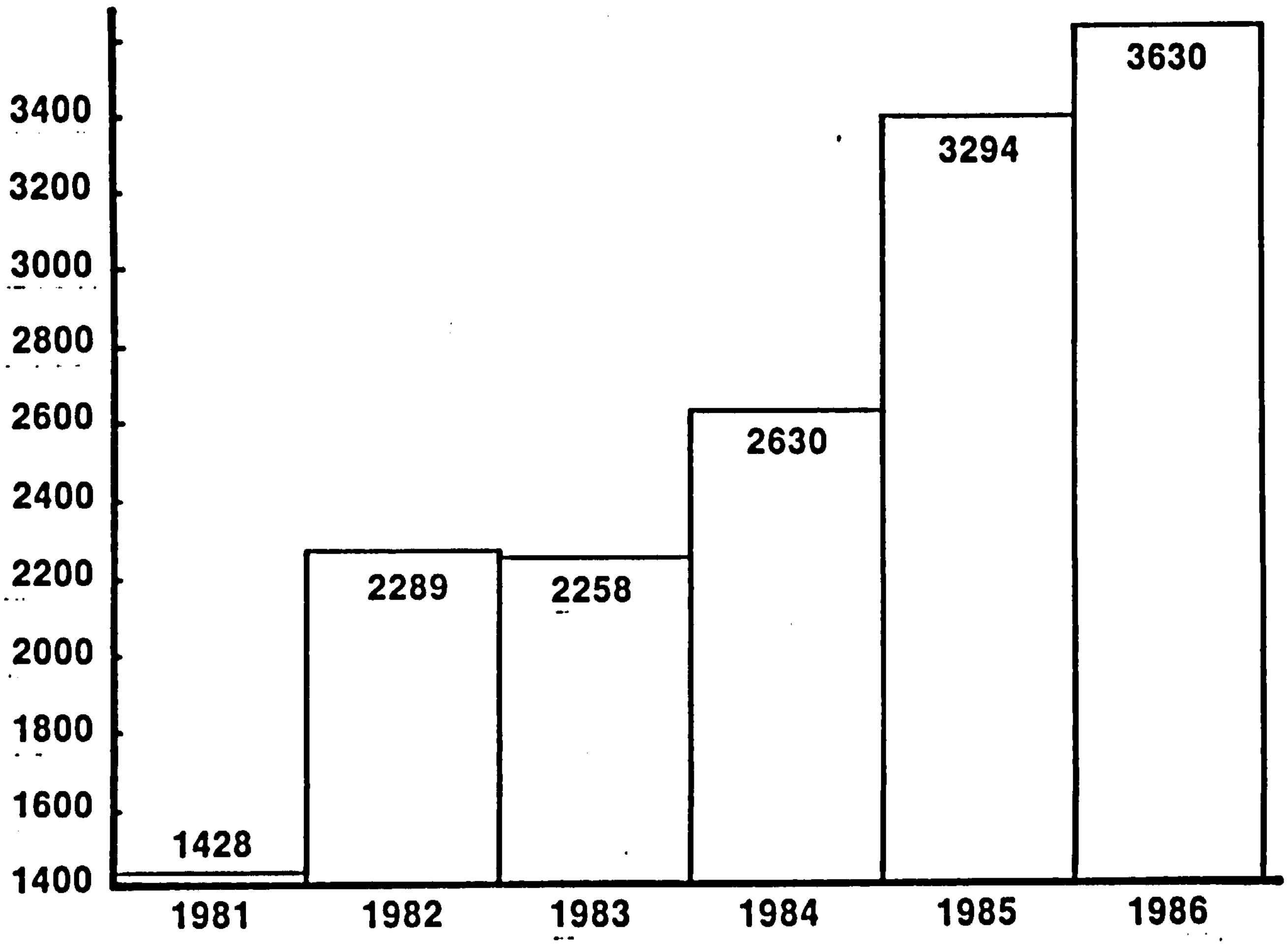
Georges Pompidou

CENTRE DE
DÉVELOPPEMENT
TECHNOLOGIQUE

- **R-D PROPOSALS**
- **R-D GENERAL COLLABORATION AGREEMENTS**
- **R-D CONTRACTS ADMINISTRATION**
  — SPONSORED RESEARCH
  — RESEARCH AGREEMENTS
  — SPECIALIZED PROFESSIONAL CONSULTING
  — INDUSTRIAL & SCIENTIFIC TESTING
  — RENTAL OF APPARATUS, EQUIPMENT, COMPUTER
- **ADMINISTRATION OF INTELLECTUAL PROPERTY POLICY**
  — AGREEMENTS RELATED TO PATENTS AND COPYRIGHTS
  — LICENSING OF TECHNOLOGIES
- **LIAISON WITH UNIVERSITY SPIN–OFF ENTERPRISES**
- **PARTICIPATION IN PRIVATE ENTERPRISES INCUBATION CENTERS**

CENTRE DE
DÉVELOPPEMENT
TECHNOLOGIQUE

R & D CONTRACT GROWTH



x 000 DOLLARS

CENTRE DE DÉVELOPPEMENT TECHNOLOGIQUE

1985-1986 ACTIVITIES

CONTRACTS: 3 631 490 $

SPONSORS: 210

	NUMBER	% $
SMALL & MEDIUM SIZE ENTERPRISES	109	10
LARGE ENTERPRISES	48	50
GOV. OF CANADA	7	20
GOV. OF QUEBEC	10	10
OTHERS	36	10
TOTAL	210	100

CONTRACTS: 234

PARTICULARITY: SELF-FINANCING OF ITS OPERATION

ÉCOLE POLYTECHNIQUE DE MONTRÉAL

EXAMPLES OF AGREEMENT WITH INDUSTRY

Hydro-Québec	Electro-technologies (microwave)
Gaz Métropolitain	Training, research, technology transfer, documentation
IBM Canada	CAD/CAM Research
Mitel Semiconducteurs	Micro-electronics master's degree program
Lavalin	Research and Training (process, instrumentation and controls)
Énergie Atomique du Canada	Software library
Bell Canada	Optic fibres
Canadair Ltée	Cooperative teaching
Pratt & Whitney Aircraft Ltée	Cooperative teaching
Alcan Limitée	Electronic probe
Texel Inc.	Geotextile filters
Dominion Textile	Ergonomics
Circo-Craft Ltée	Printed circuits board
PAPRICAN	Process small-scale model
Bell Helicopter Inc.	Plastics and composites

PROJET CASTOR

INTEGRATED SOFTWARE FOR HYDRAULICS DEVELOPMENTS

Lavalin Inc.
Le Groupe SNC
A.B.B.D.L.
Rousseau, Sauvé, Warren
Dominion Engineering
Montreal Engineering
Lalonde, Girouard, Letendre
Hydro-Québec
Société d'Énergie de la Baie James

Funding: 600K/year

\+

N.S.E.R.C.
funding

850K/year

\+

6 professors
9 researchers
27 graduate students

Funding: 600K/year

Three year program

- Geotechnics
- Turbine design
- Structures
- Hydraulics
- Computer sciences
- Site characterization

ÉCOLE POLYTECHNIQUE DE MONTRÉAL

INTELLECTUAL PROPERTY POLICY

- **APPLICATION OF PROPERTY RIGHTS**
  - ABSORB COSTS RELATED TO LEGAL PROTECTION

- **AGREEMENTS WITH INVENTORS**
  - DEVELOPMENT OF TECHNOLOGY AND MEANS OF FINANCING
  - RESPECTIVE ROLES REGARDING COMMERCIALISATION AND SEARCH FOR PARTNERS
  - ADMINISTRATIVE AND LEGAL SERVICES RE. LICENSING

- **SHARING OF NET INCOME**

	E.P.	INVENTORS
FIRST 50 000 $	50%	50%
UP TO 100 000 $	40%	60%
OVER 100 000 $	30%	70%

ÉCOLE POLYTECHNIQUE DE MONTRÉAL

UNIVERSITY SPIN-OFF ENTERPRISES

- **SUPPORT OF TECHNOLOGY COMMERCIALISATION BY PROFESSORS AND STUDENTS**
- **APPLICATION OF STRICT CRITERIA re. POTENTIAL CONFLICTS OF INTEREST**
- **PRIORITY OF SUPPORT TO HIGH-TECHNOLOGY JOB CREATING ENTERPRISES**
- **CONCRETE CONTRIBUTIONS**
  - — INCUBATION OF SOME INTERPRISES
  - — LICENCING OF TECHNOLOGIES
  - — JOINT R-D PROJECTS
  - — "AD HOC" ADMINISTRATIVE AND LEGAL SERVICES

ÉCOLE POLYTECHNIQUE DE MONTRÉAL

UNIVERSITY SPIN-OFF ENTERPRISES

ENTERPRISE	FIELD OF ACTIVITY
POLYPLASMA INC.	DEPOSITION OF LARGE VOLUME MICROWAVE PLASMA
POLYCERAM INC.	CERAMICS TECHNOLOGY
TEKTREND INT'L LTÉE	ACOUSTIC CORRELATION EQUIPMENT
BGH — MULTI-APPLICATIONS TECHNIQUES INC.	SOFTWARE AND SYSTEMS FOR URBAN PLANNING
BIONOVA INC.	BIOMEDICAL APPARATUS
AIR-INS INC.	NORMALIZED TESTING FACILITIES AND LABORATORIES
SCHEMACODE INT'L LTÉE	SOFTWARE TOOLS
PARINOVA INC.	PRODUCTION PROCESSES
LES LOGICIELS CULI INC.	ENGINEERING SOFTWARE/ MODULES

ÉCOLE POLYTECHNIQUE DE MONTRÉAL

ENTERPRISES IN INCUBATION

ENTERPRISE	ACTIVITY	PERSONNEL	
		FULL TIME	PART TIME
POLYPLASMA inc.	LARGE VOLUME MICRO-WAVE PLASMA	1	2
POLY CERAM	CERAMICS TECHNOLOGY	1	1

ÉCOLE POLYTECHNIQUE DE MONTRÉAL

TECHNOLOGY/SOFTWARE LICENSED

ENTERPRISE	ACTIVITY	PERSONNEL	
		FULL TIME	PART TIME
TEKTREND INT'L	ACOUSTIC CORRELATION EQUIPMENT	10	—
BGH — MULTI-APPLICATIONS TECHNIQUES	SOFTWARE & SYSTEMS FOR URBAN PLANNING	40	1
bionova inc	BIOMEDICAL APPARATUS	—	2

ÉCOLE POLYTECHNIQUE DE MONTRÉAL

— COLLABORATION AGREEMENTS —

ENTERPRISE	ACTIVITY	PERSONNEL FULL TIME	PERSONNEL PART TIME
AIR-INS inc.	TESTING LABORATORY	5	2
Schemacode International LTÉE	SOFTWARE TOOLS	2	1
PARINOVA inc. CONSULTANTS	PRODUCTION PROCESSES	1	1
LE GROUPE CULI INC.	ENGINEERING SOFTWARE	14	—

PRIVATE INCUBATOR PROGRAM

- **ACCESS TO SPECIALIZED EQUIPMENT AND LABORATORIES**
- **PROFESSIONAL CONSULTING** (MANAGEMENT, FINANCE, MARKETING, LEGAL, TECHNICAL)
- **ACCESS TO START-UP & SEED MONEY**
- **INFORMATION** (DATA BASES, GOVERNMENT AID PROGRAMS, TAXATION)
- **FLEXIBLE RENTAL & ACCOMMODATIONS**
- **SECRETARIAL SERVICES**
- **ACCESS TO VENTURE CAPITAL**

ÉCOLE POLYTECHNIQUE DE MONTRÉAL

OUR BENEFITS FROM UNIVERSITY-INDUSTRY COLLABORATION

- Financing of research activities
- Contribution in personnel (200 p/y)
- Financial support for students
- Procurement of software and equipment
- Financing of generic projects
- Transfer of technology to the university
- Contribution to economic growth

GERMAN/CANADIAN WORKSHOP
Waterloo, December 1986

E. White, Manager
Technology Licensing and Sales
Office of Technology Transfer
The University of Calgary
Calgary, Alberta T2N 1N4

I would like to share with you some of the experiences we have had in technology transfer at the University of Calgary.

In recognizing the need to contribute more to the community at large and to assist new business opportunities and economic growth, the University established the Office of Technology Transfer in early 1985.

In brief, the mandate of OTT is to proactively stimulate the commercialization and industrial utilization of University developed products, technologies, expertise and facilities.

We perform two main functions:

(1) Identify, assess, package and move university-developed products and technologies out to the private sector.

(2) Bring contract research serving the needs of the private sector in to the University.

Who Are We?

The Office is small, with 5 people on staff. Our objective is to be up to a full strength of 8 people at the end of 1987. We are working towards a decentralized structure with field officers located in key areas on campus -- engineering, natural sciences, computer science and medicine. Currently we have a field officer in the Department of Computer Science and we are in the process of hiring for the medical faculty in a joint appointment with Foothills Hospital. The key rationale for having personnel physically located in each faculty is the closer day-to-day working relationships that can be developed.

One success of our office is exemplified by the Foothills Hospital assigning the responsibilities for managing their technology transfer activities to the Office of Technology Transfer. The Foothills Hospital is a teaching and research hospital associated with the Faculty of Medicine at the University of Calgary. It is anticipated that OTT could similarly serve a number of institutions in the Calgary area which are related to the University. We are aiming to be extremely community-oriented in this way.

Functions of the Office

I would like to discuss the two main functions of the office, giving examples of some of the approaches we are using in our technology transfer efforts.

Contract Research

Industrial contract research is playing an increasingly significant role within the University. Since the office was established it has generated close to $3 million in industrial contract research, which represents greater than a 30% increase from the previous year.

There are two issues I would like to raise dealing with our experiences in contract research.

i) Contract Performance: When dealing with industry, we have recognized that we will have to be much more 'professional' in our approach to project management. There are faculty who have been doing work with industry for years and understand what is involved. There are others, however, who are more naive. Industry expects professionalism. They expect performance. We have to be prepared to deliver professionalism and performance or our reputation with the private sector will rapidly be tarnished. A contract that we had with a major oil company (for what appeared to be a very exciting technology) was recently terminated because the interim report was less than polished. There also appeared to be very little cooperation between the Principal Investigators and the company's project management people at the outset. Our office found out about this problem five months into the project and after the Principal Investigators had spent $13,000 to deliver a report which probably should have cost $4,000.

On a more positive note, we are currently involved in a $300 K, 3-year research project to develop software for a local company. This project is progressing extremely well, largely due to the fact that we have a full-time project manager overseeing the operation.

What comes out of this is that we need to do some educating of faculty and we need to more closely monitor performance on contract research work.

ii) Joint Venturing: The standard model of contract research is based on a buyer/seller situation. Research is paid for by a company, to be performed at the University, with the company owning the technology that has been developed during the contract period. The University's 'profit' could in this case be an academic profit in that the developed information would be used for teaching and research purposes.

Increasingly, however, the University is promoting a contractual arrangement whereby both the University and the company share in the risk and cost of the research and similarly share in the rewards.

The University, in entering a contractual arrangement such as this, is bringing to the table expertise in the area, prior technological knowledge, facilities and equipment. The company is also bringing prior knowledge to the venture. One then looks at the total package and discussions can take place as to any sharing arrangement of costs and benefits.

Our position is: the more the University contributes, the more the University expects to participate.

We recently finalized an arrangement like this between the University and a company called Willowglen.

Willowglen, a Calgary-based company involved in supervisory control and data control systems for oilfield and other industrial uses, approached the University last year with an interest in assessing some of the technology being developed in the Department of Computer Science and for the development of software for their needs. In particular, they were interested in technology in data management systems for potential inclusion into their various product lines.

The arrangement that was structured between the company and the university is a 3-year contract with a 3-man University-based research group working full-time on the project and with an employee of Willowglen establishing an office on campus and working full-time with this group.

The interesting aspect about this project is that it would probably never have gone ahead if a somewhat innovative approach had not been adopted. Willowglen could not have afforded to have this project undertaken alone. The project went ahead though under the following scenario: the National Research Council of Canada provided financial assistance through one of their programs which encourages industry/university interaction, and the University adopted a more flexible policy. The company is paying a substantially reduced overhead charge and the ownership rights to some parts of the developed software remain with the University. A royalty-free licence though has been given to the company for the use of this software. We feel that this is a win-win situation and one which we hope to emulate in future contracts.

Products & Technologies

The second main function of the office is to identify, assess, package and move university-developed products and technologies out to the private sector.

The first stage in attempting to maximize the marketing success rate is to have an inventory of projects. At the University of Calgary we have hired summer students for the past two summers to construct a database of all research projects on campus. This database is specifically tailored to our needs. By compiling and updating such an inventory, 'hot prospects' are readily identified, and a general assessment of the commercial potential of research projects, including timeframe, stage of development, etc. is provided.

The next stage is to assess these 'hot prospects'. If we have time we use business students in the Faculty of Management to assist in the market assessment of some University-based technologies. Students are a great source of help. While it is a good learning situation for the student, a lot of information can be provided about a product because the student has had the time to research the product. In addition, the service is cheap!

The third stage is the identification of a commercialization strategy. It is critical at this stage to seriously consider the role of the inventor. If the inventor has no interest in commercialization, then we probably would not be overly interested in pursuing its exploitation for we have found that there has to be some level of involvement. On the other hand, if the inventor would like to have a direct role in the commercialization process, the establishment of a spin-off company from the university could be considered. The combinations created by degree of involvement are numerous.

Licence

In our first year and a half we feel that we have achieved certain initial successes in our technology transfer efforts. We have successfully concluded 11 licence agreements covering areas such as DNA sequencing, computer software, surveying and bacteriocidal catheters. We have also generated revenues from the sale of products which, in this timeframe, exceed the total of such earnings by the University in the previous ten years. We feel that we have proven to members of the University of Calgary community that we can successfully licence technology.

I would like to mention one licencing arrangement which we are close to finalizing. We are talking with a large American pharmaceutical company who is interested in diversifying into the area of providing products to treat some sleeping disorders. We had approached the company about 8 months ago with the intent of gauging their interest in a product that was being developed by a medical researcher to treat a problem termed sleep apnea. The arrangement which is being structured includes a licence for the technology, and it also includes a long-term consulting arrangement. The key point to mention is this long-term arrangement. It is well known that the chances of a successful technology transfer activity are significantly enhanced by developing an excellent long-term working relationship, which will ultimately result in a more successful promotion of the licenced technology.

Another example of a licencing arrangement involves a researcher in the Faculty of Medicine who has developed the technology for the production of some DNA probes. We started discussions for the licencing of this technology with an American firm which, as it happened, did not go to completion. Meanwhile, Boehringer-Mannheim, a large German pharmaceutical company, had learned of this technology and as soon as discussions ceased with the American company Boehringer-Mannheim was contacted. The end result was a successful licensing arrangement which was concluded very quickly. We feel that an excellent working relation has developed between both the technical and business staff of Boehringer-Mannheim and our office and the researcher.

While we are excited about this arrangement, in some respects, we have a regret in that this technology, which was financed by Canadian taxpayers, is not being developed in Canada, thereby losing a potential for economic growth and jobs.

Spin-offs

Following on from the example I just mentioned, I would like to point out that our office is currently undertaking a slight reorientation in our objectives. We have proven that we can licence technology. But when we look around, we see that there are substantial opportunities for establishing new spin-off companies, based on technology developed at the University. Historically, the University of Calgary has not been active in the establishment of companies. In fact, prior to less than a year ago, the University had not been directly involved in the establishment of any companies. We are currently working on setting up two companies, and there are a number of researchers we are talking with who have expressed interest in exploring this opportunity. The motivation for the researcher to work closely with the University when a company is being established is that the University has, I believe, expertise in a number of key areas in the start-up phase. To offer an example, one of the companies being set up is based on the work of a professor in the Department of Chemistry. A mutually beneficial arrangement has been structured. The Office of Technology Transfer and the New Venture Development Group, which is part of the Faculty of Management, are both very involved in assisting in the establishment of this company. Benefits to the University will be through contract research and the University also has a vested interest in the company by way of a 10% equity position. We feel that we have a valuable role to play in providing advice, assistance and encouragement, and we are looking to University's such as Waterloo and UBC, both of whom have been successful in this regard.

I would like to now tell you more about the New Venture Development program which I mentioned. This program, which is only one of a few in North America, is offering education in entrepreneurship. The program was established to offer education to entrepreneurs to assist in business start-up and operation.

Our office has developed very close ties with this program in a number of ways including having the Director of OTT on the New Venture Group Board of Directors:

1) We use the students of this program to assist in the market assessment of some University-based technologies.

2) We have presented University technologies to entrepreneurs in a course called 'New Venture Opportunities'. Four University technologies are being assessed for potential establishment of start-up companies amongst the 12 students in the course this term. Essentially the aim is to match entrepreneurs who have extensive business experience and who are looking for new business opportunities with projects. This could turn out to be a major vehicle to transfer technology out of the University to the marketplace. This can also be a mechanism to address the critical issue of having an excellent team of people with expertise in the variety of areas necessary for the operation of a company.

3) Finally, students and professors provide assistance and guidance to University researchers who are contemplating establishing a spin-off company. Currently, about 4 or 5 professors are discussing the possibility of this with the New Venture Development group.

In general therefore although spin-offs are riskier than going the licencing route, and a substantial amount of time is needed to establish and assist a new company, they are more fun to do, and the potential for significant economic and financial benefits to the community at large is present.

Seed Capital

A large percentage of the projects that we are currently working with are medically-related. This can be attributed in large part to the significant level of funding provided by the Alberta Heritage Foundation for Medical Research. You might be interested in learning of a program established by the Heritage Foundation which provides two levels of technology transfer funds for medical research. There is a $25,000 grant which was awarded to 5 medical researchers at the University. This award must be used for prototype development of a medical technology. A second level is a grant of $75,000 to be used to conduct market research and further refinement of the technology towards more of a market-ready stage. We feel that the accessibility of seed capital to assist university entrepreneurs with the further refinement of their developments would significantly increase the survival rate for ideas crossing the university/business interface. This can be supported based on our experience with the Alberta Heritage Foundation for Medical Research program, through which we are seeing direct results by way of a large number of medically related products which are available for commercialization.

In this regard, our office is actively exploring various avenues from which to derive funds to be used to further develop projects.

Conclusion

In summary, I would like to make the statement that universities are arguably the source of new products and technologies. While certain initial successes have been realized in our technology transfer efforts, I would claim that the success of universities in general in transferring these products and technologies to the private sector is mediocre at best.

We are in the early stages of the learning curve. Our first year and a half has been one of exploring a variety of approaches to effective technology transfer. Through experiences in certain areas we have found organizational structures and methods, which at this point in time appear to have potential for a certain amount of success in our environmental setting. OTT is a business-learning, results-oriented office, comprising one of the major ways in which the University can contribute to the community at large. As we enter the next phase in our operations OTT will continue to play a vital linking role in the process.

NEW VENTURE DEVELOPMENT
at the University of Calgary

ARE YOU INNOVATIVE AND ENTREPRENEURIAL?

The New Venture Development Program utilizes the resources of the University of Calgary to support new, innovative business formation. The New Venture Development Group seeks to work with entrepreneurs who:

a) have creative ideas for ventures that will potentially contribute to the base economy of Alberta

b) are in early stages of venture development expansion

c) are cooperative and willing to commit time and effort to others in the process

d) have demonstrated substantial commitment to their venture

e) are seeking supportive affiliations with others

f) may have competitive advantages based upon technical advances

g) are actively seeking business assistance that they could otherwise not afford

We also seek to work with:

- investors and venture capitalists who recognize early stage ventures as attractive investment opportunities
- bankers and merchant bankers interested in financing venture development
- innovators, including inventors and R&D personnel with inventive ideas
- members of institutions and agencies committed to new venture development
- service and professional organizations with expertise in new venture development (e.g., lawyers, accountants, small business consultants, market researchers)

PROGRAMS FOR ENTREPRENEURS

Student Assistance for Entrepreneurs - Projects

To develop a venture from concept to commercialization, an entrepreneur faces many challenges. The New Venture Development Program facilitates this process by providing graduate and selected fourth or year undergraduate students to assist you in the development of your venture. The students provide the assistance through project work in university courses which are relevant to the entrepreneur's needs. Contributions come from talented and mature students in Management, Law, Industrial Design and Engineering. Some areas in which students can help include:

- opportunity analysis
- market feasibility & product design
- market research
- strategic planning
- financial planning & packaging
- information systems analysis
- communication audits
- legal analysis
- prototype development

In addition, students can draw on the unique combination of knowledgeable and dedicated teachers and mentors from both the academic and private sectors.

The educational nature of the program necessitates that projects fit course requirements and timing. Also, the students choose the venture they are interested in, therefore we cannot guarantee that every client's new venture idea will become a project. The entrepreneur is responsible for related out of pocket expenses.

Contact: Laurie Lancaster, 220-3371

PROGRAMS FOR ENTREPRENEURS cont'd

Legal Assistance Clinic

Student legal assistance for small business business is available at no charge. Third year law students specializing in business planning, supervised by members of the downtown bar, provide general information on typical legal problems such as:

- business formats
- product liability
- tax planning
- structuring business agreements
- patents, trademarks, and copyrights
- business liability

This services is made possible through the cooperation of Prof. Catherine Brown of the the Faculty of Law and the students in the Law Faculty's Business Planning Practicum Program.

Contact: Astrid Wilson, 220-6117

New Enterprise Development

This Program is designed for early-stage entrepreneurs and provides educational support which parallels the development of one's new business. The objective of the course is to help entrepreneurs increase their probability of success. Aspiring entrepreneurs will do their own information gathering, analysis and presentation, and students taking a concurrent course in new venture consulting will provide personalized assistance. The course operates over a 20 week period with opportunities for continued assistance.

Contact: Astrid Wilson, 220-6117

Action Learning for Owner/Managers

The Action Learning Program for Owner/Managers designed to provide owners and managers of successful small to medium sized enterprises with an instructional setting where they work with business peers on growth strategies for their companies. The Program consists of guided workshops and a series of seminars with guest lecturers addressing the challenges of growth. Participants may choose to take only the seminar series or the full program.

Contact: Brad Rush, 220-3805

Special Topics

Special topic sessions and courses are is held throughout the year. Working sessions have been conducted on:

- government support programs
- new venture marketing
- Small Business Equity Corp. legislation
- export marketing
- management of technological innovation

Participation has come from the university faculty, entrepreneurs, and the business community.

Contact: Kathy Rendall, 220-3378

NB: A fee is charged to entrepreneurs participating in the New Enterprise Development and Action Learning Programs.

PROGRAMS FOR ENTREPRENEURS cont'd

University Courses that May Interest You

There are a number of university courses which provide hands-on experience in new business development.

Those with appropriate high school pre-requisites who want a general introduction to business may sign up for the Introduction to Business course (POEN 201). At the senior undergraduate level there is an overview course in new venture development, Introduction to Entrepreneurship (MOHR 481). The majority of our courses are at the Master's level. People with undergraduate status may be able to register for some of the following courses, depending on academic qualifications and availability:

- new venture development overview (MOHR 781)
- opportunity identification (MOHR 799.09)
- new product development (MKTG 785)
- venture planning (POEN 783)
- new venture finance (FNCE 799.0_)
- strategic marketing (MKTG 793)
- new venture financial information systems (ACCT 785)
- technological innovation (MOHR 799.07)
- new venture consulting (MKTG 799.0)
- new venture law (POEN 793)

NETWORKING

New Venture Forums are conducted regularly on the last Tuesday of every month. The purpose of the Forums is to make contacts and provide useful knowledge and information for the benefit of community entrepreneurs, business people and investors. Topics have included:

- internationally reknowned speakers with specific areas of expertise in new venture development
- business plan presentations to potential investors
- information on funding
- legal issues
- marketing issues
- incubation facilities
- business support services for entrepreneurs

Monthly Bulletins are issued to inform the Network membership of the details of each Forun.

Joining the Network

Membership in the New Venture Network Network entitles you to receive the monthly Bulletin and to attend all the Forums.

Contact: Kathy Rendall, 220-3378

TECHNOLOGICAL INNOVATION

University scientists and engineers frequently develop ideas and inventions which are commercially promising. This program provides consultation for innovative faculty members who wish to launch new businesses. The program facilitates team formation between academics and members of the business community to provide expertise in all aspects of venture development.

Contact: Dr. Cristina Castro, 220-7820

NEW VENTURE SHOWCASE

Luncheon meetings are held in conjunction with sponsors from the business community. At these functions selected clients of the New Venture Development Program have an opportunity to make presentations to local investors. The Showcase is designed to provide an opportunity for feedback on the quality of the projects and presentations. We measure the success of the meetings by improvements in our programming and by the ultimate success of our clients in financing their ventures.

Contact: Dr. Wayne A. Long, 220-7247

We encourage you to contact our office for further information on the services and benefits available through the New Venture Development Group. Call 220-6117 or 220-5101.

NEW VENTURE DEVELOPMENT GROUP

Members of the group include individuals from the following faculties or departments at the University of Calgary:

Faculty of Management
Department of Industrial Design
Faculty of Law
Faculty of Engineering
Department of Computer Science
Department of Bio-Chemistry
Office of Technology Transfer

COMMERCIALIZATION OF PUBLICALLY FUNDED RESEARCH

at the UNIVERSITY OF BRITISH COLUMBIA, VANCOUVER, CANADA

SOME EXAMPLES AND EXPERIENCES

by

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Prepared For the German/Canadian Workshop on Commercialization of the Results of Publicly Funded Research

University of Waterloo
Waterloo, Ontario

December 2, 3, 4, 1986

* Speaker

A B S T R A C T

Commercialization of Publically Funded Research at the Univerisity of British Columbia, Vancouver, Canada: Some Examples and Experiences

The University of British Columbia (UBC) enrolls more than 34,000 students in credit courses each year. There are 1814 faculty and an experienced technical support staff of 3,000 who provide expertise not only in the traditional arts and sciences, but also in medicine, pharmaceutical sciences, engineering, agriculture, forestry, education, law, and commerce and business administration. In 1985-86, the faculty generated $63.2 million in research grants and contracts, much of it won in a rigorous peer review system, both nationally and internationally. In the past two years the number of faculty has decreased seven per cent, but research funding has increased thirty per cent. The big three research faculties are: medicine, science, and engineering, respectively.

Research funding comes from Canadian federal agencies (67%), foundations (15%), British Columbia provincial agencies (8%), Canadian companies (5%), and U.S. and foreign agencies (5%).

Commercialization of the results of publically-funded research takes place either through the formation of new spin-off companies, or through licensing technology to existing companies.

Spin-off companies are defined as those that owe their origin, directly or indirectly, to the presence of UBC. They may be formed by faculty, staff, or students leaving the University to utilize general know-how to produce goods and services for the marketplace, or they may be formed by the same group directly licensing some research product. UBC holds licences on eight such innovations. Examples of both types of technology transfer will be discussed, including first, second and third-generation spin-off companies. The University currently recognizes some 52 such spinoff companies which have been formed in the last 15 years. These 52 companies directly employ 1650 people and in 1985 had sales in excess of $88 million.

Commercialization of the products of publically-funded research through licences to existing companies are an important but generally smaller activity. UBC currently holds seven such licences and is negotiating a number of others. However, completion of the patent and "know-how" data base, which we are currently developing, plus more vigorous marketing should help expand this activity.

INTRODUCTION

The University of British Columbia (UBC) is located in the city of Vancouver in Canada's westernmost province, and is situated on a Pleistocene and bedrock peninsula overlooking the Strait of Georgia which connects to the Pacific Ocean. The campus is adjacent to an 800-hectare forest called the University Endowment Lands which is under the jurisdiction of the Greater Vancouver Regional District Parks Department and the provincial government. The University itself owns the following land:

UBC Campus	402.7	hectares
University Research Forest... Haney, B. C.	5,157	hectares
Oyster River Research Farm.... Vancouver Island, B.C.	607	hectares

In terms of student population, UBC is the second largest English language university in Canada and the oldest in the province. It was incorporated by the provincial government in 1908, admitted its first student in 1915 and moved from the downtown out to its present location in 1925.

The University grew steadily during the late 1920s and 1930s. In 1945 enrollment climbed from 2,500 to almost 10,000 as the Second World War veterans returned to the campus. Rapid enrollment expansion continued in the 1950s and 1960s but has levelled off somewhat in more recent years.

Projected session enrollments for degree programs in 1986-87 are as follows:

Winter Session 1986-87 Daytime	
Undergraduate	20,907
Graduate	3,961
Winter Session 1986-87 Evening	691
Spring Session (May-June, 1986)	3,219
Summer Session (July-Aug.,1986)	3,275
Guided Independent Study (Correspondence)	1,328
Projected Registration in non-credit, non-degree programs, 1986-87	61,750

UBC offers undergraduate and graduate degrees through 12 faculties as follows:

- Agricultural Sciences
- Applied Sciences (Engineering)
- Arts
- Commerce & Business Administration
- Pharmaceutical Sciences
- Education
- Forestry
- Graduate Studies
- Law
- Medicine
- Dentistry
- Science

In the 1986-87 academic year, UBC has the following budget:

General Purpose Operating Budget - Exclusive of Research Funding	$ 223 million
<u>Source of General Purpose Operating Income</u>	
Provincial Goverment	79.5 %
Student Fees	18.7 %
Investment Income	1.5 %
Miscellaneous	.3 %
Projected 1986-87 Research Budget	$ 67 million

RESEARCH RESOURCES AT UBC

PEOPLE

The University's most valuable resource is its 1814 faculty members and its experienced technical staff of 3000. Their expertise in such areas as science, medicine, engineering, agriculture, and forestry is world class. In the past year, the University's faculty generated more than $63 million in research grants and contracts, much of it won in open competition from outside the province in a rigorous peer review system.

In the past two years, the number of faculty has decreased seven per cent but research funding has increased thirty per cent. The big three research faculties are: medicine, science and engineering, respectively. Research funding comes from Canadian federal agencies (67%), foundations (15%), British Columbia provincial agencies (8%), Canadian companies (5%) and U.S. and foreign agencies (5%).

UBC LIBRARY

UBC's $300 million library system is the largest research collection in Western Canada, and the second largest in Canada. It contains over 2.6 million bound volumes and 4.5 million works in other formats housed in 16 separate libraries located on and off campus.

COMPUTING

UBC's large computer network features one IBM and three AMDAHL mainframe computers supporting approximately 1500 to 2000 campus terminals and microcomputers with connections to local, national and international computer networks. In addition, many research groups have dedicated access to a variety of specialized computer equipment such as array processors, AI workstations, DEC VAXs and other intermediate capacity computers.

LABORATORY FACILITIES

UBC is well equipped with state-of-the-art laboratory facilities which are continually being augmented by successful equipment and infrastructure grants from national agencies. The equipment on hand includes a Fourier transform mass spectrometer designed at UBC, GC and LC mass spectrometers, 3 nuclear magnetic resonance (NMR) devices, a world class imaging facility, plus microprobes and other facilities available nowhere else in the province.

RESEARCH SERVICES AND INDUSTRY LIAISON

The commercialization of publically funded research at the University of British Columbia is the responsibility of the Office of Research Services and Industry Liaison. This function was originally handled by the Office of Research Administration where the roots of many of today's stories began, as long as ten to fifteen years ago. In the spring of 1984, Industry Liaison was added to Research Services, the staff was increased from four to ten over two years, and a major five year operating grant was successfully negotiated from the Canada-B.C. Economic and Regional Development Agreement (ERDA) under the auspices of the federal Ministry of State - Science and Technology and the B.C. Ministry of Economic Development.

Prior to 1982, commercialization of publically funded research at UBC had a low priority with limited resources available to expedite this process. In spite of this, a number of important commercializations took place, in part through the assistance of Canadian Patents and Developments Limited. Today, the necessary resources have been provided, progressive policies are in place, the faculties are interested and cooperative. Success or failure rests with the management of the program.

COMMERCIALIZATION OF THE RESULTS OF PUBLICALLY FUNDED RESEARCH THROUGH THE FORMATION OF NEW SPIN-OFF COMPANIES BY FACULTY, STAFF AND STUDENTS LEAVING UBC

Spin-off companies are defined as those that were formed either by transfer of technology through licensing of patents or "know-how" or through the transfer of people.

One of the major ways technology is transfered from the University is through faculty, staff and students leaving the University to utilize general "know-how" gained from University courses and research to produce goods and services for the market place.

In order to have state-of-the-art "know-how" that leads to good innovations, the universities must strive for and conduct excellent research. They need a good research infrastructure and the ability to support a faculty allowed to work on the leading edge of science and technology.

At the University of British Columbia, some 44 of the 52 spin-off companies recognized to date, originated from the transfer of people from the University to the industrial world. Once this process is begun and the spirit of innovation and entrepreneurship is established in a group, it leads to the creation of second and third generation spin-off companies.

A case in point would be MACDONALD, DETTWILER AND ASSOCIATES (MDA). This company was started by Dr. John MacDonald, Department of Electrical Engineering and Dr. Vernon Dettwiler from the UBC Computing Centre. They started a company that specialized in designing and building ground station systems and image analysis systems for meteorological and remote sensing satellites. This company currently employees more than 500 people. In 1985, it had sales of $26 million and conducts business around the world.

MDI MOBILE DATA INTERNATIONAL INC. is a second generation spin-off that grew out of an innovation at MDA. MDI developes, manufactures and markets mobile data communication systems. They market data terminals for the following:

(1) police and public safety
(2) taxi companies
(3) utility companies, health care users and businesses.

In 1985, MDI had sales of $25 million and employed 260 people.

CREO ELECTRONICS CORP. is in turn a third generation spin-off company that grew out of MDI and MDA. They are developing an optical storage data system. All the technical staff came from UBC and they employ fourteen people directly and in 1985 had sales in excess of $1 million.

Once these spin-off companies start, internal technical need often drives innovation. For example, MDA's satellite data processing group required a special type of film recorder. They developed one to meet this internal need. However, it was so successful that they spun-off a separate division that is really a separate company called The Electro Optics Products Division. This organization found their film recorder could be marketed widely for plotting of printing circuit boards, graphic arts and other areas. Today, The Electro Optics Products Division directly employs 110 people and has sales of $15 million.

The bottom line of all these spin-off companies is very clear - that is, without UBC there would be no MDA, no MDI, no CREO and no Electro Optics Products Division.

COMMERCIALIZATION OF THE RESULTS OF PUBLICALLY FUNDED RESEARCH THROUGH THE FORMATION OF NEW SPIN-OFF COMPANIES BY LICENSING UBC TECHNOLOGY, PATENTS OR "KNOW-HOW"

Some eight of the 52 UBC spin-off companies, currently recognized, owe their origin directly to the licensing of UBC technology or indirectly from UBC through CPDL. Some relevant data on this type of spin-off are given below:

COMPANY	INNOVATION		FOUNDERS	EMPLOYEES
ITA (INVERSE THEORY & APPLICATION)	Geophysical Data Processing Programs	1981	UBC Faculty & Students	14
* LIPEX BIOMEMBRANES	Pharmaceutical Encapsulation Technology	1985	UBC Faculty & Staff	6
** MOLI ENERGY LTD.	Rechargeable Li-Mo Battery	1977	UBC Faculty, Staff & Businessman	128
NAROD GEOPHYSICS LTD.	Ring Core Magnetometer	1984	UBC Faculty	2
NU-FOODS	Non-dairy Frozen Dessert	1984	UBC Faculty & Businessmen	4
QUADRA LOGIC TECHNOLOGIES	Diagnostic Products Used In Treatment of Human & Animal Diseases	1981	UBC Faculty	42
TIR SYSTEMS LTD.	Light Pipe That Can Transmit Light	1983	UBC Faculty & Student	20
VORTEK INDUSTRIES LTD.	Ultra-Powerful Lamp Used In Outdoor Lighting and Semi-Conductor Annealing	1975	UBC Faculty & Student	16

* License not completed
** UBC holds equity position

For all of these aforementioned companies, UBC holds a royalty bearing licence agreement which is based upon a percentage of sales except in the case of MOLI ENERGY. In the case of MOLI, UBC rolled over a gross over-riding royalty on sales into an equity position to facilitate business transactions and to overcome the problem of "bundling" the batteries produced into other devices.

Furthermore, in all cases, except QUADRA LOGIC TECHNOLOGIES, all the licences are for a specific, identifiable product or program. The QUADRA LOGIC TECHNOLOGIES agreements are, however, "know-how" agreements.

COMMERCIALIZATION OF THE PRODUCTS OF PUBLICALLY FUNDED RESEARCH THROUGH EXISTING COMPANIES

Commercialization of the products of publically funded research through licences to existing companies are an important but generally smaller activity. UBC currently holds seven such licences and is negotiating a number of others.

The most significant of these licences is for an X-400 electronic messaging software program which was licensed to SYDNEY DEVELOPMENT LTD., Vancouver, B. C. SYDNEY markets this software world wide under the trade name MESSENGER 400. It has been selling extremely well in Europe, Canada and the United States.

We are currently compiling a patent and "know-how" data base. Once this is completed and combined with more rigorous marketing, a number of other licences of this type should develop.

THE UNIVERSITY OF BRITISH COLUMBIA (UBC) LAND

UBC CAMPUS
402.7 HECTARES

UNIVERSITY RESEARCH FOREST,
HANEY, B.C. 5,157 HECTARES

OYSTER RIVER RESEARCH FARM,
VANCOUVER ISLAND, B.C. 607 HECTARES

UNIVERSITY OF BRITISH COLUMBIA
ENROLLMENT WINTER SESSION

1986-87 DAYTIME UNDERGRADUATE	20,907
1986-87 DAYTIME GRADUATE	3,961
1986-87 EVENING WINTER SESSION	691
MAY/JUNE 1986 SPRING SESSION	3,219
JULY/AUGUST 1986 SUMMER SESSION	3,275
GUIDED INDEPENDENT STUDY (CORRESPONDENCE)	1,328
PROJECTED REGISTRATION IN NON-CREDIT & NON-DEGREE PROGRAMS, 1986-87	61,750

UNDERGRADUATE & GRADUATE DEGREE PROGRAMS IN 12 DIFFERENT FACULTIES

Agricultural Sciences
Applied Sciences (Engineering)
Arts
Commerce & Business Admin.
Dentistry
Education
Forestry
Graduate Studies
Law
Medicine
Pharmaceutical Sciences
Science

THE UNIVERSITY OF BRITISH COLUMBIA
BUDGET FOR 1886/87

GENERAL PURPOSE OPERATING BUDGET
(EXCLUSIVE OF RESEARCH FUNDING)

$223 MILLION

SOURCE OF GENERAL PURPOSE OPERATING INCOME

PROVINCIAL GOVERNMENT	79.5%
STUDENT FEES	18.7%
INVESTMENT INCOME	1.5%
MISCELLANEOUS	.3%

RESEARCH FUNDING (PROJECTED) $67 MILLION

UNIVERSITY OF BRITISH COLUMBIA
RESEARCH SERVICES AND INDUSTRY LIAISON

GRANTS

ETHICAL REVIEWS (CLINICAL & BEHAVIOURAL)
& ANIMAL CARE

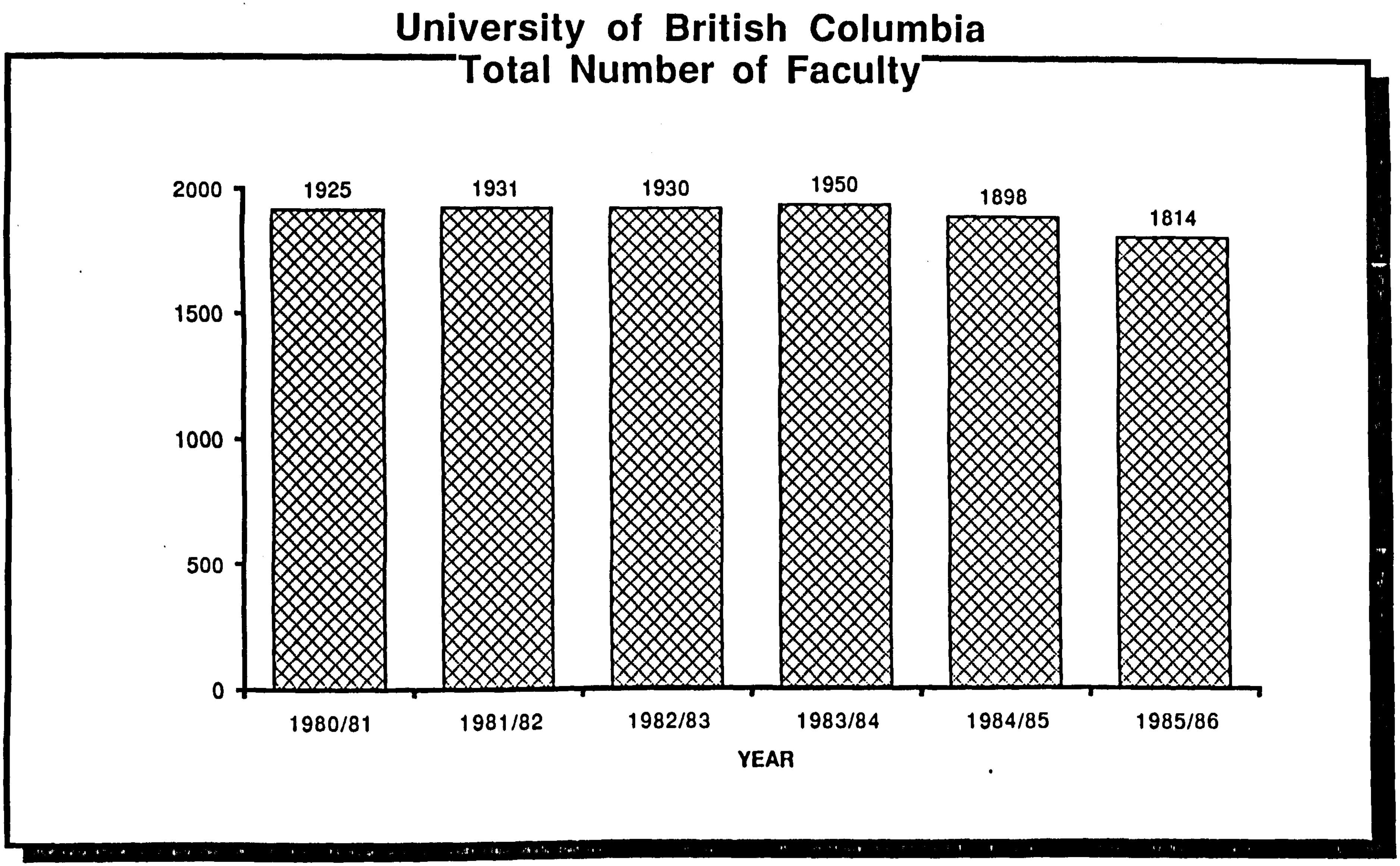
CONTRACTS (FEDERAL, PROVINCIAL & INDUSTRIAL)

COLLABORATIVE RESEARCH PROGRAMS

PATENTS, TRADEMARKS, COPYRIGHT & TRADE SECRET
PROTECTION

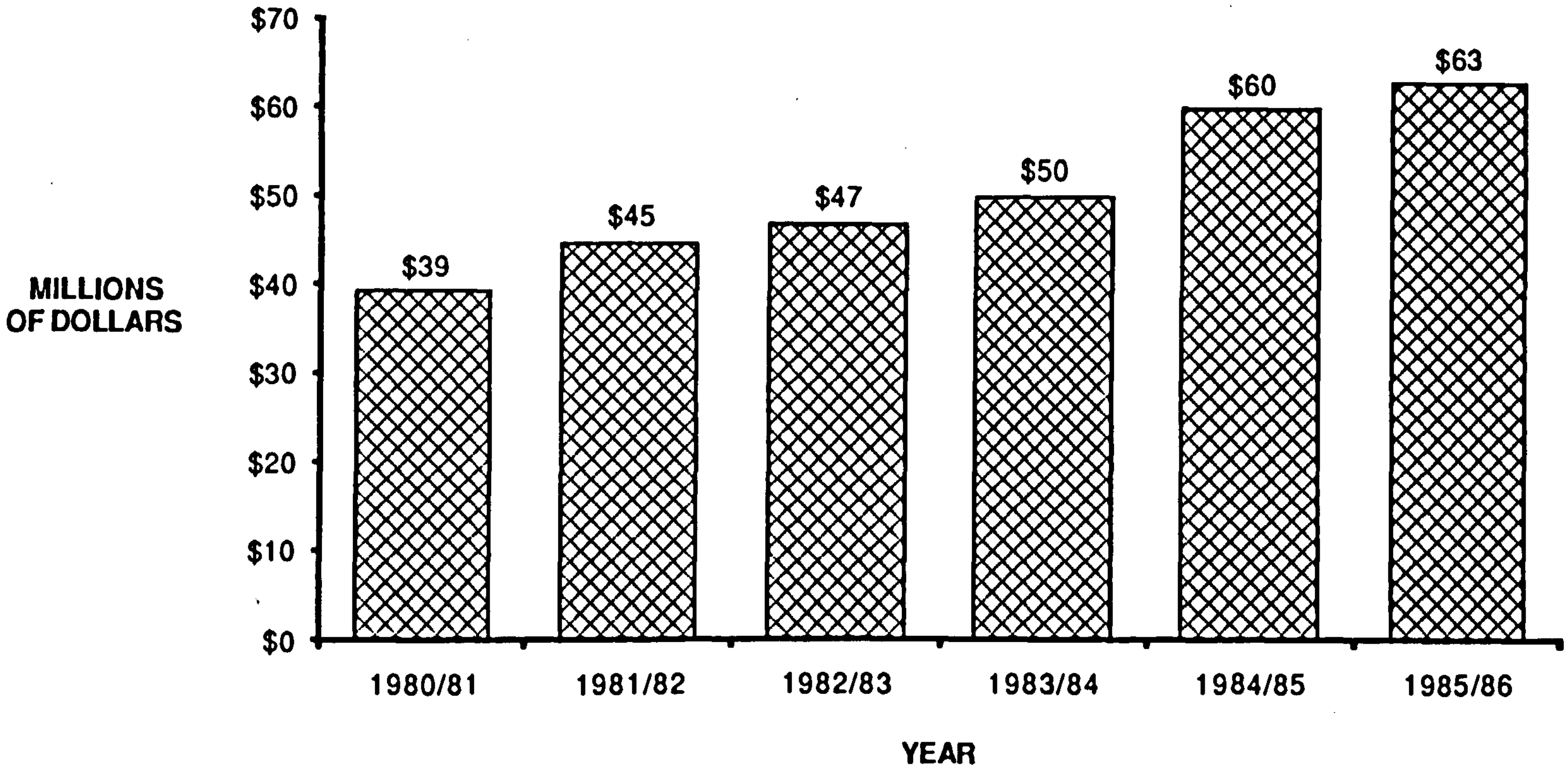
LICENSING

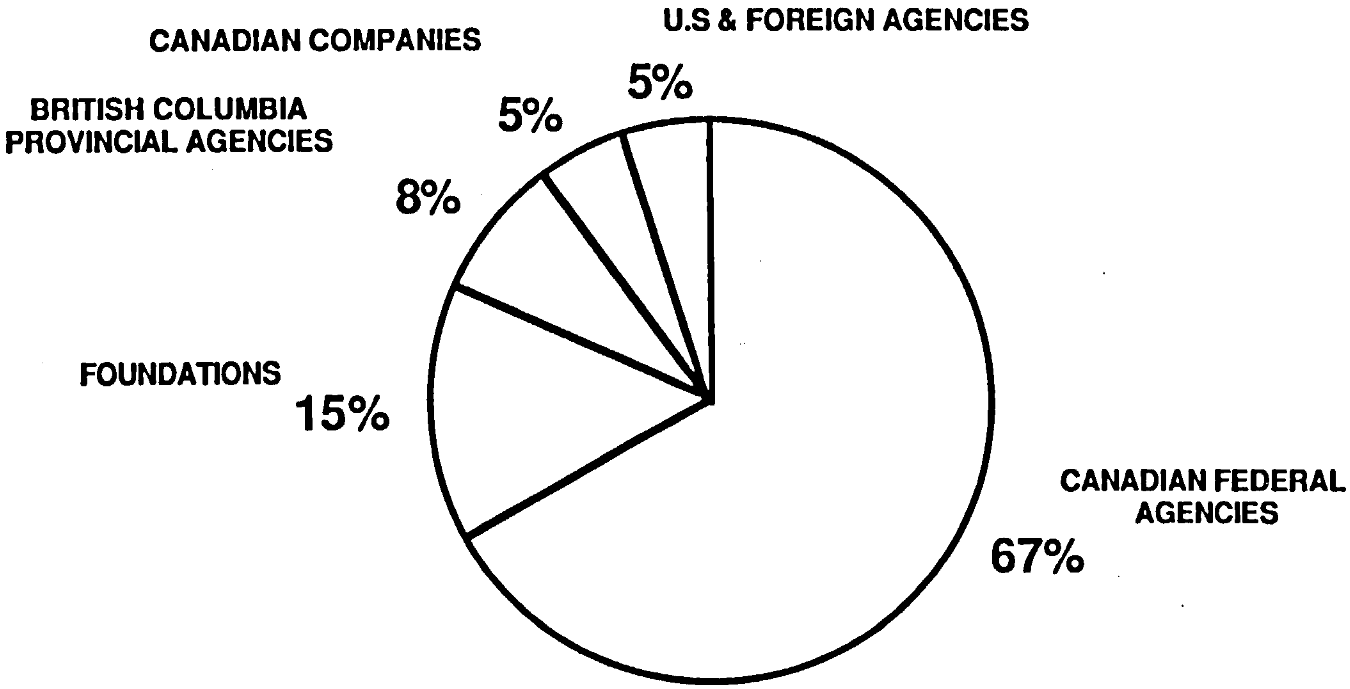
SPIN-OFF COMPANIES



University of British Columbia
Total Number of Faculty
2000
1500
1000
500
0
1925
1931
1930
1950
1898
1814
1980/81
1981/82
1982/83
1983/84
1984/85
1985/86
YEAR

University of British Columbia
Total Value of Grants & Contracts





SOURCES OF RESEARCH
FUNDING AT UBC 1985/86

THE UNIVERSITY OF BRITISH COLUMBIA
RESEARCH AWARDS 1985/86

AGRICULTURAL SCIENCES	2,479,522	3.9%
APPLIED SCIENCES	6,986,891	11.1%
ARTS	2,971,702	4.7%
COMMERCE & BUSINESS ADMIN.	492,490	.8%
DENTISTRY	876,317	1.4%
EDUCATION	1,309,568	2.1%
FORESTRY	1,314,424	2.1%
GRADUATE STUDIES	2,533,442	4.0%
LAW	303,329	.5%
MEDICINE	22,834,168	41.1%
PHARMACEUTICAL SCIENCES	1,954,056	3.1%
SCIENCE	18,559,452	29.4%
MISCELLANEOUS	280,139	.4%
TOTAL AWARDS	63,231,613	

SPIN-OFF COMPANIES FORMED BY FACULTY, STAFF AND STUDENTS LEAVING UBC (TECHNOLOGY TRANSFER THROUGH PEOPLE).

FORTY-FOUR COMPANIES RECOGNIZED TO DATE.

MACDONALD, DETTWILER & ASSOC. (MDA) THE LARGEST WITH 500 EMPLOYEES & SALES GREATER THAN $26 MILLION.

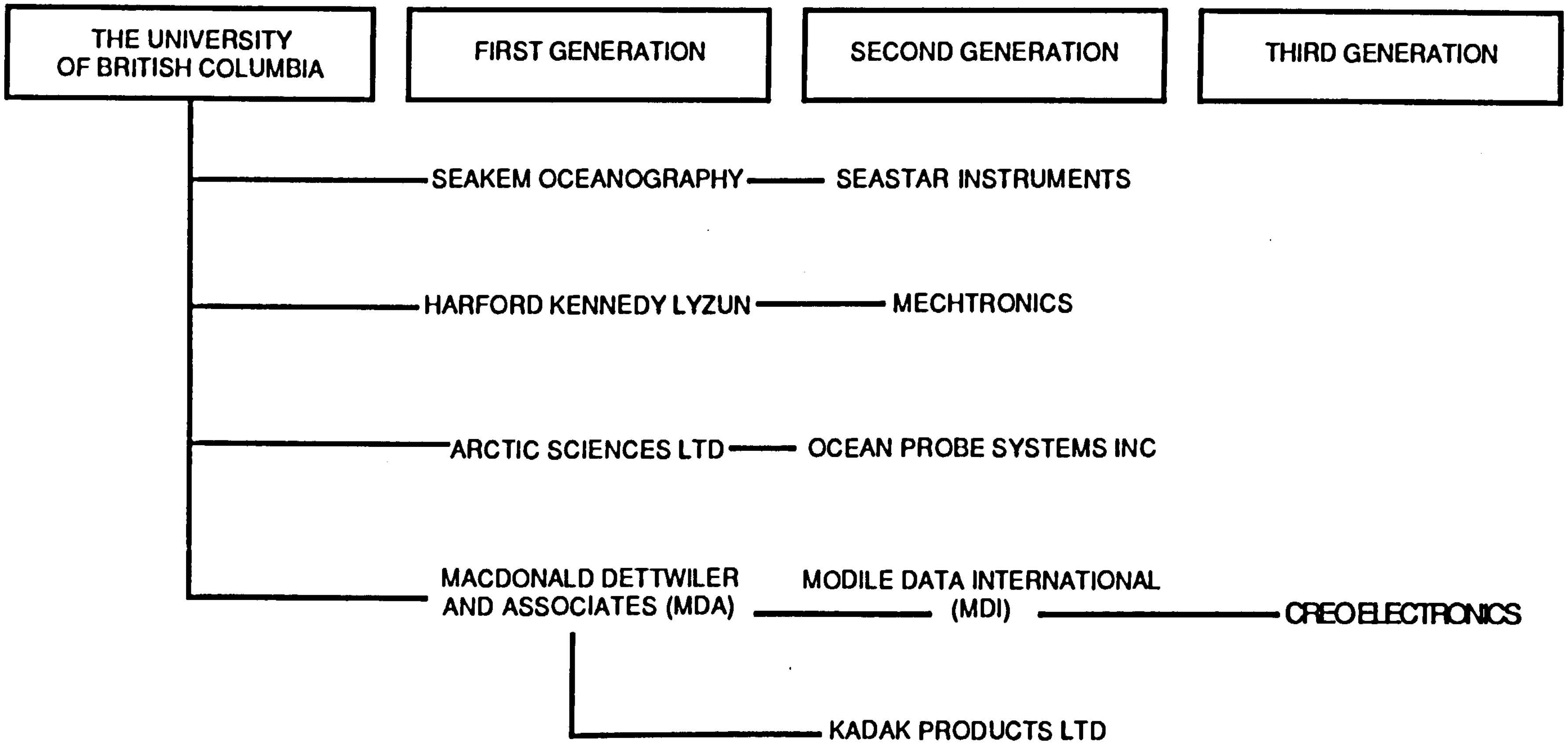
MDA SPECIALIZES IN DESIGNING & BUILDING GROUND SYSTEMS & IMAGE ANALYSIS SYSTEMS FOR METEOROLOGICAL SATELLITES & REMOTE SENSING SATELLITES

MDI MOBILE INTERNATIONAL IS A SECOND GENERATION SPIN-OFF FROM MDA WITH 260 EMPLOYEES & SALES OF $25 MILLION IN 1986

MDI MANUFACTURES & MARKETS MOBILE DATA COMMMUNICATION SYSTEMS

CREO ELECTRONICS IS A THIRD GENERATION SPIN-OFF COMPANY FROM MDA & MDI WHICH EMPLOYS 14 PEOPLE & HAS SALES OF $1 MILLION in 1985

CREO IS DESIGNING AN OPTICAL DATA STORAGE SYSTEM



EVOLUTION OF FIRST, SECOND AND THIRD GENERATION SPINOFF COMPANIES

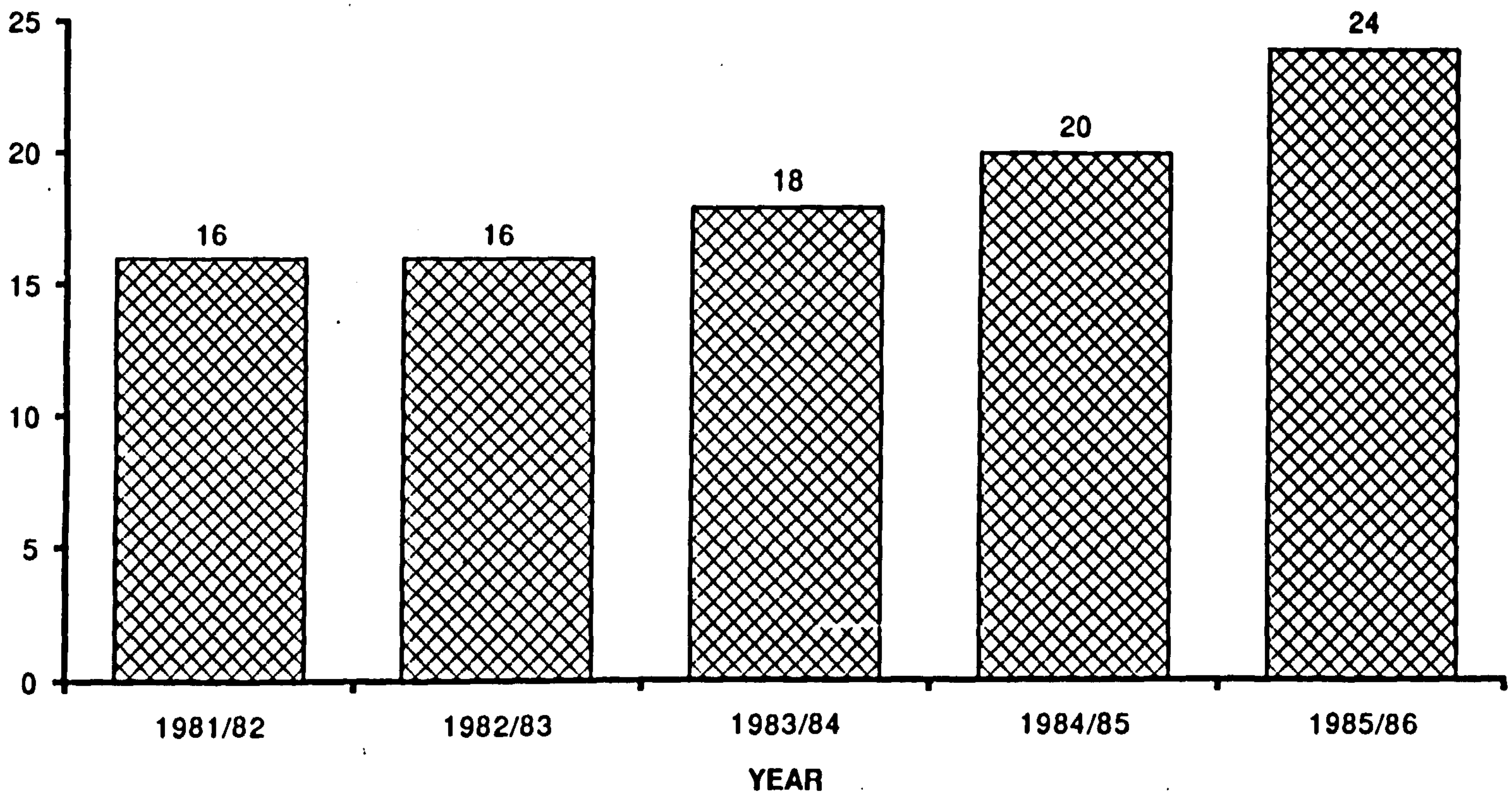
COMPANY	INNOVATION		FOUNDERS	
ITA (Inverse Theory & Application)	Geophysical data processing programs	81	UBC faculty & students	14
* LIPEX BIOMEMBRANES	Pharaceutical encap-sulation technology	85	UBC faculty & staff	6
** MOLI ENERGY LTD	Rechargable Li-Mo battery	77	UBC faculty staff & businessman	128
NAROD GEO-PHYSICS LTD	Ring core magnetometer	84	UBC faculty	2
NUFOODS	Non-dairy frozen desert	84	UBC faculty & businessmen	4
QUADARA LOGIC TECHNOLOGIES	Diagnostic products used in treatment of human & animal diseases	81	UBC faculty	42
TIR SYSTEMS LTD	Light pipe that can transmit light	78	UBC faculty & student	20
VORTEK INDUSTRIES LTD	Ultra powerful arc lamp used in outdoor lighting and semi-conductor annealing	75	UBC faculty & student	16

* Licence not completed

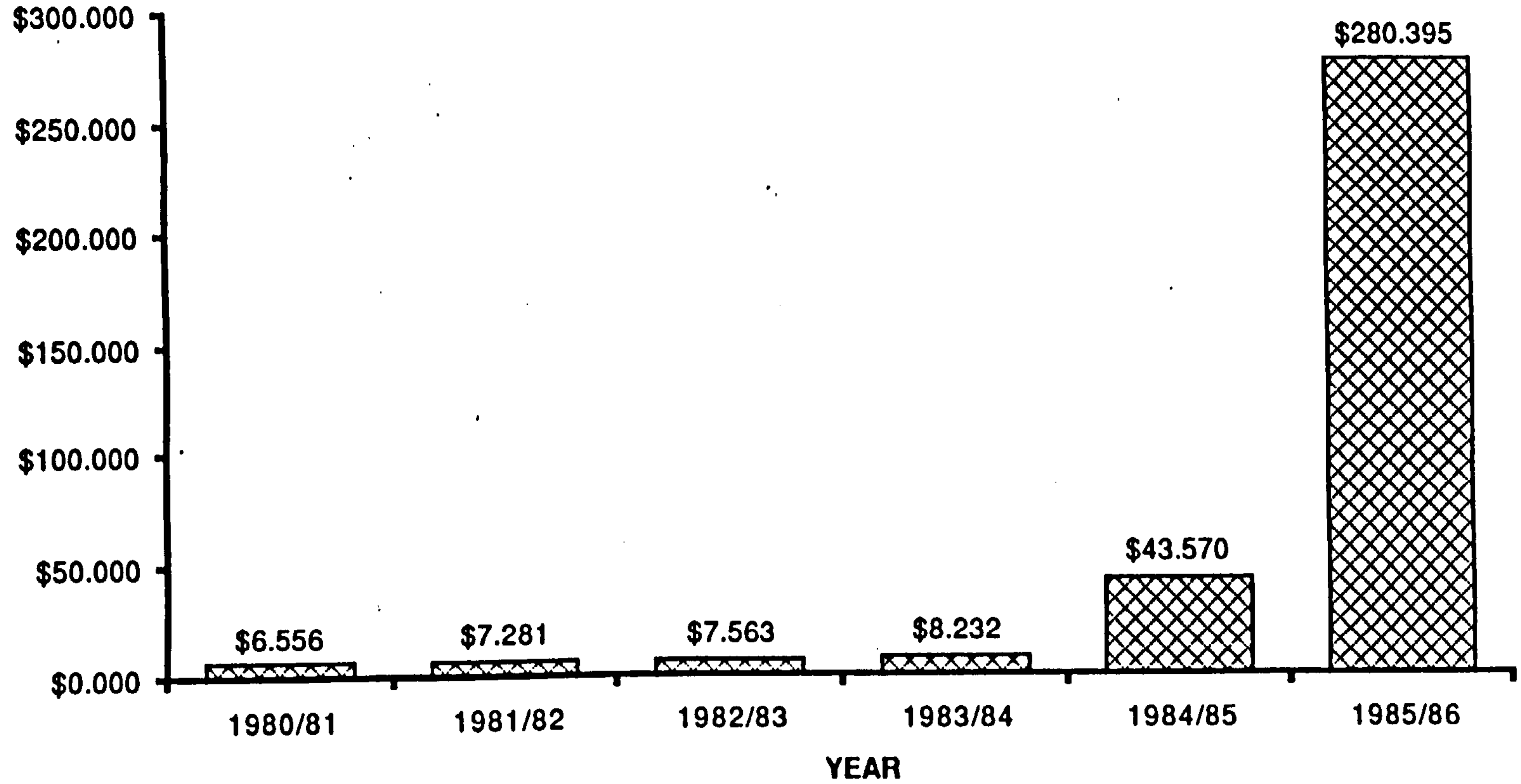
** Equity position

COMMERCIALIZATION OF RESEARCH THROUGH THE FORMATION OF NEW SPIN-OFF COMPANIES FORMED TO LICENCE UBC TECHNOLOGY, PATENTS OR KNOW-HOW

University of British Columbia
Number of Patent Disclosures



University of British Columbia
Gross Value of Royalties Received



GERMAN/CANADIAN WORKSHOP
DECEMBER 2,3,4, 1986
UNIVERSITY OF WATERLOO

COMMERCIALIZATION OF THE RESULTS OF PUBLICLY FUNDED RESEARCH

ABSTRACT

Prof. Dr. Rolf Dalheimer
President of Fachhochschule, Hamburg

Transfer of knowledge and Technology between Fachhochschule and Industry.

1. Special problems of research and development at Fachhochschule; possibilities and limits of these institutions in technology transfer.

   Inventory: Amount of know-how, framework and inner conditions, financing, general regulations.

2. Actual position of technology transfer.

   Facts about research and development at Fachhochschule, investigations and evaluations, examples for cooperation between Fachhochschule and industry/business, aspects of continuing educations, new ways of cooperation.

3. Future of technology transfer in the range of Fachhochschule.

   Stiffer competition in the academic system, principally open relation to customers or prospective customers (advertising); sufficient equipment and (further) qualification of the academic staff.

GERMAN/CANADIAN WORKSHOP
DECEMBER 2,3,4, 1986
UNIVERSITY OF WATERLOO

Dr. Rolf Dalheimer
President of Fachhochschule
Hamburg

Co-operation Between Higher Education and the Economy

Having to follow after those who have just reported on their wide range of activities and successes in technology transfer, makes me feel rather disadvantaged as a member of a Fachhochschulen who feels he has to fight hard to move with rubber boots through the heavy soil of reality. However, it may be that University and FHn Presidents, as Dr. Landfried has suggested, tend to be somewhat depressive or even a little masochistic.

Knowledge and Technology Transfer by Fachhochschulen

1. Facilities and Limitations of the Institutions

Fachhochschulen (FHn) are a relatively recent entry to the scene of higher education in the Federal Republic and have been in existence for just over 15 years. The 70 FHn, funded by the State enroll 300,000 out of a total of 1.3 M students, and currently comprise around 40% of all freshmen classes. Their subject areas are concentrated in engineering and management, with lesser involvements in the social sciences and applied arts. The FHn are handicapped by their tender age as institutions of higher education, but they also profit from a drive to develop under this handicap. By now, the FHn have come of age, and the majority of their graduates possess excellent career prospects.

The initial stages of development of these institutions resulted in a new higher level of education, especially in the engineering professions. The FHn have proved to be in many ways more dynamic and uncomplicated, when compared to the traditional universities. They have succeeded in recruiting a highly qualified teaching and research staff, all possessing professional experience before joining the institutions. The majority of graduates, especially, the engineers, business administrators, and designers, are by now well established professionals.

The relationship between the institutions and the economic sector is open and pragmatic, although not yet well defined.

The higher education bill leaves a certain amount of freedom to the Länder in their pursuit of research and development (R&D). The question of whether FHn were to involve themselves in R&D was, until recently, unresolved. (If the situation would have remained this way, I would not be here today to talk about knowledge and technology transfer (K&TT)). In the meantime, R&D has become an everyday activity in many FHn particularly in the larger ones. The FHn have thus established a stake in R&D, although the funding problems remain as yet unresolved.

Surveys have led to the following results:

- The FHn possess a substantial, mainly regional, development potential.

- The development potential is most pronounced in the personnel and knowledge transfer areas.

- They may be utilized most effectively, with public and private contractors and partners.

These developments are bound to the establishment of a framework for the execution of these activities. Herein also lie our main problem areas. Budgetary constraints in nearly all educational spheres have seriously affected R&D activities by academic staff, restricted hiring of research and auxiliary staff, and delayed purchase of new equipment. The recent substantial growth of R&D activities at FHn is a result of an increasing flow of public and private contract funding for these activities.

R&D activities are concentrated in the engineering and business administration areas, and may be attributed to K&TT. The most common mode consists of self-contained single projects, contracted by medium sized enterprises. Contracts of this nature are common to both rural and industrially located FHn. Nearly all FHn contribute to the support of small and medium sized enterprises in their regions. Once the reputation of the Fachhochschule is established, follow-up contracts and co-operation with enterprises are common.

But as I said:

Barriers still exist for an appropriate involvement in R&D. Professors at FHn are compelled by state regulations to deliver over double the number of lecture hours as compared to their colleagues at universities. This load, comprising 16 - 18 lecture hours a week, is incompatible with the role of a modern institution of higher education. Moreover, laboratory standards do not, as a rule, provide support for continuous research activities. This is, incidentally, also a drawback of many universities. All institutions of higher education in the Federal Republic expanded very rapidly during the seventies. Now, in the mid eighties, the time is ripe for equipment replacements, for which however, money is scarce. To escape from this dilemma, institutions of higher education are increasingly turning to outside contracts, and thereby are entering into competition amongst themselves, especially in view of the dwindling number of students expected in the nineties.

2. The Current State of Knowledge and Technology Transfer

Just over a month ago a meeting was held at the Fraunhofer Institute for Organization and Management Science in Stuttgardt. Its theme was "Innovation and Professional Qualifications". I would like to employ summary conclusions from the conference in my discussion.

1. For many enterprises survival in the era of dynamic technologies depends crucially on investments in human capital.

2. Medium sized enterprises will have to co-operate amongst themselves, and use continuing education facilities, technology centres, vocational schools, FHn and universities. What role do the FHn play in the adaptation to this structural change?

The FHn, due to their applied orientation, were amongst the first tertiary education establishments to realize the impact of data processing on manufacturing, and its implementation in education and research.

One has to bear in mind that the majority of our 700,000 graduates in engineering, business administration, industrial engineering and information sciences will be employed in enterprises for which reorganization to accommodate new technologies is of vital importance. We can now see which factors are going to bring industry, as the client and higher education as the producer, closer together. The private sector, and in particular small and medium size enterprises, will increasingly depend on certain forms of continuing education provided from the outside. Computers and information networks are factors for which structural adjustments have to be made, and cannot be swept away like the rationalization processes of former times.

K&TT will be an essential component of the R&D involvement for a growing number of private enterprises. In order to keep abreast of developments, higher education institutions need relations to practice. They may also need industrial sponsorships in order to survive budgetary limitations and to pursue their educational goals. On the other hand, the president of an institution of higher education is faced with the task of preserving the independence of his institution with regard to the signing of co-operative agreements for the solving of relevant problems encountered by private enterprise. At the same time he has to deal with the divergent interests of the co-operating partners.

Prof. Sarnick, Vice President of the West German Conference of Rectors, longtime president of the Technical University of Berlin, has declared that universities should adopt certain organizational practices of industry: i.e. time tabling, industrial secret retentions, etc. Generally, one should not expect, however, that higher education will become an extended arm of industry. It should not relinquish its independence, which is anchored in the constitution and results from its public commitments.

This does not only hold true for universities, as it is a fundamental prerequisite for education and research. Within their material possibilities the FHn have to secure a level of education and research which will ensure the professional competencies of their graduates, maintain the social responsibilities and an adequate freedom in planning and decisions.

I would like to add a basic premise here, that provided these conditions are met, an institution of higher education is capable of implementing various forms of co-operation with mutual benefits to all concerned and with a clear conscience.

A current example: We are aware that the implementation of CAD and CAD-CAM is a matter of survival for many small enterprises. They will only survive through employment of modern production technologies and production planning methods.

The accelerated trend toward automated production units will entail survival for only those medium sized enterprises, as contracting companies or extensions of larger units if they will adopt flexible and rapid production methods. It is a well established fact that larger companies are cutting into the markets of smaller enterprises by rigorously enforcing modern production technologies. Big companies can afford to employ teams of CAD-CAM experts to rationalize their production and penetrate the less attractive market areas of the smaller companies. Therefore, there are sufficient reasons to search for regional co-operation agreements between industry and education to further continuing education and to solve common problems. Centres for new technologies abound, i.e. CAD training centres, centres for microelectronics applications, and information technology. It is a matter of experience that even this open form of co-operation does not always work. The idea is that the FHn could act as a neutral partner with industry and assist a company in selecting the most appropriate CAD system for example. What actually happens, in most cases, however, is that the industry buys its system first and then comes to the FHn for assistance "to repair the damage".

With the growth of private R&D there has also resulted a growth of FHn projects in this area. An investigation by the West German Conference of University Presidents has indicated a growth in contracts awarded to FHn which also corresponds to an increase at universities. The average for all FHn is no more than 310,000DM per year. The trend setters in this respect show a range between 700,000 and 2M DM per year in the years 1982-4.

The majority of projects are initiated and financed by industry. Information on the sources of this support reveal that 40% is from the private sector and in some Länder in the South, this source approaches 60%. Total contributions to institutional budgets are still in the range of a few percent only. Moreover, the total funding amounts are also modest, the percentage increases although impressive, do not compare favorably with industrial giants such as Siemens whose R&D funding has increased from 3.5B to 4.8B from 1982 to 1984. In comparison, investments of FHn in R&D are quite modest. On the other hand, one should not necessarily associate absolute funding levels to research and technology transfer successes.

In 1983-84 there were 300 companies in the Hamburg area, employing 77% of all industrial employees, involved in R&D. Only 18 companies, i.e. 6% contracted research out to higher education in the City. This notwithstanding the highly diversified and qualified nature of the City's institutions. The story is similar in the other Länder, with the possible exception of the South, although industry possesses only limited R&D capacities, which would seem to be a natural stimulus for such co-operation. But companies have to be convinced they need new technology transferred to them.

3. Co-operation Schemes

Which are the forms of co-operation available to the FHn and the private sector, from which both can gain without damage to the autonomy and public responsibilities of the FHn?

I will attempt to answer this question with reference to the results of a working session on "Higher Education Institutional Involvement in Innovation Consulting and Technology Transfer" which took place at the TU Berlin in March this year. The meeting dealt with university activities in this area. The discussion centered on old and new organizational associations, on possible partners, goal settings, time projections, and degrees of institutionalization.

It is interesting to note how close the approaches of universities and FHn have come together.

- The FHn have TT consulting centres with 24 hr. telephone service.

- There are independent fund granting agencies which provide remuneration for consulting academic staff.

- There are public supporting agencies interested in furthering co-operation between FHn and smaller enterprises.

- There is publicly funded co-operation between the unions and higher education researching the impacts of technologies on employees.

Let me outline the following forms of co-operation:
First: The individualized TT. R&D contracts are executed by an academic member of staff under industrial contract or through public funding.

Second: The Institutionalized TT. R&D contracts involve traditional and newer forms of higher education institutions as consulting bodies for TT.

The most widespread form of TT is the independent K&TT involving consultancy. This applies to both FHn and universities. These are mostly closed ended single projects given in contract by medium size enterprises. FHn provide an established service in this area for industrial and rural regions. There exist some threshold fears on both sides, and it would be expedient to provide more freedoms for the FH consultants. Activities concentrate on research, development and consulting.

In addition, every year thousands of student projects are completed in co-operation with industry, a very good example of technology transfer. This form of TT is not documented by any statistics. I estimate that at the FH Hamburg at least 400 student projects are completed every year in co-operation with the economy of the region. Unfortunately, none of these projects lead to a higher degree awarded to the students as the FHn mandate does not go beyond the award of a first degree.

The following examples of co-operation of FH Hamburg at the request of industry may be of interest:

a) A company producing equipment for the disabled asked for a "speaking" typewriting machine for blind employees. It was developed.

b) Impressed by this development a bowling hall owner asked for a similar development for his blind customers. FHn helped.

c) A specialty fruit company had problems in apple selection. A machine was developed for selection on basis of size and colour.

d) We helped solve a very difficult problem of preventing certain groundwater pollution - using sealing by concrete injections.

e) We developed a system for determining the remaining fluid cargo in a ship as it was being unloaded.

The various examples have all been demonstrated at various international fairs such as the Hanover Fair and this is very good both for the institution and for the professors concerned.

As to the institutional forms of co-operation, the FHn provide in addition to the traditional services, such as materials testing and continuing education, a wide variety of consulting and research facilities which represent a significant contribution to K&TT.

The part time transfer consultant has in may cases developed into transfer consulting offices which again have led to TT centres, and TT parks.

A success story in this area is provided by the TFH Berlin which reports that it has accrued 75% of all R&D projects awarded in Berlin, but also in other parts of the country the contracts have shown substantial growth.

We must also mention institutions attached to higher education involved in R&D. For example, in Microelectronics, Materials Science and Manufacturing. The size and funding of these institutions also tend to increase. They have various constitutional forms dependent on their mandates, financing and organizational structure. Here too the FHn lag behind due to lack of personnel and funding.

The possibilities are exemplified by the Fraunhofer Institutes for applied research with 36 establishments. Similar institutions in association with FHn could improve research and education levels. It would then also be possible to pursue longer term projects, as for example, the influence of regional structural changes on employment etc.

Even in a small country like the FRG it is impossible to predict the optimal organizational concept. Regional, structural and historical factors are involved in an assessment. People have to be brought together, barriers surmounted, prejudices discarded, and problems defined. The Fhn are doing all they can in the areas of R&D. With appropriate private and public support they will provide a growing contribution to R&D in the Federal Republic. Despite some of our pessimism concerning public limitations and barriers, the system does in fact work far better than many give it credit for.

UNIVERSITY OF WATERLOO

DEPARTMENT OF CO-OPERATIVE EDUCATION

AND CAREER SERVICES

(DR. JOHN WESTLAKE)

PRESENTATION

TO

GERMAN/CANADIAN WORKSHOP

WEDNESDAY, DECEMBER 3, 1986

TECHNOLOGY TRANSFER AND CO-OPERATIVE EDUCATION

Co-operative education is based on the concept that 'a learning experience can occur outside of the classroom', and that, in fact, 'some learning is better acquired outside of the classroom'. Co-operative education, as we know it today, is best defined as a process of education which formally integrates (and alternates) a student's academic study on campus with work related to the student's course of academic study.

The University of Waterloo was founded in 1957 and from beginning was committed to concept of co-operative education. The co-op program began in 1957 in the Engineering Faculty with approximately 75 students. Over the years the university has grown and so has co-op. Co-op programs are now offered in all faculties. There are approximately 8700 students in co-operative education programs today which is approximately 50% of the total university enrollment. About 7,000 of the co-op students are in what might be considered 'technical' disciplines (Engineering - 3000, Math - 3000, Science - 1000). Canada wide there are 25,000 co-op students enrollded at 25 community colleges and 25 universities.

The program for co-op students is comprised of alternating 4 month academic terms on campus with 4 month work terms in industry, government or business. All students begin their academic program in year 1 in September, then half of students "remain on campus" to complete their first year and remaining students are placed in work term positions for the January-April period. This results in an alternating academic/work term sequence which insures that co-op students are available to employers on a year round basis. The students are required to spend two work terms with a particular employer. They are then 'free' to seek employment with other participating employers. The work terms are monitored by professional staff within the Department of Co-operative Education called "co-ordinators". For example, co-ordinators for the engineering program are registered professional engineers with the Association of Professional Engineers of Ontario and have extensive industrial experience. The co-ordinators visit as many students as possible 'on the job' during the work term to discuss their progress. The supervisors of the students are also visited to obtain feedback on the student's performance.

This process results in the fact that the students are in a 'learning mode' on the work term. In fact, the work term is an integral part of the educational process. Conversely, the students will take their academic training and skills to the work place and attempt to apply them to the job that they are performing for their employers. This obviously results in a transfer of skills, knowledge, expertise and technology from the university to industry and vice versa. This is a mutually beneficial result. As expected, the students become progressively more involved in 'higher level' technical projects as they proceed through the co-op program by virtue of their accumulating academic background and prior work experience.

On any given work term the technology flow is occurring in both direction. However, depending upon the particular employment situation, the emphasis may be in one direction or the other.

Example

Computer Expertise

Many of our co-op students are hired by employers who are experts in the area of computer technology, that is, companies that are on the leading edge. Employers hire these students because they possess a certain level of academic and practical experience, but there is no doubt that the students get involved in some extremely high level, sophisticated projects that certainly give them experience far beyond that which they would acquire on campus. The students bring this knowledge back to campus (providing it is not proprietary) for the benefit of classmates and professors. This tends to keep the classroom situation relevant and up-to-date. In fact, in one course, the professor asked a student in the class to give three lectures on a certain topic in the curriculum because the student had worked for two work terms in industry in that particular area.

A related route for technology transfer involves the requirement that students must write comprehensive work reports related to their work term employment and these reports are evaluated by the faculty members in the student's academic department. This is an excellent mechanism for the faculty to keep up-to-date with what the students are doing on their work terms.

Let's consider the other side of the coin:

Many students entering first year have taken courses in high school in computing and they generally take computer courses in first year. They are, what we call 'computer literate'.

Over the past few years there have been many small employers who have decided that they must "computerize" some aspect of their business. For example, this may involve the setting up of computer files for payroll, invoicing, etc. Typically, no one on the employer's permanent staff has the expertise to do this. Many of our 1st and 2nd year students have been hired to perform this function and have done a superb job. This could be considered transfer of technology to the employer.

Example

Statistical Process Control

One of our large employers, General Motors of Canada Limited, is dedicated to the concept of improvement in quality and productivity and over the past couple of years has hired many of our co-op students to work in their manufacturing facilities in the area of statistical process control. The students are acquiring a good deal 'high level' experience and training in the techniques and applications of S.P.C. on their work terms in a "modernizing" industry that they will bring back to the classroom.

Conversely,

There are numerous instances of small employers, who recognize importance and value of S.P.C., but have neither the time or expertise to initiate such a program. These employers have hired co-op students to do just that. In some cases the students have had to "learn" about S.P.C., set up the program, and train the employers' permanent staff. The degree of sophistication varies, but this is a clear case of technology transfer from the university to the employer. Employer response to this type of contribution by our students is extremely positive.

Another aspect of technology transfer from industry to university is the fact that students get a chance, on their work terms, to work with some very sophisticated, "state-of-the art" equipment.

CAD (Computer Aided Design)

More and more students are having the opportunity to work with, or at least learn about, CAD systems on their work terms. They certainly bring this knowledge and expertise back to campus. (It's sort of too bad that we can't go one step further and bring the entire CAD system back on campus.)

Robotics

This is another area that could be viewed in the same manner. An increasing number of student getting jobs in the area of robotics.

These are just a few examples to illustrate the concept of the transfer of knowledge, expertise and technology. It is a "two way" flow most of the time but the emphasis can vary, depending upon the specific employment situation.

In some cases students become involved in an area or field on their work term (i.e. research and development) and there is parallel or related research activity being conducted on campus. Students act as embassadors or facilitators to foster communication and collaboration between the two groups involved. An example of this is the case of a student who had worked with one of our employers for a couple of work terms in the areas of CAD design of integrated circuits. Subsequently he was working in same area of research for a professor on campus during a work term and actually negotiated with his previous employer to give him time on their CAD/CAM systems to do work for the professor on campus and thus established a working relationship between the two parties.

I might point out that the co-ordinators in our department are also instrumental in establishing links for the purpose of technology transfer. They are all well aware of the various centres and institutes of expertise on campus and promote the same with employers at appropiate opportunities as they visit students and employers on the work term visits.

To this point we have considered the university/industry technology transfer process. However, co-op students are also the vehicle for industry/industry transfer of technology as well. As previously noted, students do have the opportunity to work for different employers during the course of their 6 work terms on the co-op program. Therefore, with the exception of proprietary knowledge, they also transfer skills, technology and expertise as they work for different employers on their work terms.

I would like to conclude by pointing out the connection between co-op students and government initiatives or programs to enhance technology transfer and promote research and product development in industry. Each work term approximately 50 co-op engineering and science students are hired by employers who have obtained funding from government agencies for some aspect of research and product development. Two main programs are sponsored by the National Research Council (NRC) and the Natural Sciences and Engineering Research Council (NSERC). These programs subsidize the salaries of the co-op students for the work term with the employer sponsored by the funding agency. The university (field co-ordinators) promote the funding programs sponsored by NSERC and NRC and these agencies promote the co-op program to their clients as a source of qualified manpower.

GERMAN/CANADIAN WORKSHOP
DECEMBER 2,3,4, 1986
UNIVERSITY OF WATERLOO

PROVIDING ROLE MODELS FOR CHEMICAL ENGINEERING STUDENTS

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Waterloo Centre for Process
Development
University of Waterloo

The University of Waterloo encourages students to consider entrepreneural activity as a viable employment alternative upon graduation from Chemical Engineering. In order to provide a proper environment to support such a program, role models are necessary and the Waterloo Centre for Process Development provides a credible outlet for Engineering Professors to practice entrepreneural activity without having to leave their Faculty positions.

1. A University Partner for Industry

In 1978 the Chemical Engineering Department of the University of Waterloo initiated a unique experimental organization called the Waterloo Centre for Process Development (WCPD). Under the auspices of the Centre, professors and students are encouraged to think of the possible industrial ramifications of the results of their basic research.

Since its establishment in 1978, WCPD has earned a world-wide reputation for successfully taking promising, basic ideas beyond the traditional university bench-scale limits to the pilot or demonstration plant levels. Success has been achieved in two ways:

a) through in-house funded project activity and
b) through contract activity with industry

A semi-autonomous organization operating within the University of Waterloo, the WCPD has become self-sufficient through licensing fees, royalty payments and government or industry contract activity. A start-up grant of $1 million over five years has been transformed into an annual cash flow of between $1.3 and $2.0 million. Eighteen technologies have been developed providing seventy-seven patents and eight licensing agreements. During the same period, over 60 mission oriented research contracts have been conducted through the Centre.

The WCPD offers its clients expertise in many areas of modern chemical engineering, utilizing the skills of the large faculty and graduate research group under the umbrella of Chemical Engineering Department. It typically employs in the order of 50 research engineers, technicians, co-operative students and principal investigators. The expertise of the personnel ranges over the areas of Biotechnical Engineering, Polymer Technology, Extractive Metallurgy, Computer Applications in Process Control and Statistics, Heat and Mass Transfer, Air and Water Pollution.

The University of Waterloo's traditional close ties with industry, reinforced by its pioneering co-operative education program, have resulted in attracting more industry sponsored contract research and more in-house project research than any similar Canadian institution.

2. Bridging the Gap - The Technology Transfer

The Centre's approach to technology transfer utilizes four basic strategies to overcome the traditionally frustrating challenge.

Firstly, it identifies promising, basic research ideas developed within the University and funds them beyond traditional bench-scale limits to the pilot plant or demonstration levels. WCPD encourages Professors to enter into an Inventor's Agreement such that a new invention can be patented, developed and promoted to industry. The Inventor's Agreement provides the services of the WCPD for the development and promotion activities and at the same time, it provides revenue incentives to the inventor. Not only principal investigators are involved in an Inventor's Agreement. There are instances of students, who, having worked on the development of the technology, are also involved in such agreements. This is a big incentive for students to get involved in practical research.

Secondly, the Centre licenses the demonstrated technology to industry to allow full commercialization and to establish a funding base of royalty revenues for the Centre and the University. Experience has shown that it takes many years to obtain industrial licenses that are returning profits to the University. The process of licensing is very complicated and involves the patenting process where applicable, the promotion of the invention, the development of demonstration plants or prototypes, licensing negotiating, legal documentation of the licenses, and the on-going administering of the licensing agreement. The Centre's infrastructure has been organized in such a way that the principal investigators are free to work on the development of their inventions to their satisfaction.

Thirdly, the Centre employs co-operative and graduate students to supplement its professional staff in some projects and contracts, thereby providing a pool of experienced personnel that are available for continuing employment on the technology in industry. It has become abundantly clear that the best way to transfer technology is through the human being rather than the written report. It is extremely attractive to students to work on projects within the University which lead them into interesting careers outside after they graduate.

Fourthly, the Centre actively attracts industrial government sponsored, mission oriented research contracts, which provide a window on the marketplace to help identify opportunities and focus project activity. There are many examples of industrial research contracts which have led to on-going licensing agreements between the University and the industrial client.

3. <u>Human Resources and Support Systems</u>

The Centre enjoys the advantages of being able to call on the special resources of the University's excellent faculties and unique facilities.

The Chemical Engineering Department is the largest in Canada, with 31 Full-time professors, over 100 graduate students and 40 full-time research engineers and postdoctoral fellows. These combined human resources can, over the years, develop a large amount of new technology, which, if exploited, can generate a great deal of industry.

The research facilities that have been assembled by the Centre are considered to be state-of-the-art. With increases in research expenditures exceeding 100% over the past four years, the physical facilities have kept up with the rapid pace of development of high technology in the laboratory. For example, WCPD was the first organization in the world to have access to the Advanced Control System marketted by IBM through a unique contract with that corporation. Waterloo was able to install ACS on a brand new computer system and develop the user's course for that system, which is now marketted to many corporations, both in North America and the rest of the world.

WCPD has a Board of Directors which includes leaders of Canadian and multinational corporations. The Board of Directors provides the role of ambassadors to industry. They reassure the business contacts of the Centre with the awareness of the realities of research being done at the University for industry.

4. Success Examples

4.1 Waterloo SCP Bioconversion Process (1)

WCPD has speeded up the natural recycling system that turns garbage into animal food. The idea for the Single Cell Protein Bioconversion Process was a spin off from some consulting work done a decade ago for a corporation looking for ways to use petrochemicals as a feedstock for producing protein. The inventor wondered if a feedstock could be developed out of polluting waste materials such as carbohydrates like sawdust and the sludge from pulp and paper mills.

One of the keys to creating an economical process was to find a way around having to liquify the feedstock. Instead, the Centre researchers looked for a microbe that would convert the feedstock in its solid form. They also had to find the right kind of microbe and the proper chemical mix for it to work in to speed up the process. Several microbes have been isolated to do this and are now used in the patented process. In the earlier stages of development, conversion would produce an edible product in 48 hours. After work by WCPD, conversion now takes only four hours by using a specially designed fermentation bioreactor.

The process is so competitive that, aside from the pilot program in Vancouver, set up by Envirocon Ltd., which was licensed by the Centre to use the process, there has also been interest expressed in it in France, Yugoslavia, Mexico and many other countries.

4.2 Grain Drying Process Control System (5)

The Centre was asked to apply high technology to one of agricultures' most energy consuming processes - grain drying.

It took Centre researchers, a year of research, study, creative thinking and testing to produce a solution. The problem they had to solve was more than just drying corn. They had to dry it just right; and use as little energy as possible in the process. Fresh picked corn has a high moisture content - anywhere from 23 to 40 percent in most of Ontario - and that content must be reduced to at least 15.5 percent, the accepted Canadian standard for safe corn storage. Corn is continuously dried in large, 80-foot-high (25-metre-high) silo-type structures. If too much heat is used, the corn gets too dry. This not only wastes time and energy, but it also cuts down the weight of the corn. By placing moisture analyzers at the top of the dryer, the corn's moisture content - which can vary according to the field it came from, the weather, when it was picked and how long it has been waiting to be dried - can be measured when it enters. Then, computers determine the proper amount of drying time to be applied to that batch as it goes down through the dryer.

Canadian Farm Tec Systems owns the system and pays a royalty to WCPD. It has already sold fifty systems in Canada and plans to market two hundred in the U.S. in 1986. The process has created a job for the graduate student who helped in the research on the project. Since then the company has also hired two other research workers, who are now dealing with related problems in other areas of agriculture.

4.3 The Water Scrubber (4)

WCPD developed a gas cleaning scrubber rated by many as the most efficient "wet scrubber" ever invented in terms of energy requirement to achieve a set objective. Water is sprayed into the air to be cleaned using special sonnic nozzles. This spray of water is highly efficient at washing particulates and other contaminants from the air. The contaminant can then be removed in the water through centrifugal force or filters.

While having a fan as an integral unit in the Scrubber the key to the system's success is the nozzle. The nozzles used in the scrubber can produce droplets in the wide variety of sizes required for the various applications presented by industry. When there are regulatory changes made concerning the degree of removal, the air nozzle is simply adjusted until it is spraying the right size droplets to meet the new regulations and put it back to work.

The Scrubber has received extensive testing on industrial pollutants, especially in the pulp and paper as well as the metallurgical industries.

4.4 The Boiler Ash Monitoring System (2) (3)

The Centre was approached by the Canadian Electrical Association in 1980 and asked if it were possible to develop a method to measure the ash build-up that fouls coal-burning furnaces. Ash build-up in the giant, steam generating furnaces can cost a furnace 75 percent of its heat-transfer efficiency and, when too much of it builds up, can also cause what the industry calls a "catastrophic shut down". Such a shut-down in a power generating station can cost a utility $40,000 a day. In the U.S. and Canada these shutdowns cost utilities more than $400 million a year.

The novel method of handling fouling deposits is to use steam jets installed inside the furnace to periodically "steam clean" the walls and tubes. But no operator ever knows exactly when and where to fire off the steam jets. Now, for the first time in history, a boiler operator can know where and how much fouling he has in his boiler and he can then take precautions to prevent it.

By placing specially designed heat flux meter sensors inside furnaces (sensors able to withstand temperatures of up to 2,000 C for five years) and hooking them up to microcomputers and associated screens, the Centre's researchers have been able to create a picture of the inside of a furnace while it is operating. The screen's representation is color coded and can warn operators when and where fouled areas are developing in time to let them turn on specific steam jets to clean the offending trouble spots before the fouling becomes serious. The computer system also makes it possible to study the effects of the different types of coal used and any other factor that adds to or detracts from efficient operation. The Centre has installed its prototype system at two power plants. The system is licensed to one of the world's largest boiler manufacturers.

4.5 Process Control/Monitoring System (6)

More than nine man years of research and development have gone into the new software package, which, when it is imbedded in an Industrial AT microcomputer, provides a very sophisticated process control and monitoring system for small to medium-sized plants. The system includes a new control algorithm specification language for engineers (CASLE) which was designed for the process engineer not a computer programmer. This language removes the barrier between the engineer and the instrumentation. Thus, the process engineer uses CASLE's interactive editor to specify -

- standard control algorithms (PID, Lead/Lag Ratio)
- custom continuous algorithms
- batch and sequence processing
- alarm and abnormal condition handling
- trending and data logging
- report generation
- hard and soft digital or analog point definition
- simulation and forced value features

The system (called ForSite) with its true real-time operating system is integrated into a single circuit board that provides industrial reliability. The user begins by specifying a desired control strategy. He then draws the required display schematics and simulates the plant to test the design. Then it can control the operation. For all of this, only one system and one microcomputer is required.

5. Role Models

The five examples of projects undertaken by WCPD which have led to industrial exploitation of University research have provided excellent role models and research experience for a large number of students. Since 1979, WCPD has created a total of 293 man years of research and development activity. This total includes 30 undergraduates, 92 graduates and 102 principal investigator years. In addition, it is known that more than fifteen industrial jobs have been created as a result of the technology transfer. It is concluded that this type of activity broadens and enriches the University by providing role models on which to develop skills of students and faculty alike.

6. Acknowledgements

The Canadian Federal Department of Regional Industrial and Economic Expansion is acknowledged for its support of the work reported in this paper.

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GERMAN/CANADIAN WORKSHOP

DECEMBER 2,3,4, 1986

PRESENTATION

BY

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UNIVERSITY OF WATERLOO

COMPUTING AT WATERLOO

History

University of Waterloo was created by a special act of the Legislature of the Province of Ontario in 1957. Computing has played an important role in both the Academic life and the Administrative processes of the University since 1959.

The first computer was an IBM 650 machine based on tube technology. It was replaced with a transistorized IBM 1620 computer which was installed in a centrally administered Computer Centre in 1960. For the next several years, the installed computer capacity kept pace with the rapid growth of the University through the successive installations of an IBM 1710, an IBM 7040, and finally an IBM 360/75 in 1967. Shortly after the arrival of this new machine, the Mathematics and Computer Building was opened, and for a brief period UW had the largest operating computer centre in Canada.

In these early years of rapid growth emphasis was maintained on making computer power available to students, as well as to faculty researchers and administrative data processors. The desire to make computing an important part of undergraduate education soon led to the recognition that appropriate educational software was not available. In a teaching environment, the most important attributes of language processors are speed and comprehensible error diagnostics. To meet this requirement, four undergraduate mathematics students[1] were hired for the summer of 1965 to write WATFOR[(T)], a FORTRAN load and go compiler. The initial WATFOR compiler was written to run on the IBM 7040 computer, and reduced the processing time of a typical student's FORTRAN programme from over a minute to less than a second. In addition, it provided error diagnostics in plain English instead of a code. Thus WATFOR provided a most important advance toward the goal of providing access to computer resources to students, and at the same time leaving resources available for other users. During the winter of 1966/67 an IBM 360/40 was installed so that WATFOR could be rewritten for the

[1] The original WATFOR authors were: Robert Zarnke, Angus German, James Mitchell, Richard Shirley.

360 series of machines. The project was carried out by Paul Dirksen, the present Director of the Department of Computing Services, and Paul Cress, and was completed in time for the use of Fall classes on the 360/75 in 1967.

In the years following the installation of the 360/75 in the new building, progress continued in expediting the processing of student programs in a batch environment. Some of the more important developments included writing a faster 360 Assembly Language (ASMG), a load and go COBOL compiler (WATBOL), a simulated teaching machine for teaching Assembly and Machine Languages (SPECTRE), the development of a "cafeteria style" job submission and retrieval service, and the establishment of remote job entry and printer stations in other buildings on campus. In fact, at one time there were remote job entry stations in other Universities as well, including Wilfred Laurier University in Waterloo and Brock University in St. Catharines.

While the central Computing Centre grew during the late 1960's and early 1970's, other computing centres began to be established within several faculties on the Campus. Some of these centres were:

1. A specialized graphics computing centre in Engineering, centred on a DEC PDP9 (1967).
2. A 360/40 installed in the Faculty of Mathematics to provide APL service (1969).
3. A Nova minicomputer installed in Physics to provide specialized teaching software to undergraduate physics students.
4. A Xerox 530 computer installed in the Faculty of Arts to act as a remote job entry station to the central computer, as well as to provide local computer power for special projects.

Many of these satellite centres served their purpose and have been phased out. Others have evolved into more modern centres which are still in operation today. For example, the Physics centre now operates on a modern JANet network of IBM personal computers, while the Mathematics APL facility has evolved into the Mathematics Faculty Computer Facility, operating a Honeywell DPS/8 time-sharing computer for research and student computing.

In 1973 the central Computer Centre began a gradual process of conversion from a predominantly batch processing environment to a predominantly time-sharing environment. The first step in this process came with the installation of an IBM 370/145 computer which ran under the VM/370 operating system with CMS (Cambridge Monitoring System). This machine was replaced 2 years later with a larger 370/158, which in turn was replaced with an IBM 4341 in 1980. Since then, the central resource devoted to VM/370 CMS has grown to 7 IBM 4341's of which 4 are connected together to look to the user like one system. The change of emphasis from batch-processing to time-sharing became complete with the retirement of the 360/75 in 1979.

Waterloo Computing Today

Computers are used in every faculty at the University of Waterloo for instructional, research and administrative purposes. Students in all departments use a computer as part of an academic course. In fact, it has been estimated that at least 90% of all students at UW will take at least one course involving the use of the computer. Some students, such as those in Computer Science, Engineering or Science will take courses that teach the skills and techniques of programming a computer. Others will learn to use the computer as a tool to help them complete an assignment in statistics or chemistry. Some students will be drilled in some aspect of a course in a Computer Aided Learning environment, and many others will use a text formatter on a computer to prepare an essay or a report.

Substantial student computing is carried out on the larger 4341 computers, but an ever-increasing share is moving to microcomputers. Every faculty on campus has at least one microcomputer lab for student use, as well as terminal rooms that access the main computers.

Research and the computer can mean using the computer as a calculation tool, and there are researchers in every faculty who do this. Some professors and graduate students are conducting investigations to see how the computer can be used to improve productivity in industry and in the office. A very important area of computer research involves the enhancement of hardware and software, to extend the function of computers.

The use of the computer as an administrative tool continues to expand. Lecture notes are prepared, students' papers are marked, and their grades on various tests and assignments are recorded, all with the assistance of the computer. Literally thousands of documents are prepared on computers at UW every year. These range from the previously mentioned student term papers and lecture notes, to PhD. theses and research papers to be submitted to scholarly journals. A number of journals are published at U W; these are usually prepared on the computer, and then sent directly to the University's phototypesetter, where the final copy is produced. Many faculty members have published books in the same way.

Other substantial administrative applications are directed to carrying on the University's business, in areas such as student records and registration, financial accounting, and operations analysis.

The following sections describe some of the interesting applications of computers in the various faculties on campus.

The Faculty of Arts

To many people, it would seem that the departments that constitute the Arts Faculty would not be traditional users of computers. This fact was recognized a number of years ago by people leading the Arts Faculty, but they also recognized the fact that there were many projects either under way or being contemplated, where the computer could be an invaluable tool. To provide assistance for these researchers, many of whom had no previous computer experience, the Arts Computing Office was established. Many faculty members in both the Social Sciences and the Humanities have been aided in their computer projects by this group.

Computer projects undertaken by the Arts faculty are as varied as the research interests of the faculty members in the various departments. In the Social Science departments, statistical analysis of survey and research data is an important part of their research work. A strong interest among researchers in this group in performing secondary analysis on survey data led to the establishment of the Data Resource Centre, which is part of the Department of Computing Services. The Canadian Centre for Election Studies, in the Political Science Department, was formed to carry out analysis on Canadian election data. Of course statistical analysis of this data, some of which involves tens of thousands of cases, could not even be considered without the use of the computer.

The Psychology Department uses the computer to analyze results of experiments, but in this department the role of the computer in the experimental process is extended to the presentation of stimuli, and to collection of data. This function was once carried out by minicomputers, but is now done by micros almost exclusively.

Researchers in the Humanities also use the computer for performing statistical analysis on data; this data may be survey data, or it could be the analysis of word use by a particular author. Research in this area frequently involves the organization of information, usually bibliographic in nature, into data bases. One early project that did this was the Victorian Periodicals Project, which, as its name implies, involved the accumulation and organization of information about British periodicals published during the Victorian era. This project was later extended to include early British periodicals.

Some researchers have advanced their presentation of textual data to include videotex. Several such projects were undertaken by the Arts Faculty as part of the University's 25th Anniversary projects. One of these involved an extensive geographical guide for the novels of Thomas Hardy.

The Arts Language Lab boasts the only facility on campus where computer aided instruction has been used extensively and continuously for many years. A computer, originally a mainframe but now a micro, is used to transmit facts and basic skills in foreign languages, as a supplement to the regular classroom lectures. The CAI team has not only created courseware, but has produced tools to aid in courseware development.

The Faculty of Science

The computer is important to the researcher in science as a computation and simulation tool. This is true for the student with results to analyze from a first year experiment, and for the advanced researcher in the lab. This fact was recognized by the Physics Department a number of years ago, and they acquired a Nova minicomputer exclusively for student use, the first department on campus to do this. Two years ago, when it was no longer useful, it was replaced by a network of microcomputers. Two other micro networks have been added in the faculty. In addition to using these micros and the main IBM system, the Chemistry Department has a VAX for some of their large scale computations.

Students in Science use the computer to solve their numerical problems, to produce graphs, and to perform statistical analyses. This past year, a course was given in Technical Writing, and the students used text formatting packages on the computer to carry out their assignments for this course.

The Faculty of Environmental Studies

The Environmental Studies Faculty has established a Methods and Design Laboratory, with facilities and staff to support research projects in their faculty. Researchers within Environmental Studies have developed and experimented with software for remote sensing, specifically satellite image analysis and computer cartography. The particular emphasis of research in image analysis and computerized map generation includes software for digital terrain models, graphic information systems, and applied interactive computer graphics. Much of this work is done on a VAX 11/780 recently acquired for the purpose.

The Faculty of Human Kinetics and Leisure Studies

Use of the computer in HKLS is varied. Statistical analysis is common, and the Leisure Studies Data Bank is an important part of the Faculty. The SIRLS project is a computerized bibliography of leisure and sport that is used by researchers on and off campus as well as by students doing projects for their courses. Faculty members in Dance have also worked with researchers in the Computer Graphics Lab in Computer Science to develop an interactive editor for Benesh Dance Notation. Without such developments, the history of dance could be lost, as it is recorded nowhere but in the minds of the choreographer and the dancers.

One interesting project in this Faculty involves the entering of the holdings of all the museums in Wellington County and the Region of Waterloo (including 3 museums at UW) into a common data base.

The Faculty of Engineering

Many computing projects in Engineering are part of the Institute of Computer Research, but there are several others. The *WATSTAR lab, which is a network of around 30 Superbrain micros was developed in the Faculty of Engineering to support student computing.

A variety of software used in both research and teaching has been developed. One such example is a set of programs written to teach and aid in the development of fabricating silicon devices and circuits including: WATAND, an interactive circuit analysis program, and WATMOS, a 3-D simulator of VLSI devices.

There are a number of projects in Engineering involving Computer Aided Design, and Computer Aided Manufacturing (CAD/CAM). Many of these projects involve the implementation of CAD/CAM software on micros, such as the research on the design of spiral bevel gears, and their manufacture by a computer controlled machine tool.

Other CAD/CAM projects involve research in Model Analysis and Finite Element Analysis. A generalized program for control of Robots is being developed, based on a menu technique, with provision for using the post-processor approach for individual types of Robots.

There is also the CADGE project, being undertaken with the Faculty of Mathematics, to establish a centre in computer aided engineering.

In the Department of Chemical Engineering, IBM's computer process control software package, ACS, is being used for undergraduate and postgraduate teaching, process control research, and associated industrial contract activity. In addition, on-line process simulation capability is provided through an interface to the SPEED-UP process simulation system. The entire set of software runs on a dedicated IBM 4341 computer with associated peripherals.

The Faculty of Mathematics

Mathematics supports many computer-based research projects, some of them on a Honeywell computer, others on VAX computers, and still others on micros. Many of these projects are part of the Institute for Computer Research which is described elsewhere in this document.

The development of software, aimed at both teaching and research, is an important aspect of the development work that has been undertaken in Mathematics. Two such software packages are a PROLOG compiler, which is a language used in Artificial Intelligence research, and SPARSPAK, a package designed for handling sparse matrices.

Institute for Computer Research

Director Eric Manning, BSc, MSc (Waterloo), PhD (Illinois)

Over the past ten years, several first-class computer research groups have evolved at the University of Waterloo. These groups specialize in different aspects of computer science or technology. They all have been highly successful at mission-oriented projects and they all have international reputations.

Recently they have been brought together in a single organization, The Institute for Computer Research. The Institute facilitates cooperation among its groups and allows them to make better use of the facilities, staff and services. Close cooperation among groups allows for the undertaking of projects, such as office automation or robotics, which demand the expertise of several groups. It also results in better-trained graduates who have a broader and deeper knowledge of a wide range of topics in computer research. The groups comprising the Institute of Computer Research are:

1. THE COMPUTER COMMUNICATIONS NETWORKS GROUP

   Director J.W.N. Wong, BS, MS, PhD (UCLA)

   CCNG works in four research areas: performance analysis and modelling of computer networks, local area computer network technology, distributed processing, and videotex. Significant new research results have been achieved in performance analysis of packet networks, local area networks, distributed systems and multiple-access protocols for local area networks and satellites. Currently, CCNG members are concentrating on studies of the effects of network protocols and user applications on system performance.

A new type of local area network based on the use of a side channel to run a conflict-free multiple access protocol has been constructed. It is called WELNET; higher level protocols to support a variety of uses are being designed and implemented. A testbed for distributed system software called Shoshin has also been developed. Ten LSI-11/23 computers, each executing a copy of the kernal of a fully distributed operating system, are interconnected by a fast, parallel packet bus. Shoshin provides a facility for the evaluation of distributed algorithms and software, and is now being ported to a set of Motorola 68000 computers. Finally, CCNG has been involved in Telidon technology, including the design of databases and data structures for videotex systems.

2. THE COMPUTER GRAPHICS LABORATORY

Director K. S. Booth, BS (CALTECH), PhD (UC Berkeley)

The Computer Graphics Laboratory (CGL) performs research in interactive computer graphics. Facilities include a VAX 11/780, an Ikonas 3000 frame buffer, and an Evans and Sutherland Multi-Picture System. New results on the mathematics of Beta-spline representations for sculptured surfaces are being applied to computer animation and document preparation. CGL researchers have focussed much of their effort on the careful design and implementation of interactive tools for users to create and manipulate graphical images. These tools have been used in three systems which have been developed at CGL: a Paint program which allows the user to create diagrams using a digitizing tablet stylus or puck as a brush; an interactive layout program for microelectronic circuits, developed jointly with ICR's VLSI group; and a Benesh Notation Editor which allows the user to create and edit scores for ballet choreography. Other projects include computer-aided theatrical set and lighting design, videotex information provider systems, colour theory and visible surface algorithms.

3. THE COMPUTER SYSTEMS GROUP

Director Eric Mackie, BA (Waterloo)

The primary interest of the group is the construction of software tools aimed at the program development task. Such software tools include compilers which provide good diagnostic messages and fast compilation, interactive programming systems and interactive editors with appropriate human interfaces. These tools have been used in educational institutions to support teaching and research, and in business and government organizations to support scientific and commercial programming activities. Some of the well known pieces of software which have been developed by the Computer Systems Group include:

WATFOR and WATFIV - compilers for the FORTRAN language
WATBOL - a compiler for the COBOL language
WIDJET - an interactive editor
WATERLOO BASIC - an interactive system for programming in the BASIC language
WATERLOO PASCAL - a compiler for the PASCAL language

These pieces of software all operate on a large variety of digital computers including those made by IBM and DEC.

The Computer Systems Group has been involved with microprocessors and microcomputers for a number of years and has built several microprocessor-based systems. They have constructed microcomputer systems to support programming in different languages including APL, BASIC, FORTRAN, PASCAL, COBOL and assembler.

4. THE PATTERN ANALYSIS AND MACHINE INTELLIGENCE GROUP

Director A. K. C. Wong, MSc, MASc, PhD (Waterloo)

The PAMI Group performs research in four related areas, image processing, pattern recognition, computer-aided design, and information-processing aspects of robotics. The Group operates a well-equipped laboratory which includes a

DEC VAX 11/750 computer, a FPS-100E array processor, a Grinnel image display system, a video digitizer and various workstations. The Group's current efforts include the development of algorithms for optical handwritten character recognition, texture recognition, satellite signal processing, the modelling of human vision, cartography related projects and the application of human vision algorithms to robotics.

5. THE SOFTWARE DEVELOPMENT GROUP

Director J.Ll. Morris, BSc (Leicester), PhD (St. Andrews)

The Software Development Group's (SDG) mission is to provide an industrial software production environment within the University, to allow students and staff to apprentice in some of the practical aspects of software engineering. SDG undertakes the processes of designing, building, modifying and maintaining software products; this has required the group to do work on human factors and on software engineering support tools. SDG was formally created in 1982; it functioned for several years previously as a part of the Math Faculty Computing Facility (MFCF).

6. THE SOFTWARE PORTABILITY GROUP

Director M. A. Malcolm, BSc, MSEng (Denver), MASc, PhD (Stanford)

The Port group was formed in 1975 to study problems associated with software portability. The goal is to create software technology which will permit the inexpensive movement of software from one hardware environment to another. This permits an investment in software to be decoupled from current hardware, and new hardware technology can be more easily exploited.

The Port Group developed the well-known Thoth operating system as an experimental prototype. About 35 man-years of development effort went into Thoth; it has been moved or ported to six different vendors' minicomputers and microcomputers in 1 to 1 1/2 man-years per computer.

Since 1980, the Port group has developed powerful software for personal computers interconnected by a local network for applications such as office automation, education and process control. A new portable operating system, called Waterloo Port, has been developed for this environment. Much of the researchers' attention has been focussed on designing a good user interface for these workstations, and on implementing tools for adapting Waterloo Port to different types of processors, keyboards, displays or pointing devices and local networks.

Although a Waterloo Port workstation is fully functional as a stand-alone unit, many future applications will require the interconnection of workstations by a local network. The Port group has developed their workstation software for a local network environment and has addressed topics such as process structures that can recover from network failures, network message-passing protocols, and network file servers.

7. THE SYMBOLIC COMPUTATION GROUP

Co-Directors

K.O. Geddes, BA (Saskatchewan), MASc, PhD (Toronto) G.H. Gonnet, M. Math, PhD (Waterloo)

The Symbolic Computation Group (SCG) was formed in 1980 to pursue research and development work in symbolic mathematics using computers. A major project is the enhancement of the Maple symbolic algebra system developed at UW. Maple consists of a language, an interactive programming environment and a library of mathematical software. It supports a wide range of mathematical manipulation and provides user-programmed symbolic mathematical computation in a notationally convenient way. Maple runs effectively on time-sharing systems and on new 32-bit workstations. One of SCG's primary goals is to make symbolic computation widely accessible to applied mathematicians, scientists, engineers, educators and students.

8. VERY-LARGE-SCALE INTEGRATED CIRCUITS GROUP

Director M.I. Elmasry, BSc (Cairo), MASc, PhD (Ottawa)

The Very-Large-Scale Integrated Circuits Group does research in microelectronics with emphasis on very-large-scale integrated (VLSI) circuits. Members of the group are from the Departments of Electrical Engineering, Computer Science and System Design Engineering. They are interested in VLSI devices, circuits, and software design tools for VLSI. Simulation and design programs developed by members of the group with colleagues at Waterloo are well-known world wide and are used in both industry and universities.

Current research projects in the group include symbolic chip layout, silicon compilers, device modelling and mixed-mode simulation. The group uses a DEC VAX 11/780 and colour graphic workstations and has access to the Northern Telecom Silicon Foundry.

Revision Level: D01XM

X2700 -- Waterloo SCRIPT - Version 84.0 (84FEB1) 16:24:36 May 3, 1984

Interface: BISYNC Revision: D01EB

Mode: 2770/3780 Leased

Data Encoding: EBCDIC

Fonts Available: Job Status: No Errors

XCP14-L	8958 Bytes	Rev. 8
Titan10iso-P	22092 Bytes	Rev. 6
TrendPSiso-P	19866 Bytes	Rev. 4
TrendPS-P	11696 Bytes	Rev. 5
Kosmos10-P	10320 Bytes	Rev. 7
Kosmos12B-P	14272 Bytes	Rev. 7
Titan10B-P	12548 Bytes	Rev. 7

SOFTWARE LICENSING

The University of Waterloo has been distributing and licensing software for over fifteen years. This paper discusses why this activity has developed, problems peculiar to software as an intellectual property, and some recent changes in the University's historical approach.

THE UNIVERSITY OF WATERLOO

The University of Waterloo (UW) was founded in 1957 and has grown to an enrollment of over 21000 full and part-time students, with 745 faculty members and 1800 support staff. Since its inception it has emphasized the teaching of computing and the use of computers by undergraduate and graduate students in many disciplines. In particular UW supports a large Department of Computer Science within the world's largest Faculty of Mathematics. This department taught 10415 student-term courses in the last academic year.

Because of the emphasis on student computing, UW has been forced to be a pioneer in developing software suitable to an educational environment. There is an interesting discussion of UW's early efforts in this field in the May 1982 issue of "Perspectives in Computing"[1] published by IBM. The article includes an interview with Professor J.W. Graham who is a leading innovator in computing at UW.

SOFTWARE DEVELOPMENT AT WATERLOO

The first major programme written at Waterloo was a "load and go"

FORTRAN compiler that was named WATFOR for WATerloo FORtran. WATFOR was written to run on the IBM 7040-7090 family of machines which were installed in many North American Universities at the time. The programme was successful in reducing the run time for an average student job by a factor of 60 to 100, thereby making it practical to run several thousand student jobs per day. In addition it provided excellent error diagnostics. A year later, WATFOR was re-written to run on the IBM 360 family of machines, and it quickly became a programme in great demand throughout North America.

This pattern was typical of many subsequent software developments at UW. The software was written originally to meet a need at UW, which was seeking to keep its undergraduate programmes, particularly in Computer Science, up to date. Once the software was ready for use, it was immediately attractive to other University installations, and, in many cases, to commercial and government installations as well. Thus a policy for sharing UW software with the rest of the world had to be developed.

HISTORICAL APPROACH TO SOFTWARE DISTRIBUTION AND LICENSING

Until recently, UW has distributed its software under the guidance of these policy objectives:

(1) Software is distributed, or "shared", with other educational institutions for a license fee designed to recover UW's costs of distribution, development and maintenance.

(2) UW seeks to protect its proprietary interest in its software.

(3) UW seeks to minimize any potential liability arising from its distribution of software.

(4) Distribution of software to commercial and government installations is done at a "competitive" price, to avoid charges of unfair competition with tax paying commercial software businesses.

The following are some of the clauses presently used in UW Software Licensing Contracts which illustrate the objectives listed above:

1. Cost Recovery:

Example 1. This License shall run for a term of years from the day of 19 : provided that if the Licensee shall not then be in default with respect to the terms of this Agreement, the term hereof, at the option of the Licensee, may be extended, upon giving written notice to that effect to the Licensor, and provided that the Licensor consents in writing, this Agreement shall be extended for an additional period of one (1) year and, at the option of the Licensee, and with the written consent of the Licensor, the term hereof may be further extended, in similár mahner and provided that the Licensee shall not then be in default, from year to year during each renewal year thereafter. Such notice of renewal shall be given by the Licensee to the Licensor at least forty-five (45) days prior to the date of expiration of the then current licence year and the Licensor shall give notice of consent to the renewal within thirty (30) days of the expiration of the then current licence year. Each renewal shall be upon the same terms and conditions as herein set out.

Example 2: The Licensee shall pay to the Licensor yearly and every year during the said term, for the use of the said Program, a licence fee of Nine Hundred Dollars ($900.00), the first of such payments to be made in advance on the date of the commencement of the licence term referred to above and the subsequent yearly payments of Nine Hundred Dollars ($900.00), shall be made in advance within thirty (30) days of the date of commencement of each year of the said licence term or any renewal thereof.

Note that one of the effects of the 1st clause is to give UW an option not to renew the Agreement on an anniversary date. This can be used to renegotiate a new price if circumstances warrant, as well as to allow UW to drop support for a given product or withdraw it from the market.

2. <u>Proprietary Interest</u>

Example 1. Title to the Program and any material associated therewith shall at all times remain in the Licensor.

Example 2. This Licence shall be non-exclusive and the Licensor shall have the right to grant any further and additional licences or to make such other use of the said Program as it shall desire.

Example 3. The Licensee may modify the said Program and/or any material associated therewith, in machine readable form, to adapt the same for the Licensee's own use having regard to the Licensee's own peculiar requirements and to this extent may merge the program into other program material to form an updated work, provided that upon the termination of this licence, the program and material associated therewith shall be removed from the updated work and shall be destroyed as provided in the within Agreement. The Program, though merged with any other program material, shall be used only on the CPU's above referred to and shall remain subject to the terms of the within Agreement.

Example 4. The Licensee shall acquire no right, title or interest in, to or with respect to, the name "WATBOL" or to the Program itself and the Licensee agrees that the name WATBOL and the Programs are and shall at all times be the sole property of the University of Waterloo.

Example 5. The Licensee shall at all times hereafter keep secret and confidential, the Program and all technical information, data or materials relating to the Program.

Example 6. The Licensee shall not assign, sublet or transfer the within Licence, nor, shall the Licensee for purposes of financial gain, offer a service to any person, corporation or entity, which service includes the use of the said Program.

Example 7. Upon the termination of the within Agreement, whether pursuant to the terms hereof, or by effluxion of time, or otherwise, the Program and any materials associated therewith shall be removed from any location in which the Program is being used and all materials, duplicates and copies relating thereto shall be destroyed by the Licensee. The Licensee, upon such termination, shall provide the Licensor with such reasonable evidentiary informtion and material as shall enable the Licensor to satisfy itself as to such removal and destruction of the said Program, materials, duplicates and copies relating thereto. Without intending to limit the generality of the foregoing, upon any such termination the Licensee shall complete, execute and give to the Licensor the "Termination of the WATBOL Agreement" form provided by the Licensor.

Example 8. (a) Whenever any representation, written, printed or oral, shall be made by the Licensee relating to the said Program, such representation shall be accompanied by a reference to "WATBOL" and the Computer Science Department, University of Waterloo", as the originator of the Program.

(b) Any reference to the term WATBOL shall be accompanied by appropriate notice stating that WATBOL is a trademark of the University of Waterloo.

3. <u>Potential</u> <u>Liability</u>:

Example 1. The Licensor and the Licensee agree that the content of the WATBOL Program is fully defined in machine readable form on the WATBOL Distribution Tape to be delivered by the Licensor to the Licensee; the said parties hereto also agree that there are no understandings, agreements, warranties or representations express or implied, between the said parties with respect to or relating to the content of the WATBOL Program other than as defined by the said Distribution Tape.

Example 2. The Licensor agrees to furnish and provide such maintenance, without charge, at such time or times, and for such period of time, as the Licensor in its absolute discretion shall deem necessary and advisable. Any communications regarding Program Maintenance shall be addressed to the WATBOL Co-ordinator, Computing Centre, University of Waterloo, Waterloo, Ontario. N2L 3G1.

Example 3. The Licensor makes no representation with respect to its adequacy of this Program for any particular purpose or with respect to the adequacy to produce any particular result. The Licensee agrees that the Licensor or any of its employees, agents or contractors shall not be liable under any claim, charge or demand whether in contract, tort (including negligence), criminal law or otherwise, for any and all loss, cost, charge, claim, demand, fee, expense or damage of every nature and kind arising out of, connected with, resulting from or sustained as a result of executing this Contract or for performing all or any part of this Contract. In no event shall the Licensor be liable for special, direct, indirect or consequential damages, losses, costs, charges, claims, demands, fees or expenses of any nature or kind.

Example 4. The Licensee agrees to indemnify the Licensor, its successors and assigns, against any and all loss, cost, charge, claim, demand, fee, damage or expense of every nature or kind which may at any time hereafter be sustained by the Licensor by reason of or in consequence of having executed or performed all or any part of this Contract.

Example 5. The Licensor shall not, by reason of termination or nonrenewal of this Agreement, be liable to the Licensee for compensation, reimbursement or damages on account of the loss of prospective profits on anticipated sales or on account of expenditures, investments, leases or commitments in connection with the business or goodwill of the Licensee or otherwise.

The fourth paragraph cited above seeks to shift the risk of using the software to the customer installation. This paragraph is one UW has always insisted upon, but it has caused more administrative problems than any other aspect of the contracts. Understandably, most prospective users do not wish to sign such a broad indemnity.

SCOPE OF LICENSING OPERATIONS

By the end of the 1981-82 fiscal year, UW had 1732 Software Licensing Agreements in force. Gross income for the year amounted to some $1,700,000. There are approximately 30 Software Products sub-licensed to over 1000 installations worldwide.

A CHANGING ENVIRONMENT

Two recent developments have caused the University to modify its historical approach to software licensing and distribution:

(1) A diversification of software sources within the University. While most of the software licensed to date has been produced by the Computer Systems Group, an increasing number of programmes are being produced by other research groups, in application areas as well as Computer Science related work. This diversification has caused the University to adopt a formal policy approach to software licensing and distribution.

(2) Funding Crisis; Many universities in Canada, and particularly in Ontario, are facing a financial

crisis brought on by diminishing government support. Consequently, UW is seeking other possible sources of income. It's reputation and experience in software product development and licensing provides one promising source of additional revenues.

In response to these developments the University has recently adopted a formal Software Policy (see Appendix A) and a set of corresponding guidelines. The policy establishes a formal way for UW to interface with software developers throughout the University. Its main emphasis is on the question of "ownership" of software, or, more precisely, ownership of the rights to use or otherwise exploit software products produced on the campus.

Secondly, UW has incorporated a wholly owned subsidiary company, called Waterloo Software Applications Centre Inc., which will act as a holding company for other subsidiary companies in various software-related fields. One such subsidiary, WATSOFT Products Inc. has already been established to distribute and licence UW produced software, and possibly to develop software on its own under contract or for commercial exploitation.

SOFTWARE POLICY

There are a number of features of the new UW Software Policy that distinguish UW's approach to certain key issues from the approach of most other Universities which have tackled this problem.2

One such feature is the distinction made between software and inventions or other forms of intellectual property. While UW's Patent Policy formed a starting point for the development of the Software Policy, there is an important difference in that the University hires staff members to write software, but it doesn't hire people to "invent" things. Thus, while the UW Patent Policy can straightforwardly acknowledge the ownership rights of an inventor to his invention, regardless of whether the inventor is Faculty, Staff or Student, it is reluctant to do so in the case of software. A distinction is made, in the case of "software created for the University in the discharge of the normal responsibilities of employment". The University assumes it owns any software of this status, and all rights pertaining to it. Except in this case, it is assumed that the individuals or research groups who originate software own it, with the proviso that UW retains the right to use, for internal purposes, any software written using UW facilities.

When a researcher, student or research group writes a programme or software package, the question often arises whether the programme has any potential attraction to others. An author or originator can approach the University with a request for assistance in distributing his product. The principles governing University participation in any such distribution are:

(a) A right of refusal; UW retains the right to refuse to participate in any given case.

(b) Assignment of Rights; the Author must assign to UW all rights necessary for UW to be able to enter into licensing contracts.

(c) Assurance of Originality; UW demands written assurance from the Author that it is his work.

(d) Access to Maintenance; the more widely a programme is used, the more likely it is that errors or "bugs" will be detected. UW requires assurance that maintenance sufficient to meet its contractual obligations will be forthcoming either from the author(s) or someone else thoroughly familiar with the programme.

(e) Revenue Sharing; Arrangements differ depending on the circumstances under which the software was created. In the case of software produced by formally recognized research groups, most of the revenue is allocated to the group for further research. In the case of individuals, revenues are split evenly among the author(s), the department or faculty which contributed resources, and the University. These ratios can be altered to accommodate special circumstances.

Table I - Revenue Sharing Guidelines

ORIGINATING GROUP	SOFTWARE OWNED BY	OWNERS' SHARE	DEPT./FACULTY SHARE	UNIVERSITY SHARE
SEMI-AUTONOMOUS RESEARCH GROUP	GROUP	90%	N/A	10%
FORMAL RESEARCH GROUP	GROUP	80%	10%	10%
OPERATING DEPT	UNIVERSITY	N/A	67%	33%
INDIVIDUAL(S)	INDIVIDUAL(S)	33%	33%	33%

In adopting the software policy UW recognizes that there remain several important issues which require attention. These arise mainly because of the unique character of software as an intellectual property and include:

(i) Evaluation: It is difficult, particularly in the case of application programs, to know how good a program really is. Some of the questions that arise are:

(a) What is the value of the program to a potential user?

(b) Is it a program which does what the author believes or represents it to do?

(c) Does UW want to be associated with the sponsorship or distribution of the program?

The problem of evaluation is a critical one for which there are no easy answers. One suggestion currently under consideration is to assign programmes a category something like this:

Category A: A program guaranteed to meet its performance specifications and which UW will maintain.

Category B: A program the user accepts as is. UW will attempt to assist in removing bugs within certain limits.

Category C: An untested program which UW will only maintain as discretion dictates.

IBM used to use a similar kind of categorization for its program products.

(ii) Marketing: Until recently almost all the programs UW distributed were products like computer utilities, language compilers, assemblers and other special programs of interest to those who offer computer services to others. These have been marketed in a passive manner, more or less waiting for customers to call and ask for the products of their choice. In the case of application programs, it is likely more aggressive marketing may be required in order to have a program become widely used. Such marketing must take place among potential users, rather than suppliers of computing services, which could be costly and time-consuming. Presently at UW, we leave the marketing to the author(s), who promote their programs through conferences, publications, etc.

(iii) Protection of Proprietary Interest: The difficulties here all arise from the nature of computer programs as forms of intellectual property. Unfortunately the law is only beginning to catch up to the computer revolution, and the legal means of protecting authorship rights such as patent, copyright or trade secret law are only beginning to become properly applicable to software. To discuss each of these briefly:

(a) Patents: From time to time the Patent Offices in both the United States and Canada have issued patents for software products. Few of these patents have survived a challenge in court, though not all have been challenged yet. In those cases where patents have been upheld at the level of the US Supreme Court, the decisions have been split. There is an interesting and brief discussion of patentability of software in Computer Law and Tax Report, Vol 7, Number 9, April 1981.3 To the question "Are programs patentable", the answer appears to be "Yes and no". In one case cited in the above reference, the majority opinion of the Court said "When a claim recites a mathematical formula...., an inquiry must be made into whether the claim is seeking patent protection for that formula in the abstract. A mathematical formula as such is not accorded the protection of our patent laws...." But, "when a claim containing a mathematical formula implements or applies that formula in a structure or process which, when considered as a whole, is performing a function which the patent laws were designed to protect...., then the claim satisfies the requirements of Section 101." Patents do not seem to provide a reliable means of protection at the present time.

(b) Copyright: Almost everyone who distributes or licences software invokes copyright. Is it effective?

There is no doubt that a specific version of a program can be printed, bound and copyrighted, thereby protecting that version from unauthorized copying by others. However, if someone were to take the program and change all the variable names, or even just some of them, would this still be the same version for copyright purposes? If it is, then perhaps a few additional minor changes would be sufficient to render the new version non-infringing. Despite the difficulties, some progress has been made over the last ten years or so in updating the copyright law to extend its applicability to works which exist in non-printed media. In a case in federal court in San Francisco in August, 1981, the judge ruled that a program stored in ROM (read only memory) was copyrightable under the US 1976 Copyright Act which became effective in January 1978.4 The Act says that "works of authorship" are copyrightable if they can be fixed in "any tangible medium of expression, now known or later discovered, from which they can be perceived, reproduced, or otherwise communicated either directly or with the aid of a machine or device". The judge ruled that under Section 101 and 102 a computer program is "a work of authorship" subject to copyright, and a silicon chip is "a tangible medium of expression" within the meaning of the copyright law.4

In the US, the Computer Software Copyright Act of 1980 went into effect on December 12, 1980. The new Act includes the first federal legislative definition of a computer program: "A set of statements or instructions to be used directly or indirectly in a computer in order to bring about a certain result". With programs thus defined, Congress has made it clear that programs can be copyrighted.5 Notice that this definition does not distinguish between source and object programs.

To the extent that programs can be copyrighted, it may be argued that they cannot be protected by trade secret. The purpose of copyright protection is to encourage public distribution of the article that is copyrighted, which is inconsistent with trade secret protection. However, neither copyright nor patent protects ideas, so protecting an algorithm by trade secret and contractual methods is still important.

(c) Trade Secret: UW still relies primarily on trade secret and contractual methods to protect its proprietary interests. The large number of contract clauses concerning proprietary interests quoted earlier illustrates this approach.

(d) Trade Name Registration: UW has registered trade-names such as WATFOR, WATFIV, WATBOL, WATERLOO PORT and others to prevent other software suppliers from marketing similar products under these names. One case arose a few years ago in which a company advertised a WATFOR package for a computer system for which WATFOR hadn't been written. It wasn't necessary to go to court in this instance, since the company desisted after receiving a letter from UW lawyers.

(e) Security Devices: Over the years UW has adopted two kinds of security devices to aid in the prevention of theft. In the case of software written for large systems, certain instructions can be inserted which ensure that the software is being run on the licensed machine, and which will render the program unusable after a given expiry date. Thus customers must renew or cease using the product after the license period has expired. In the case of software written for microcomputers, UW is using a "security chip" which customers for certain products must buy. Without the chip, the software, which is distributed on PROM'S (programmable read only memory chips) is unusable.

WATSOFT

UW's second response to the problems of software explosion and funding crisis has been the establishment of a wholly-owned separately incorporated company called Waterloo Software Applications Centre Inc. The function of this company is to act as a holding company for subsidiaries which will engage in software related enterprises for profit which will be returned through the holding company to UW. The first of the subsidiary companies, WATSOFT Products Inc., has already been established. It's primary business is software distribution, but it is anticipated that it might expand into software development in its own right. The accompanying chart shows the corporate relationship amongst WATSOFT, UW and some other companies that have become involved. The corporate structure is expected to yield benefits as follows:

(i) University of Waterloo: UW will continue to derive the same benefits it enjoyed when it distributed the software directly. In addition, it derives benefits from selling computer services to subsidiaries at commercial rates, and income may increase due to more professional and aggressive marketing. Liabilities, always a major cause of concern, will now be limited to UW's investment in the Company concerned.

(ii) Software Authors: Through the medium of a separate company, it is possible to extend financial incentives to software producers which are difficult to provide within the University itself. Such incentives can include share ownership as well as royalties.

(iii) Customers: Software users will benefit from dealing with a business which can assume business risks, and which will take a more commercial approach to software packaging and documentation.

INSTITUTE FOR COMPUTER RESEARCH

Because of the emphasis in this paper on the software production environment at UW, it is appropriate to mention the recent formation of the Institute For Computer Research. The ICR is made up of a number of research groups in computer-related fields. The groups are being brought together to foster cooperation among themselves, and to share facilities and staff. The member groups participate in technology transfer through contract work, shared development projects, production and licensing of software, and publication in research journals. The ICR will also provide industry with an improved relationship with UW computer-related research activities through:

(a) highly qualified graduates familiar with state-of-the art technology,

(b) industrial sabbaticals,

(c) update courses to allow industrial managers to quickly get current in new technologies,

(d) closer cooperation on research ventures

(e) an improved flow of information in both directions, and

(f) timely awareness of new research results.

Interested companies can participate in three ways; an Affiliates Program, a Visiting Professionals Program, and a Corporate Partners Program. A detailed description of these programs can be obtained by writing to the Director of the Institute, Dr. Eric Manning, at the University of Waterloo, Waterloo, Ontario, Canada, N2L 3G1.

CONCLUSION

Software products are created at UW in four distinct environments: (i) individuals in academic faculties or departments, (ii) research groups, (iii) operating departments or (iv) within the Institute for Computer Research. In all cases except operating departments, software products and the rights to exploit them are regarded as the property of the originators. The new software policy adopted by UW stresses the importance of the establishment of ownership rights, and provides a policy for interaction between authors and the University if University assistance is requested for distribution or licensing.

Software authors have the option of turning to WATSOFT Products Inc. for assistance in marketing and licensing. In this case, the authors would enter into a business arrangement with the Company. Authors have another option of distributing their products themselves, or arranging for some other private sponsor. In all cases, UW reserves the right to use software developed using UW resources.

The problems peculiar to licensing of software arise from its unique characteristics of being easily plagiarized and copied. Current laws in both Canada and the US have not yet met the challenge posed by these problems. However, progress is being made particularly in the area of Çopyright Law in the US. In the meantime, the most effective protection of proprietary rights for software lies in trade secret and contract law; supplemented where possible by hardware or software security devices.

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UNIVERSITY OF WATERLOO

FOUNDED 1957

1981-82 ENROLMENT	FULL TIME	15600
	PART TIME	6100
		21700
CO-OP ENROLMENT		7700
CORRESPONDENCE STUDENTS		4500

FACULTIES:
- MATHEMATICS
- ENGINEERING
- ARTS
- SCIENCE
- ENVIRONMENTAL STUDIES (ARCHITECTURE)
- HUMAN KINETICS & LEISURE STUDIES
- SCHOOL OF OPTOMETRY

FACULTY 745

STAFF 1800

1981-82 BUDGETED INCOME $133,521,000

RESEARCH COMPONENT	$21,000,000
OF WHICH CONTRACTS ARE (GOV'T & INDUSTRY)	5,000,000

MATHEMATICS FACULTY

STUDENTS	605 PART TIME UNDERGRADS 3612 UNDERGRADS 323 GRADS
CO-OP STUDENTS	2555
HONOUR COMPUTER SCIENCE STUDENTS	523

LARGEST ENROLMENT OF MATH STUDENTS IN THE WORLD

TERM-COURSE REGISTRATIONS IN COMPUTING COURSES 10415

MATH CONTESTS 65,000 ENTRIES IN 1981

COMPUTER SCIENCE DAYS

COMPUTING FACILITIES

DEPARTMENT OF COMPUTING SERVICES

IBM 4341 CONFIGURATION (SSI)

IBM 370/150

3 DEC PDP 11's - WIDJET

IBM SERIES 1 - WIDJET, MICROCOMPUTER LABS

240 TERMINALS

64 MICROCOMPUTERS - COMMODORE PETS
SUPERPETS
IBM PC'S
MICROWATS

MATHEMATICS FACULTY COMPUTING FACILITY

HONEYWELL 6066

WICAT MICROCOMPUTERS

COMPUTER SYSTEMS GROUP

IBM 4331

DEC PDP 11/45

MICROCOMPUTERS

WATERLOO SOFTWARE

EDUCATIONAL REQUIREMENTS ⟶ SOFTWARE ⟶ DIST'N

DISTRIBUTION & LICENSING

OBJECTIVES:

(1) RECOVER COSTS OF DIST'N, DEVELOPMENT

(2) PROTECT PROPRIETARY INTEREST

(3) MINIMIZE POTENTIAL LIABILITY

(4) AVOID "UNFAIR COMPETITION" WITH TAX-PAYING COMPANIES

EXAMPLES OF CLAUSES

(1) PROPRIETARY INTERESTS

*** TITLE TO THE PROGRAM AND ANY MATERIAL ASSOCIATED THEREWITH SHALL AT ALL TIMES REMAIN IN THE LICENSOR.

*** THE LICENSEE SHALL ACQUIRE NO RIGHT, TITLE OR INTEREST IN, TO OR WITH RESPECT TO, THE NAME "WATBOL" OR TO THE PROGRAM ITSELF AND THE LICENSEE AGREES THAT THE NAME WATBOL AND THE PROGRAMS ARE AND SHALL AT ALL TIMES BE THE SOLE PROPERTY OF THE UNIVERSITY OF WATERLOO.

*** THE LICENSEE SHALL AT ALL TIMES HEREAFTER KEEP SECRET AND CONFIDENTIAL, THE PROGRAM AND ALL TECHNICAL INFORMATION, DATA OR MATERIALS RELATING TO THE PROGRAM.

EXAMPLES OF CLAUSES

(2) LIABILITY

*** THE LICENSOR AGREES TO FURNISH AND PROVIDE SUCH MAINTENANCE, WITHOUT CHARGE, AT SUCH TIME OR TIMES, AND FOR SUCH PERIOD OF TIME, AS THE LICENSOR IN ITS ABSOLUTE DISCRETION SHALL DEEM NECESSARY AND ADVISABLE. ANY COMMUNICATIONS REGARDING PROGRAM MAINTENANCE SHALL BE ADDRESSED TO THE WATBOL COORDINATOR, COMPUTING CENTRE, UNIVERSITY OF WATERLOO, WATERLOO, ONTARIO. N2L 3G1

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*** ....THE LICENSOR MAKES NO REPRESENTATION WITH RESPECT TO ITS ADEQUACY OF THIS PROGRAM FOR ANY PARTICULAR PURPOSE OR WITH RESPECT TO THE ADEQUACY TO PRODUCE ANY PARTICULAR RESULT. THE LICENSEE AGREES THAT THE LICENSOR OR ANY OF ITS EMPLOYEES, AGENTS OR CONTRACTORS SHALL NOT BE LIABLE UNDER ANY CLAIM, CHARGE OR DEMAND WHETHER IN CONTRACT, TORT (INCLUDING NEGLIGENCE), CRIMINAL LAW OR OTHERWISE, FOR ANY AND ALL LOSS, COST, CHARGE, CLAIM, DEMAND, FEE, EXPENSE OR DAMAGE OF EVERY NATURE AND KIND ARISING OUT OF, CONNECTED WITH, RESULTING FROM OR SUSTAINED AS A RESULT OF EXECUTING THIS CONTRACT OR FOR PERFORMING ALL OR ANY PART OF THIS CONTRACT. IN NO EVENT SHALL THE LICENSOR BE LIABLE FOR SPECIAL, DIRECT, INDIRECT OR CONSEQUENTIAL DAMAGES, LOSSES, COSTS, CHARGES, CLAIMS, DEMANDS, FEES OR EXPENSES OF ANY NATURE OR KIND.

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EXAMPLES OF CLAUSES

(2) LIABILITY (CONT'D)

*** THE LICENSEE AGREES TO INDEMNIFY THE LICENSOR, ITS SUCCESSORS AND ASSIGNS, AGAINST ANY AND ALL LOSS, COST, CHARGE, CLAIM, DEMAND, FEE, DAMAGE OR EXPENSE OF EVERY NATURE OR KIND WHICH MAY AT ANY TIME HEREAFTER BE SUSTAINED BY THE LICENSOR BY REASON OF OR IN CONSEQUENCE OF HAVING EXECUTED OR PERFORMED ALL OR ANY PART OF THIS CONTRACT.

SCOPE OF LICENSING OPERATIONS

	PRODUCT	1981-82 INCOME FROM NEW CONTRACTS	TOTAL CONTRACTS IN FORCE
CSG	SCRIPT	$ 76,500	342
	WATBOL-11	34,800	254
	WATBOL	25,200	219
	WATFIV	50,400	338
	TOTAL	$353,500	1712
NONCSG			
	FRED	$ 36,000	8
	WATERLOO TELIDON	30,000	1
	SPARSPAK	8,250	11
TOTALS		$427,750	1732

TOTAL INCOME FROM SOFTWARE LICENSING, 1981-82

$ 1,700,000

A CHANGING ENVIRONMENT

(1) DIVERSIFICATION OF SOFTWARE SOURCES

(2) FUNDING CRISIS

RESPONSE

(1) SOFTWARE POLICY - TO ESTABLISH FORMAL PROCEDURES FOR UNIVERSITY INTERFACE WITH SOFTWARE ORIGINATORS

(2) WATSOFT - TO ESTABLISH A COMMERCIALLY ORIENTED SOFTWARE DISTRIBUTION BUSINESS.

SOFTWARE POLICY

(1) DISTINGUISHES SOFTWARE FROM PATENTS, OTHER INTELLECTUAL PROPERTY

(2) ORIGINATORS (AUTHORS) "OWN" THE SOFTWARE

(3) UNIVERSITY CLAIMS A "RIGHT OF USE" TO SOFTWARE DEVELOPED USING UNIVERSITY FACILITIES

(4) PRINCIPLES OF UNIVERSITY PARTICIPATION IN DISTRIBUTION AND LICENSING

- (A) RIGHT OF REFUSAL
- (B) ASSIGNMENT OF RIGHTS FROM OWNER TO UNIVERSITY
- (C) ASSURANCE OF ORIGINALITY
- (D) ACCESS TO MAINTENANCE
- (E) REVENUE SHARING - GUIDELINES

DIFFICULTIES & OUTSTANDING PROBLEMS - S/W POLICY

(1) EVALUATION

(2) MARKETING

(3) PROTECTION OF PROPRIETARY INTEREST

- (A) PATENT LAW
- (B) COPYRIGHT LAW
- (C) TRADE SECRET
- (D) TRADE NAME REGISTRATION
- (E) SECURITY DEVICES - HARDWARE
  SOFTWARE

SOFTWARE RESEARCH ENVIRONMENT AT WATERLOO

1. ACADEMIC FACULTIES/DEPARTMENTS

2. RESEARCH GROUPS:
   - C S G
   - C C N G
   - S D G
   - W C P D
   - OTHERS

3. OPERATING DEPARTMENTS:
   - D C S
   - DATA PROCESSING
   - OPERATIONS ANALYSIS
   - LIBRARY

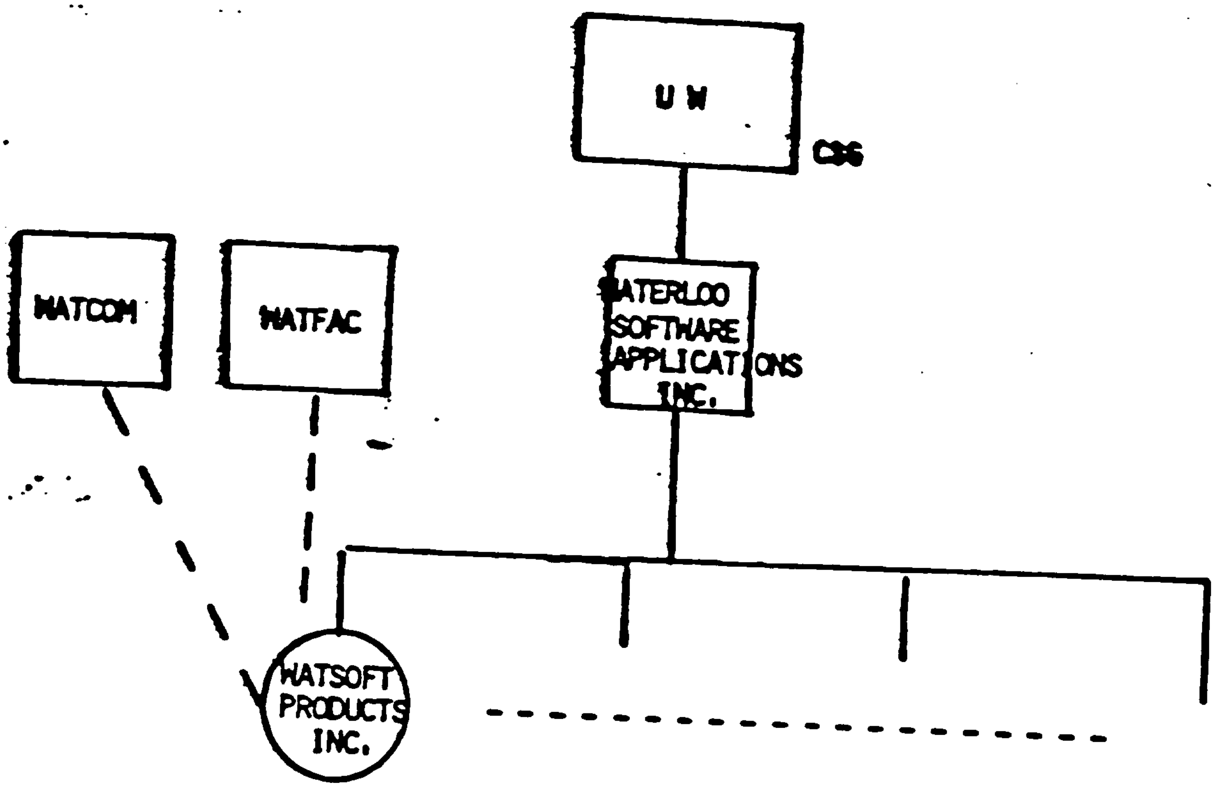
4. I C R

SOFTWARE DISTRIBUTION AGENCIES

1. U W - OFFICE OF RESEARCH

2. WATSOFT

3. OUTSIDE AGENCIES



WATSOFT PRODUCTS INC. DISTRIBUTES SOFTWARE UNDER LICENSE FROM:

U W (CSG)

WATFAC

WATCOM

ICR - INSTITUTE OF COMPUTER RESEARCH

PARTICIPATING GROUPS :

- VLSI CIRCUITS GROUP
- SOFTWARE PORTABILITY GROUP
- SOFTWARE DEVELOPMENT GROUP
- PATTERN ANALYSIS & MACHINE INTELLIGENCE GROUP
- COMPUTER SYSTEMS GROUP
- COMPUTER GRAPHICS LABORATORY
- COMPUTER COMMUNICATIONS NETWORK GROUP

COOPERATION WITH INDUSTRY :

- AFFILIATES PROGRAM
- VISITING PROFESSIONALS PROGRAM
- CORPORATE PARTNERS PROGRAM

GERMAN/CANADIAN WORKSHOP
DECEMBER 2,3,4, 1986
UNIVERSITY OF WATERLOO

COMMERCIALIZATION OF THE RESULTS OF PUBLICLY FUNDED RESEARCH

A B S T R A C T

Mr. Jürgen Allesch, Managing Director
Technology Transfer Agency
Germany

Analysis and Perspectives of Co-operation Between Universities and the Economy in the Federal Republic of Germany

The lecture will describe the results of a project initiated by the Federal Ministry for Education and Science. The study was prepared over several years and will be completed by the end of 1986.

It gives detailed information on:

- the complete empirial presentation of transfer activities at German universities;

- a poll of professors about their contacts and co-operation with the economy;

- description of typical institutional models for technology transfer at German universities.

This presentation of university activities is completed by a survey of the "transfer and innovation scene" in the Federal Republic of Germany.

Analysis and Perspectives of Cooperation between Universities and Industry in the Federal Republic of Germany

Jürgen Allesch, Managing Director, Technologie-Vermittlungs-Agentur e.V., Berlin (West)

Paper presented at the German/Canadian Workshop "Commercialization of the Results of Publicly Funded Research" on December 2,3,4, 1986 at the University of Waterloo, Canada

Table of Contents:

Analysis and Perspectives of Cooperation between Universities and Industry in the Federal Republic of Germany

1) General Situation of Universities in the Federal Republic of Germany

The university educationsystem in the Federal Republik of Germany differs fundamentally from the educationsystem in Canada and in the United States.
The most important differences are:

- The universities are almost only land-grant universities. Several smaller private universities don't play an important role.

- This system of land-grant universities corresponds with a general free university education. That is students have to pay nearly no university fees.

In 1984, in the Federal Republic of Germany there were 58 universities and technical universities, 15 theological universities, 26 universities of arts, 9 Gesamthochschulen and 119 polytechnic colleges. The differences between universities and technical universities are more or less of a historical nature technical universities developed out of schools of engineering and up to this day they still have a technical scientific priority.

In 1984, at all universities and the polytechnic colleges there worked a scientific staff of 90.000 persons, including 33.000 professors. The number of students ran up to more than 1.3 millions.

2. University and Industry

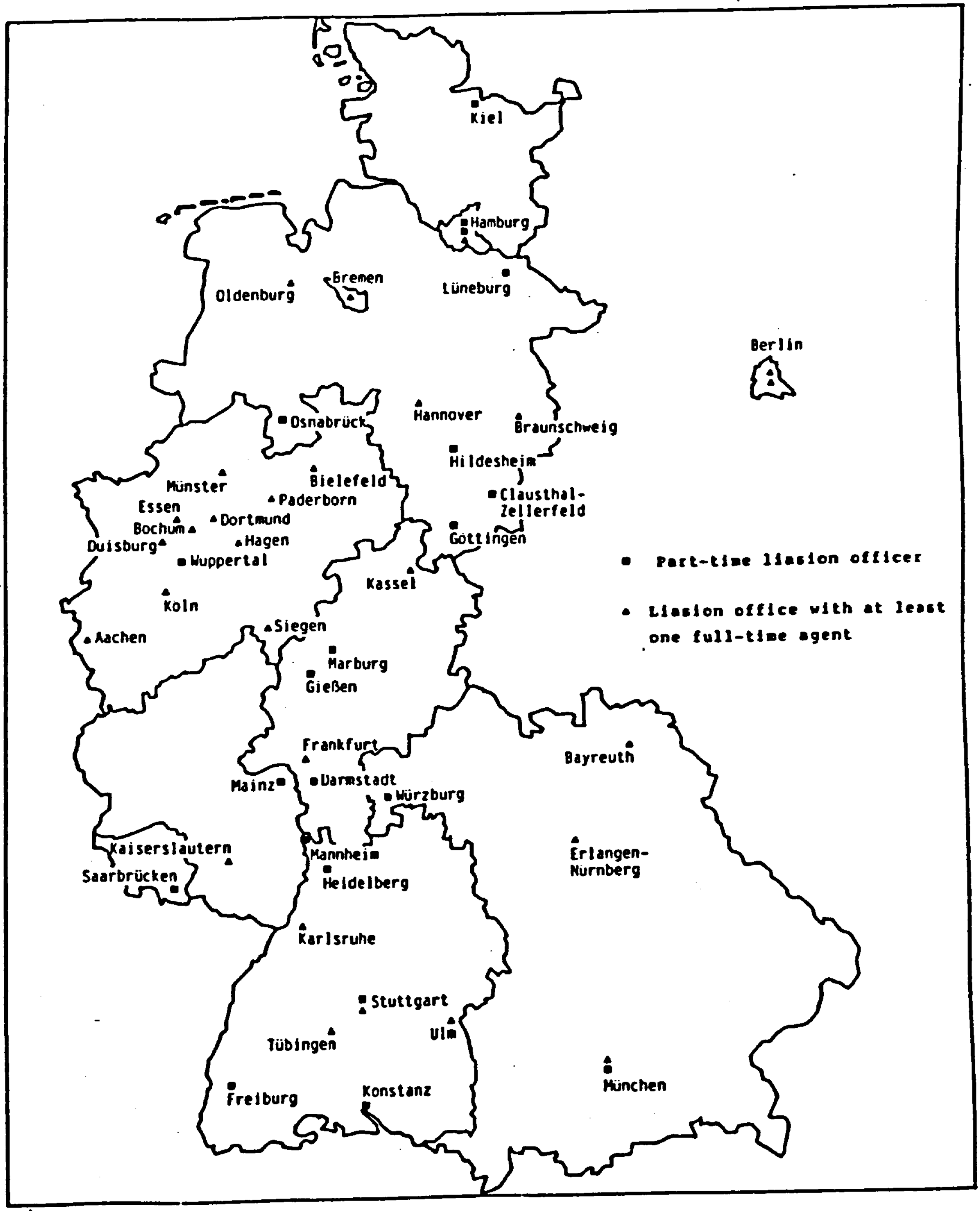
Institutions of scientific education are the the largest research institutes of a nation. The average expenditure for university research amounted to 6.6 thousand million DM, more than half of the public funds for research and development.
In the Federal Republic of Germany the scientific system divides into two levels: Universities are the most important representatives of basic research, whereas in industry applied research and development are pursued. The time-lag between basic research and industrial application has become much shorter,especially in the field of new technologies such as biotechnology and microelectronics. However, the proportion of research funds given to the university from industry, the so-called "funds from third parties", has not changed significantly in the past few years. Therefore, the demand on universities to use their own research potential for preserving and enlarging the innovation capacity of industry has increased. Universities, especially technical universities have traditionally strong contacts with large-scale enterprises. Contacts with small and medium-sized enterprises (SME) and their supply of the latest technical know-how and of qualified academic staff are less frequent (cf.ALLESCH, PREISS-ALLESCH, 1984).

At the request of the Bundesministerium für Bildung und Wissenschaft (BMBW-Federal Ministry for Education and Science) the research project "PROWIS" at the Technical University of Berlin made an inquiry of university professors about the topic "cooperation with industry" (cf. ALLESCH et al.,1986). Between December 1984 and April 1985 8857 university teachers were consulted. Based on 1823 evaluated replies - a number,which covers 20 % of the German professors for economics, engineering and natural science - there resulted the following division of contacts to industry: 70 % of the professors in universities have contacts to industry. But only 14 % of university teachers are in touch with small enterprises; contact with the work of medium scale enterprises amounts to less than 30 % of their work with industry. The main industrial partners of universities are large-scale enterprises employing over 500 employees - contact amounts to nearly 57 %. However, small and medium-sized enterprises, because of their structural economic importance, should not be neglected and need special help from the universities in their attempt to adapt themselves to the technological change.

In the past, the establishment of useful cooperation between university and small and medium-scale firms has often been frustrated by lack of information on both sides, as well as by a fear of contact. Consequently, during the past few years, universities have discovered organized knowledge and technology transfer as a new field of activity (cf. BUDACH,ADLER,1984).
Of the 58 universities in the Federal Republic of Germany 49 have institutionalized some form of liasion office or technology transfer unit (cf.fig.1), with measures ranging from the appointment of a transfer agent as part-time job to the establishment of a full-scale transfer agency employing several full-time employees and numerous free lance employees and some on fixed-term contracts.

Transfer agencies have been established at technical universities, the "classical" universities and at Gesamthochschulen.The know-how transferred is not restricted to the technological/ scientific field but covers the whole spectrum of university knowledge and research. The models of organization have been adopted by the universities in a different way. At the universities part-time transfer agency officers predominate although recently a definite trend towards the establishment of a properly institutionalized transfer agency with several full-time staff has become noticeable. There are currently 17 such agencies although their organizational relationship with their host institution again covers a wide spectrum ranging from a central establishment set up by the university administration through bodies

Fig.1: Establishment of Organized University Knowledge and Technology Transfer in the FRG (State: April 1986)
source: ALLESCH et al.,1986



responsible to a particular subject area to outside bodies which are only connected with the host institution by means of a co-operation contract.

The staffing of transfer institutes differs widely. One can say, that about a third of the transfer agencies are adequately staffed and in a position to develop a comprehensive, wide-ranging service. To fulfill the demands made on a transfer agency, it requires a minimum staffing of 2 full-time scientific workers plus one administrative officer.

The equipment of transfer institutes varies as widely as the range of organizational models. The staffing, material and the financial requirements are all dependent on the sort of organizational model adopted and especially on the range of services planned for the transfer agency. On the other hand, the spectrum of activities is very much determined by the funds available. The method of funding, therefore, varies according to the style of organization adopted and according to the possibilities for the universities in the different "Länder". Examples can be found of offices funded completely by the university budget, partly funded by the "Bund-Länder-Kommission für Bildungsplanung und Forschungsförderung" as a part of a pilot project, via several models of mixed funding (partly funded by the university on the one hand and partly by other sources such as sponsors, project work, donations on the other hand) to the ideal of total self- financing by revenues or third party financing.

3. Action Areas of Technology Transfer

Transfer offices have developed a number of activities which can be categorized as follows:

- Information transfer
- Technology transfer
- Personnel transfer
- Start-ups of companies
- Further education

- Information Transfer

Information transfer is one of the central tasks of the transfer of scientific knowledge. This area has a university political dimension in addition to its function of straightforward information transfer. That is, it also makes clear to the public the results of university research by means of information brochures, exhibitions and representations at fairs. Its basic task, however, is of course to inform the market of university research and inform the university of market potential.
The inquiry made by PROWIS in 1984 showed that 95 % of transfer offices worked on information transfer. The major themes were general information about research at universities, detailed information about current and completed research projects as well as information about translatable results of research and development. More and more, transfer offices are also offering literature searches from international on-line databases, i.e. aids for the accession of up-to-date scientific literature.

Participation in innovation or industrial fairs plays an important part in the marketing of a university. In the Federal Republic of Germany, the Hannover fair with its special exhibition hall for "Research and Technology" is used by a large number of German universities and polytechnics to present their results on a national stage.

- Technology Transfer

By this it is meant the initiation, provision and nurturing of specific cooperation products between universities and outside partners in the fields of research and development. It involves the full range of legal support in respect of contracts and administration, which, especially for short-term small co-operation projects with small and medium-scale enterprises, can cause problems.

- Personnel Transfer

Personnel transfer is a most effective form of technology transfer, since it is person-oriented. However, small and medium-sized enterprises need support in order to overcome obstacles and barriers for this form of transfer. An organized form of personnel transfer is a field for further development. Many transfer offices have started to provide industry with qualified graduates.
Below there will be described a new model of personnel transfer which has been established at Berlin (West).

- Start-ups of Companies

This field of activity receives more and more attention by the universities. The development of new enterprises with new technology in the area around the university is not only an effective measure for the dissemination and implementation of new technology but at the same time a suitable means for the creation of firms which will introduce technical innovations into industry and further job places. At the same time, scientific know-how is generated in the region around the university.

Recently a number of incubator units and technology parks have been established and further ones are being planned. For most of them the universities play an important and active role. The "Berliner Innovations- und Grunderzentrum" (BIG) (Berlin Centre for Innovation ans New Enterprises), the first German institue of this,kind, was opened in November 1983 but it is already being extensively enlarged on account of its success. A good description of the German and European innovation centres and science parks is given in AMANN (1986).

- Further Education

As a result of the rapid changes in technology there will be a need for professionally related further education and the universities should develop measures to provide this. The use of new technology by industry and the progress of scientific knowledge in research requires an effort to be made for this further qualification. The professional further education should be the responsibility of particular professors and scientists. For the transfer-offices special "transfer-related" subjects are being considered. By "transfer-related" we mean those measures which are concerned with the problems of technology and innovation management. Innovation management is defined as the full range of methods and procedures required for the efficient planning of innovation projects, their organization and guidance (cf. ALLESCH,1986 a).

Nearly the half of the German transfer offices carry through programmes of further education, mainly in the fields of technology, technology and innovation management and marketing. Further education in respect of the initial stages of new firms is also gaining in importance

This wide spectrum of initiatives or the collaboration between universities and regional or national industry gives an important impetus to regional innovation policy and may, in the long run, give an important impetus to overall economic development.

4. Institutional and organizational forms for the transfer of knowlegde and technology through universities.

4.1 Ideal-typical Models

Concepts of institutionalization for information and technology transfer are dependend on many factors. For this reason it cannot be claimed to outline complete and generally transferable strategies. The following basic forms of institutionalization are possible and show manifold varieties and expressions.

Central Model

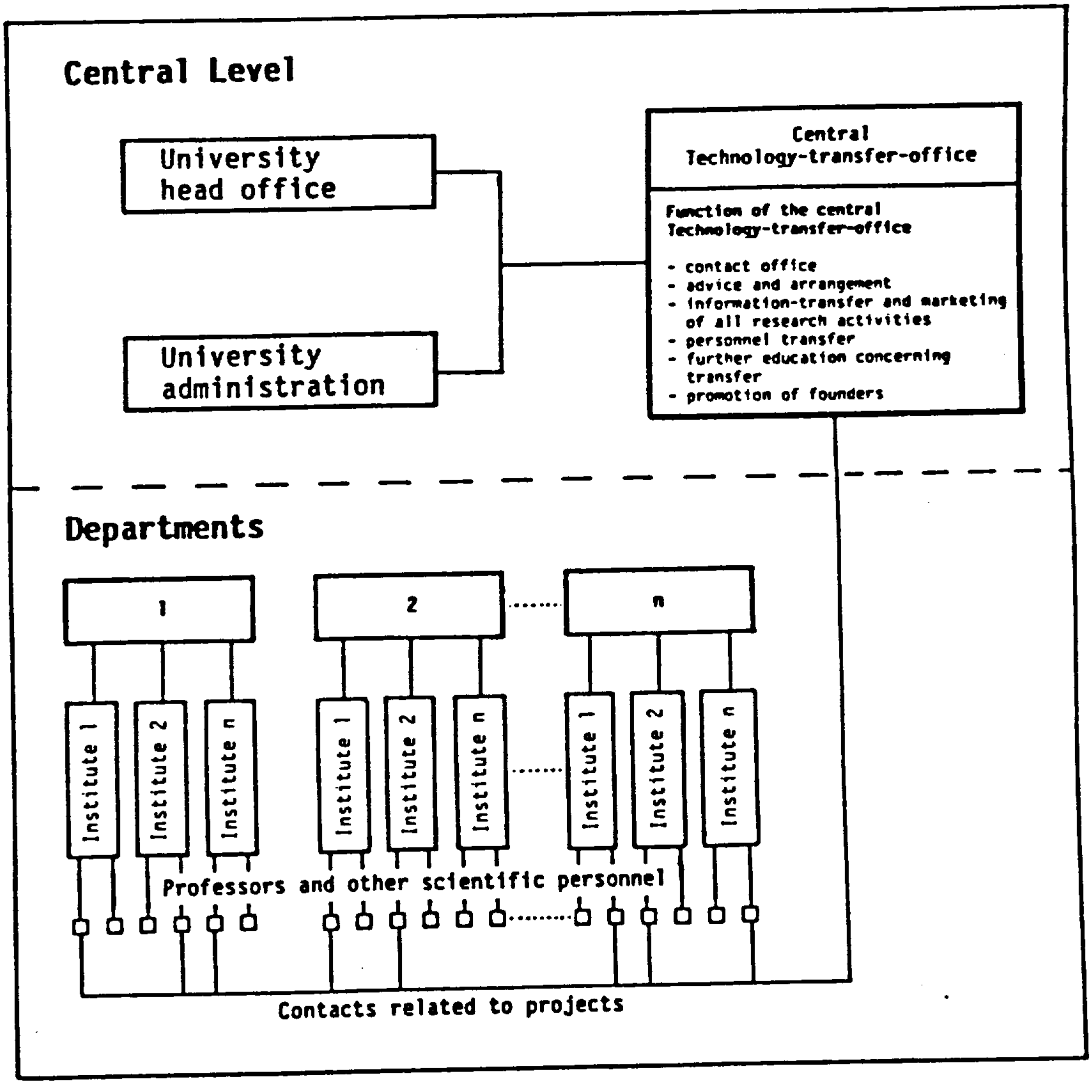
In this model institutionalization of information and techology transfer takes place in form of a central agency.

In the initial stage central agencies are often equipped with only one collaborator. In this stage the most important tasks have a reference to contact arrangements and information transfer, for example about the attendance at fairs and the preparation of a catalog of efficency about research activities of universities. An important expansion of these tasks is the aqisition of cooperation projects as well as activities to encourage the willingness of cooperation of university teachers, who have very few contacts with the pratice. In this stage of development the transfer agency is financed out of the university budget.

The transfer agencies, which have widend their efficency spectrum and have stronger personnel capacities after a phase of consolidation, can establish regional contacts on a larger scale. The central settlement grants those transfer agencies different functions. One task consists in convincing universities intern as well as extern partners and in informing about possibilites and changes of cooperations. In addition to it the transfer agencies should give advice concerning general questions of technology transfer on a financial, legal and administrative level. Further the offer of universities for the economy could be shown offensive through different media. The most important task is to aquire and to initiate definite transfer projects. The degree of integration of the technology transer agency into existing transfer projects can vary from the initiation of a cooperation to an institutionalized partnership in the sense of a

Fig.2:

Model 1 for the organisation of a transfer office: Central Model
(Source: PROWIS)



project management. Even in regard to existing direct cooperations between science and economy there are alternative possibilities for an incorporation of a transfer agency.

For the performance of a wider spectrum of tasks (cfg. cap.3.) a personnel staff of two scientific coworkers and further administrative personnel as a minimum should be estimated. In dependence of the university political tasks and the offered services result in different forms of financing. A financing by the university or by public funds is possible, if in case of a broadened spectrum of tasks the effects of transfer activities highly benefit the further development of instruction and science. Through further education activities , but even through other services, the possibility of a mixed financing is offered, maybe even with the goal of self-financing.

For transfer agencies, which try to exercise a wider spectrum of efficency internal as well as external problems arise.

Internal the take over of many functions means the risk of an increasing administration effort, which can limit the necessary flexibility of transfer activities. Further a central agency has to deal with the risk not to be able to cover all fields.

External the question arises, if certain functions in the transfer process are already exercised or could be exercised more efficantly by other transfer institutions concerning the partner as well as possible measurements. Basically it has to be considered, if it is wise

- to teach the knowledge to only one university,
- to distribute the knowledge only regional,
- and to effect a speciliazation on certain sizes of corporations.

Further the financing of a transfer agency, which exerises university and research political tasks as well as regional economic and structre political tasks, will be discussed in public.

Decentral Model

Another concept of institutionilization of a transfer agency is the decentral subject specific institution. This can be in form of a part-time activity of a coworker as well as an autonomous institution with a couple co-workers. The latter presumes an especially scientific subject with numerous potential services, which are transferable.

The special advantage of a special subject transfer agency is the close neighborhood with producers of new knowledge and new technologies and with this the high degree of technological competence on the side of the transfer co-workers, because mostly the scientists work in the same subject.

Furthermore the subject specific concentration to a limited number of external interlocutors admits a special preparation of information for the target-group. With that

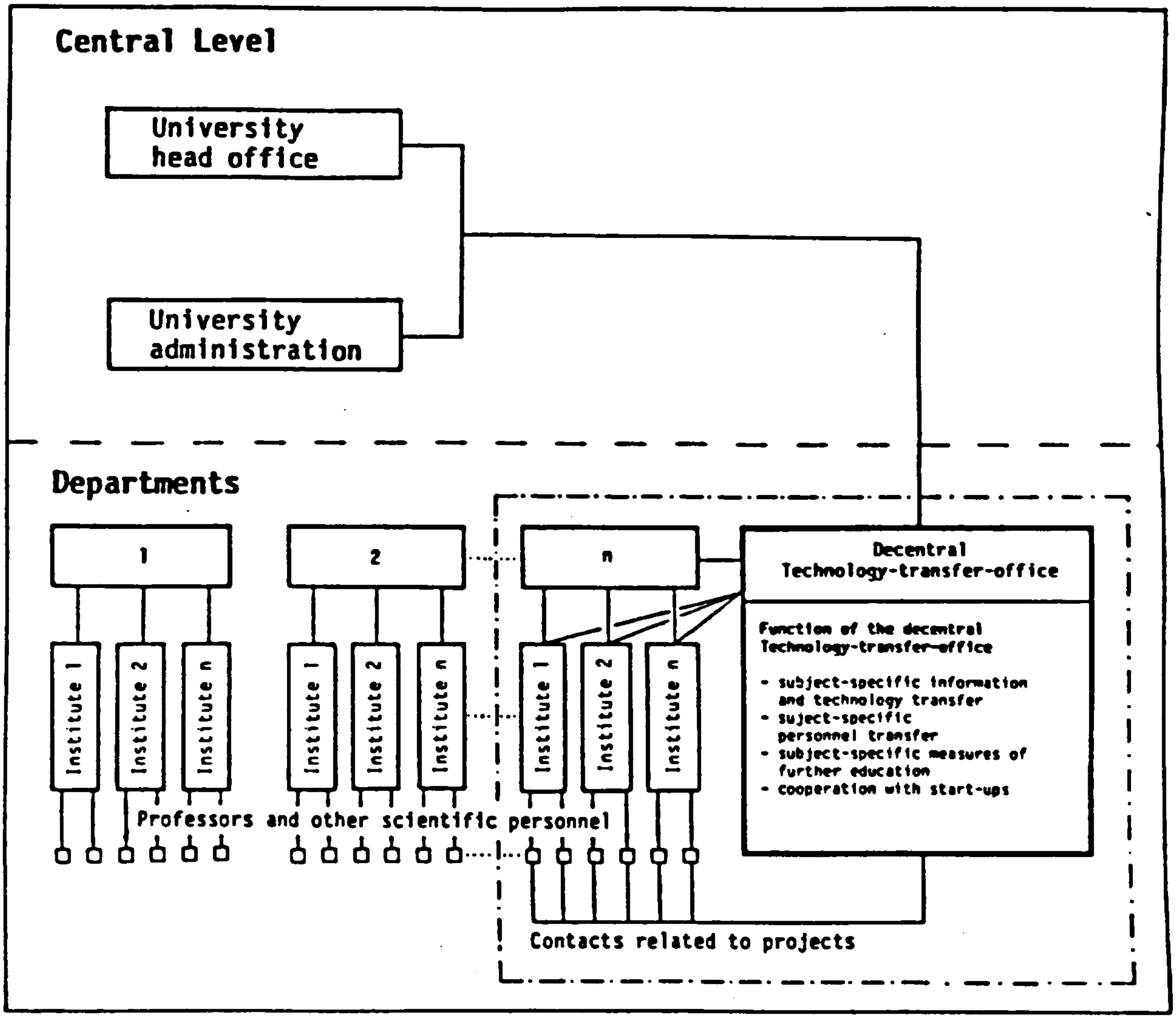
- the risk of a deviation of activities and target-groups, which is too wide, will be opposed,
- the development of an administration, which is too big, will be limited,
- the possibility of a wide use of new knowledge will be optimized.

An example for a decentral transfer agency is the information center for microelectronic at the university of Karlsruhe.

Nevertheless a subject and institute specific transfer agency is not able to offer such a wide supply on all transfer levels as it is possible for a central agency. On the mentioned transfer

Fig.3:

Model 2 for the organisation of a transfer office: Decentral Model
(Source: PROWIS)



levels activities of a decentral transfer agent or a transfer agency are scientific and technology specific, i.e. technology and information transfer can be offered in a highly specified form. Compared with this the support of the founding of technology oriented enterprises represents only a minor field of activities, because a sufficent advice for founders through a decentral agency can be provided only up to a certain point.

The problems of the decentral model lay

- in the technical specification for customers
- and by this missing possibilities for interdisziplin cooperation as it is necessary for many problems in the practice.

Besides this the limitation of customers, due to the high technological specification of the transfer agency, can easely lead to the suspicion that industry influences the university. Even more as a third-party financing can be achieved by project aquiration and -performance.

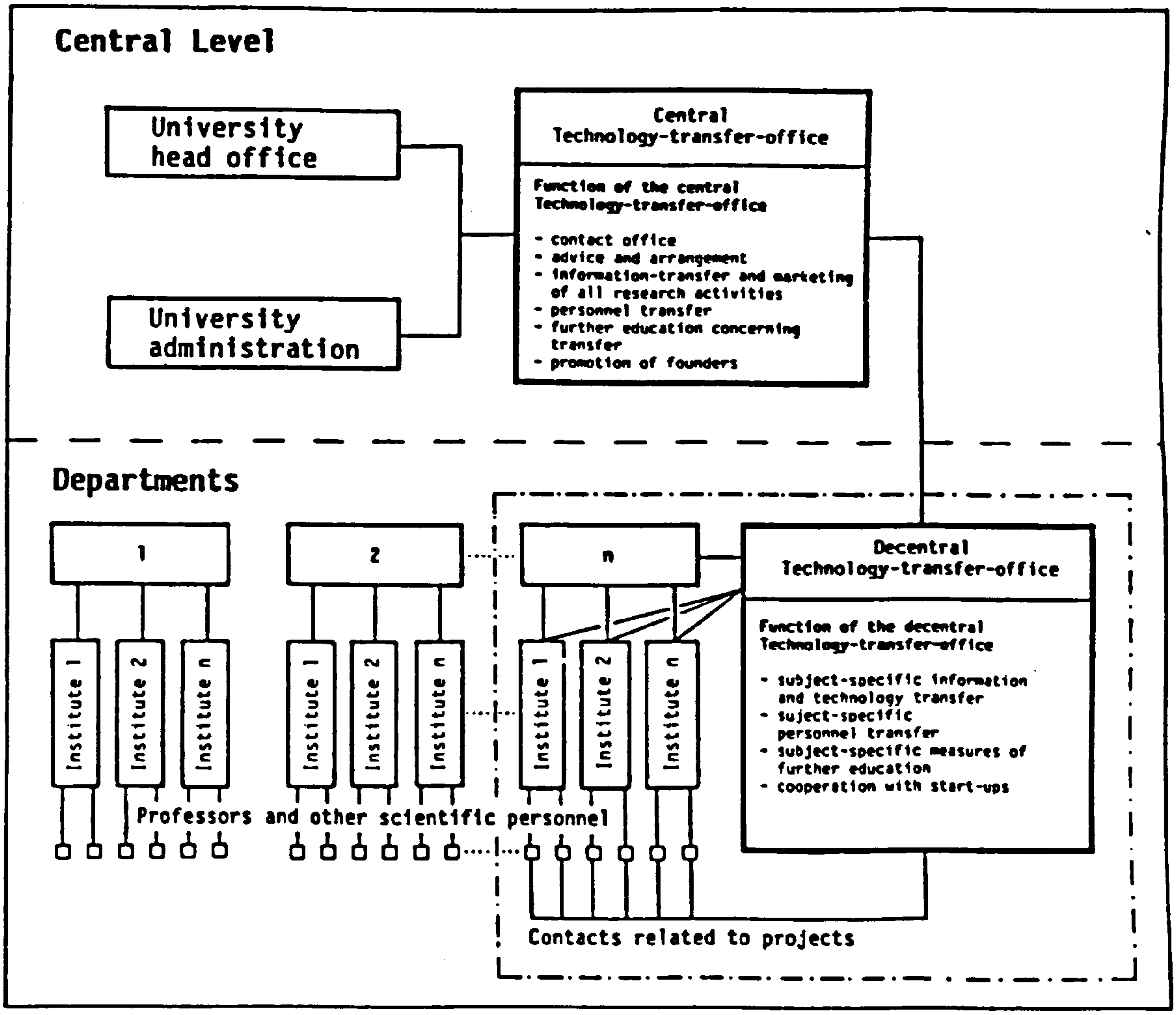
Mixed Model

While a number of modelling alternatives are possible for the organization of central and decentral transfer agencies, a medium variance could exist in form of a mixed model based on the division of labour.

While a central agency could offer the whole spectrum of efficency of the knowledge and technology transfer the information and technology transfer on a specialized level are exercised by the central agency as well as directly by the department institute. An overlapping of subjects of both transfer insitutes of a university is hardly to be feared, because the central agency concentrates on overlapping efficency subjects and with this deals regional oriented as well as related to the group

Fig.4:

Model 3 for the organisation of a transfer office: Mixed Model
(Source: PROWIS)



of small and medium-sized enterprises. The cooperation of both agencies open up the posibility of a connection of technological and operational marketing and adminstrative Know-How. Besides this the central transfer institution can take on the administration of third-party money, carry out the first legal advice for cooperation contracts and take on a mediatory function related to legal questions of patents and licences.

The mixed model seems best for universities, which have specific advantages in research in special fields. With this specialized scientific potential they have a good base for the establishment of subject specific transfer and information institution.

Institutionalization of transfer agencies in the subjects as well as on the central level means involvement of much personnel. For such a transfer net, which is internal of the university, a mixed funding by third-party money and the university's budget seems best.

4.2. Practical Examples

Example for the central model: TU-transfer (Berlin)

An example for a central model is the technology transfer office of the Technical University of Berlin (TU- transfer).
TU-transfer is staffed with several full-time scientific workers and has the tasks:

- arrangement and advice of projects concerning cooperation between companies and university (development by order)
- advice for the preparation and carrying-through of cooperation projects between companies and university.

Additional TU-transfer offers a wide information service. Among other things TU-transfer yearly compiles a booklet "research market Berlin", which gives a summary of ralizable cooperation offers of the university institutes and of the institutes to the companies.

Example for the decentral model: the FZI at Karlsruhe

In 1983 the "Research Center for Computer Science at the University of Karlsruhe" (FZI) was established. The FZI works in close relation to the institute of information of the university of Karlsruhe. Since the 1.1.1985 the FZI is an independant foundation . The specially close relationship between the foundation and the university is accomplished through the fact that all research grpoups at the FZI are headed by professors of the computer science institute. This mans the professors do their research and teaching at the university on one hand and advice of activities at the FZI on the other hand.

The construction permits to imply research results from universities into projects with industries and the other way around to bring the problems of the practice in contact with university research. A serious problem which should not be forgotten is the overtime of the professors without working 60 to 70 hours a week. We hope the working conditions can be reduced by organizational measures after the initial stage.

FZI's Fields of Activities

The spectrum of present activities will be outlined only global by the specification of the subjects on which research groups work at the present time:

- CAD/CAM technology
- databanksystems
- efficency analysis of computers, data communications
- microelectronics
- microcomputers in technology
- soft ware technology
- technical expertsystems and robotics

In these fields 40 scientists and 10 other co-workers under eight professors work for the operation of the central technical institutions and services. For the future an extension up to 60 scientists is planned .

Financing

All projectgroups in the research center work autonomous, i.e. they aquire and balance by themselves. The long-term planning intend to produce 2/3 of the costs by the FZI itself and to cover 1/3 through a grant. This grant is even bigger at the moment, because increased funds for example must be used for the financing of necessary starter research and for financing of transferactivities etc. The distribution of the grant to the research groups depends on their success, because the group which advertises more get a higher share of the grant.

Pros and Cons

The advantages of the described concepts are advantages against the usual university structure. Therefore they are typically of an organizing kind:

- an autonomous jobplan with the possibility to build up an adequate personnel infrastructure
- short ways of decisions
- management operation (at least internal)
- as an organisation easier to survey (especially important for medium-sized enterprises)
- different research fields are under one roof and can cooperate with each other
- close cooperation with the university under a wise partition and addition of functions
- complementary education for students of the FZI close to practice.

As disadvantages have appeared:

- obligation to the state budget
- fixing of the salaries to the level of public salaries
- reduction of initial salaries of co-workers due to the present effective dispension about the initial salaries within the public service
- honorary activities of professors without a decrease of their other engagements in the universities.

Existing Experiences

The present work of the FZI throughout shows good results, which was worth the hard work of all people involved. Certainly up to now no problems or crisis have occured which could not have been solved with the spirit and solidarity of the initial phase. In the long-term it will be necessary to reach certain precautions to cover oneselve against misplanning and failure and to give a good base for the coming successful work through extensive research and an effective infrastrucutre.

Example for the Mixed Model: the Transfer Office at Aachen

An example for the mixed model is the transfer office of the Technical University of Aachen. The transfer activities, which are put through by the Technical University of Aachen were supplemented by measures, which manage to do a decentral partizipation of the departments.

At the institute for engineering plastic of the Technical University a transfer office was established especially for the craft-companies. This transfer office of the institute is aimed to the specific technical problems of the handicraft. The arrangement of experts, the procurement of information and the apply for public funds should additionally support the

craft-companies.
Projects, on which the institute for engineering plastic cooperates with craft-companies, are:

- hot-water soil heating made of plastic
- flow diagramms for injection moulding tools
- construction-handbook for toolmaker

The experiences of Aachen show, that a mixed transfer model creates the possiblitiy to get more precise to the problems and structure of branches.

5. Problems and Perspectives of Technology Transfer at Universities

An important task of university transfer agencies is the support of university teachers in their development of collaboration projects with external partners and to help them open up new areas of such collaboration. A pre-condition for this is an accurate knowledge of the specific problems and obstacles which university teachers are confronted with in the development of such collaboration. The findings of the above mentioned inquiry of PROWIS have shown, that university teachers who cooperate with a transfer agency cooperate much more frequently with small and medium-sized enterprises than other university teachers. Moreover they find their cooperation partners more often in the region of their university.

Intra-mural Problems

The university teachers listed the most important problems and obstacles inside the university in the development of contacts with outside industry as follows:

- No adequate staff capacity (e.g. scientific non-professional teaching staff, technical staff)

- The burden of teaching and research
- Financial settlement of projects developed with funds from third parties is not being sufficiently flexible
- Restrictions resulting from regulations about part-time activities
- Lack of payment possibilities for participating staff
- Inflexible employment practice resp. staff management

Extra-mural Problems

Outside the university the following difficulties were mentioned:

- Lack of experience in cooperating with universities
- Difficulties in finding cooperation possibilities with adequate partners in the regional environment
- Lack of external partners who are prepared to long-term co-operation with the university
- Lack of finances in industry for cooperation with universities
- Lack of information about the performance and efficiency of universities
- Difficulties of firms to define their problems and identify the need for solutions.

Instruments for the Improvement

The university teachers considered the following measures would be helpful to improve the flow of technology transfer from universities:

- Regular meetings of scientists and partners from industry
- Improvement of the inter-disciplinary cooperation within the university
- The release of university teachers so that they may undertake temporary employment in firms (in form of "sabbatical years")
- Promotion of co-operative research and development
- Special teaching posts for practicians from industry

- Promotion of commercial activities of professors.

It remains to remark that in this new field of transfer activity universities have developed effective instruments to help them cope with the new demands put on them. There is the risk, however, that the transfer agencies, due to their inadequate staffing and finances, will not come up to expectations. In order to be effective, especially the connection of university transfer activities with the increased industrial demands for technology transfer has to be improved.
In several European countries there are discussed and practised enabling mechanisms to develop better contact between university and industry (a general view of the discussion at this stage in Great Britain in the Federal Republic of Germany is given in BMBW, 1986).

6. Innovation and Regional Development: the "Berlin Model"

The described problems of technology transfer at universities are one of several aspects, wherefore in Berlin (West) a new model of technology transfer has been developed and established during the last years.
A city like Berlin (West) presents quasi-ideal conditions for technology transfer activities. With two universities, several colleges of higher education and a great number of public and private research institutes, Berlin (West) has a scientific potential which makes this city a major center of research and development in Europe.
On the other side, Berlin is one of the most important industrial cities of the Federal Republic of Germany. About 2.200 enterprises employ more than 160.000 people. 25 % of the output is exported into member countries of the European Community. Small and medium-sized enterprises form 95 % of all Berlin business.

For some years now, there are several transfer agencies working in Berlin (West). The most important ones are: the transfer agen-

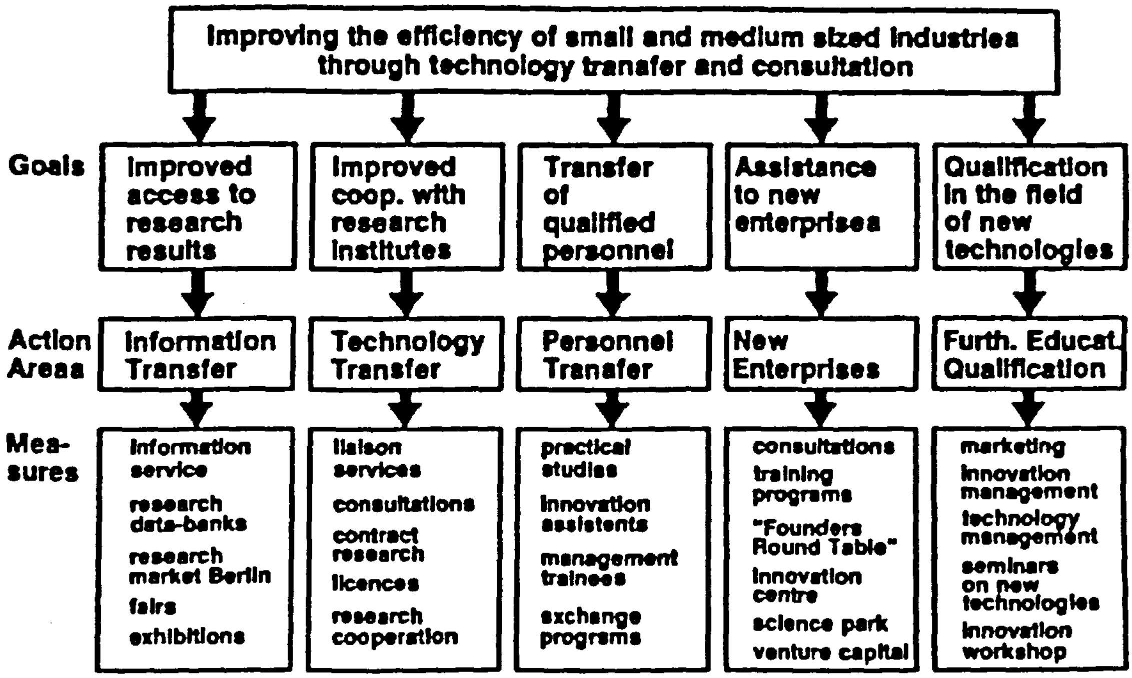
cy of the Technical University of Berlin; the consulting-services of the chamber of industry and commerce; the technology-centre of the VDI (association of German engineers), which is oriented more to the national level; the Technologie-Vermittlungs-Agentur (Technology-Transfer-Agency,TVA). In the following there is a more detailed description of the activities of the TVA.
As a result of a further development of technology transfer conceptions, the TVA is an institution out of university, supported by industry, industrial associations, administration and science. The essential specific of TVA's work is the connection with an innovation-oriented policy of regional development,led by the Senate of Berlin (West). The task of the TVA is to translate this policy into practice.

The outlined industrial and university conditions of Berlin (West) are the background for the "Berlin Model"(cf. fig.5), a regional approach of industrial policy to improve especially the capability for innovation of the small and medium-sized enterprises by the transfer of technology. Experience and studies show that especially the small and medium-sized enterprises can scarcely master the complex process of innovation by themselves due to personnel, financial and organizational deficits (cf. EWERS et al., 1984; ALLESCH,1986a). Their margin for product improvement and modernisation is very small and often that means having to shut down when the situation for demand and competiton changes. From the overall economic point of view it is necessary to provide adequate support.The special task for regional technology transfer and innovation consulting institutes is to provide information, equipment and experts as a contribution to solve the innovation problems of the regional economy, especially of the small and medium-sized enterprises.

With regard to the described problems of small and medium-sized enterprises and with regard to innovation as a whole,the "Berlin Model" works on the above described areas which can be activated for technological transfer:

Fig.5:

"The Berlin Model" for Technology Transfer and Innovation



- Information transfer
- Technology transfer
- Transfer of personnel
- Start-ups of enterprises
- Qualification consulting

Information Transfer

The TVA-information service is a support to the company's information-management with:

- An extensive online-data bank service with access to 900 national and international data banks, that means to the newest state of science and research.
- Inquiries about market situations and technical standards.

Till now the TVA has answered about 1.500 data bank inquiries.The importance and the worth of information as the base of entrepreneurial decisions is increasingly recognized. The TVA - as a regional information-broker - has more and more inquiries.

Technology Transfer

Small and medium-sized enterprises do not have the necessary resources for research and development. They do not have the know-how to carry out developments without outside help.
They lack:

- The personnel and technical requirements
- The financial possibilities
- The contacts and the experience with external offers of technology.

At these deficits the TVA begins to work as an advisory capacity. The advisers of the TVA are the mediators between the sme's and the experts of science and business. After the analysis of the problems the TVA looks for the right partner, arranges the first contacts, helps to make contracts and cares for the projects of co-operation.

Start-ups of enterprises

The establishment of new enterprises gains increasing attention by the institutes providing regional economic development. Berlin's program to grant financial aid was improved step by step and cumulated in 1983 in the foundation of the Berlin Center for Innovation and New Enterprises (BIG),the first such innovation center in the Federal Republic of Germany.
The Technical University of Berlin (TUB) is till the end of 1986 responsible for the activities of the BIG. In the urban district of Wedding the TUB can dispose of a huge building. The piece of land extends over a surface of 11.617 square meters, the complex itself over 30.000 square meters. At the moment the BIG accomodates 33 young technology-oriented companies on an area of 5.000 square meters. Research institutes of the TUB also work at the site in Wedding. That also gives the companies a chance for co-operation with the nearby TUB-institutes.

Besides this special activity of the BIG,the TVA assists technology-oriented new enterprises in getting through the difficult start-up-phase.

TVA's wide range of services includes the following:

- Evaluation of the innovation concept with regard to technologies and marketing potentials,
- Arranging for contacts to be made with experts on special problems,
- Financial counselling (public funding, venture capital),
- Advice and assistance with the search for suitable industrial premises,
- Assistance in recruiting staff members.

Qualification Consulting

In co-operation with the Berlin Labour Exchange TVA assits Berlin firms in solving their difficult problem of staff planning and qualification. For this purpose TVA has set up the transfer group Continous Training. Its advice and service offer comprises:

- Advice on staff planning and operations planning,
- Initiating and organizing of inservice and inter-company qualifying schemes,
- Counseling on public funds to be obtained for the period of professional adjustment of new staff members and for their qualification.

Transfer of Personnel

A well-qualified staff is the prerequisite for innovation and dynamic business development. The TVA -Personnel-Transfer-service assists Berlin firms in recruiting qualified university graduates and postgraduates as specialists and management trainees (innovation assistants).

As recruitments are always risky, the Senator for Economy and Labour sponsors the employment of innovation assistants by covering 40 % of their taxable gross income for a period of 12 months, the maximum being DM 24.000 p.a.
Only those personnel service businesses and manufacturing companies qualify for application whose annual turnover does not exceed DM 50 million in the year prior to that of application.
Applications can be filed at TVA.
The aim of the measure is:

- To facilitate the recruiting of university graduates in small and medium-sized enterprises. That also means to reduce prejudices against university graduates.
- To open new fields of occupation for university graduates. That means, existing orientations of university graduates to

the research and development departments of large-scale firms should be complemented by small and medium-sized enterprises as a possible field of activity.

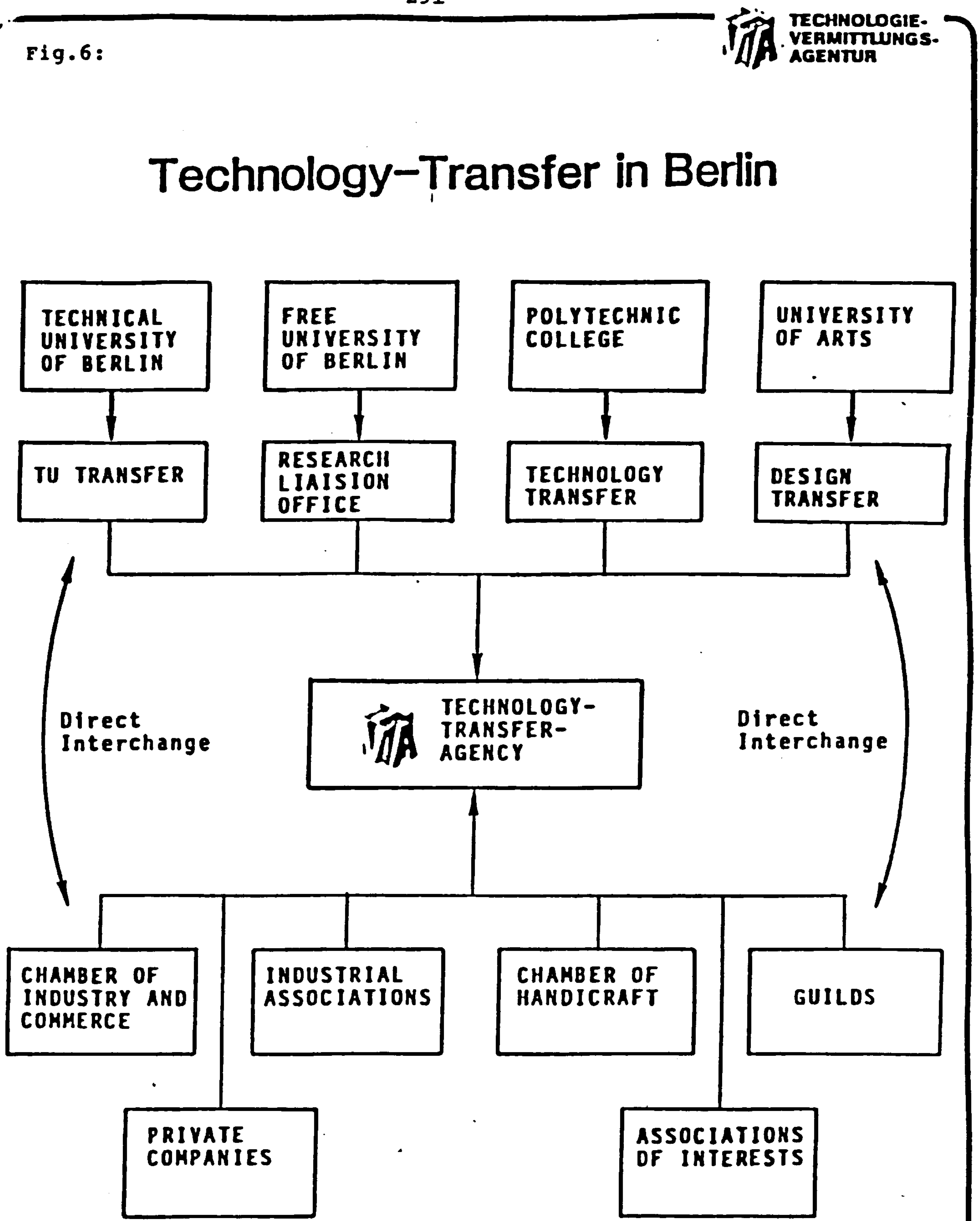
Up to now about 320 innovation assistants could be placed with Berlin enterprises. There is a big demand that hardly be met in microelectronics, information and data processing (cf.fig 4,5,6). More than 50 % of the supported firms did not have any experience with university graduates.

The Setting-up of an Innovation Network

The outlined Berlin model of innovation and technology transfer is an integral approach to regional innovation policy, at which the TVA takes a central function (cf. fig.6). By a mixture of methods the endogenous potential should be forced for a new economic development of a whole region. The examples of Boston and Silicon Valley and also the so-called Cambridge Phenomenon prove that regional centers of economic and technological expansion can induce a cumulative process of a positive regional development. Of course there are environmental conditions for the success of regional centers of technological expansion. Important is the existence of the following factors:
multinational companies, small and medium-sized companies, consultants, venture capital, banks with experience in innovation financing, transportation and communication structures, research institutes, universities and polytechnics, qualified work-force, premises, regional development policies and programs, cultural infrastructure and the social acceptance for entrepreneurs.

In consideration of these conditions the Berlin Model proceeds from the assumption, that besides of new technology-oriented start-ups it is possible, to gain the small and medium-sized enterprises for an increased adoption of new technologies. Therefore the Berlin Model is in practice the setting-up of an innovation network (cf. BULLOCK,1984). This network should integrate

Fig.6:


TECHNOLOGIE-
VERMITTLUNGS-
AGENTUR
Technology-Transfer in Berlin
TECHNICAL UNIVERSITY OF BERLIN
FREE UNIVERSITY OF BERLIN
POLYTECHNIC COLLEGE
UNIVERSITY OF ARTS
TU TRANSFER
RESEARCH LIAISION OFFICE
TECHNOLOGY TRANSFER
DESIGN TRANSFER
Direct Interchange
TECHNOLOGY-TRANSFER-AGENCY
Direct Interchange
CHAMBER OF INDUSTRY AND COMMERCE
INDUSTRIAL ASSOCIATIONS
CHAMBER OF HANDICRAFT
GUILDS
PRIVATE COMPANIES
ASSOCIATIONS OF INTERESTS

all factors, which are pertinent for a new stage of industrial development: firms, banks, universities, administration, organizations and institutions. A process of networking is able to create an innovative climate: the economic development of a region is based on a permanent innovation-oriented co-operation and stimulation.

An innovative climate can improve especially the ability of small and medium-sized enterprises to stand the challenge of competition. Berlin can get the status of an industrial metropolis with a new and important position within the national and international competition (cf.EWERS,o.J.;ALLESCH, SCHRÖDER,1986).

Résumé: Towards a International Dimension

The Berlin Model, the attempt to create a regional center of technological and economic development, cannot be seen isolated from the national and international levels of transfer activities. A continous exchange of information and by that co-operation is necessary not only for a regional and development, but also for an innovative climate all over the western industrial nations.

If one proceeds from a conception, that the international technology-oriented development has to be thought as a connection of the regional, national and international levels, the existing state of cooperation must be improved continously. Conferences, exhibitions and fairs, a permanent process of information-exchange is necessary to get closer to the goal of a world that co-operates better even in the field of technology and innovation.

The initiated process of an international networking has to be forced to build up the framework for a new, technology-based economic perspective for the future.

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Appendix 1: Technology-Transfer- Offices at German Universities
Source : PROWIS

	Scientific University	Model of Organisation	partner for Requests
1	Rheinisch-Westfalische Technische Hochschule Aachen Templergraben 55 5100 Aachen	a) Senatsbeauftragter f. Technologietransfer b) Zentrale Transferstelle "Buro Technologie-Transfer" (BTI) c) Technologietransferstelle d. Nordrhein-Westfal. Handwerks am Inst. f. Kunststoffverarbeitung	a) Prof. Dr. W. Eversheim b) R. Roericht (Leiter des BTI) c) F.W. Weber (Inst. f. Kunststoffverarb.)
2	Universitat Bayreuth Opernstraße 22/IV Postfach 30 08 8580 Bayreuth	2. Zentrale Transferstelle "Kontaktstelle Technologietransfer"	Dr. H.-W. Ludwigs (Leiter)
3	Freie Universitat Berlin Altensteinstraße 40 1000 Berlin 33	Zentrale Transferstelle beim Präsidenten "Forschungsvermittlungsstelle"	Dr. A. Timmermann (Leiter)
4	Technische Universität Berlin Fasanenstraße 4 1000 Berlin 12	Zentrale Technologietransferstelle beim Präsidenten "TU-transfer"	H. Förster (kommissar. Leitung)
5	Universität Bielefeld Universitätsstraße Postfach 86 40 4800 Bielefeld	Zentrale wissenschaftliche Einrichtung "Zentrum f. Wissenschaft u. Praxis" (ZWuP)	Prof. Dr. P. Naewe (Inst. f. Wirtschaftswissenschaften) (Geschafts-führender Direktor)
6	Ruhr-Universität Bochum Gebäude NB 1/132 Universitatsstraße 150 4630 Bochum/Querenburg 1	Zentrale Transferstelle "Unikontakt - Kontaktstelle Universität/Wirtschaft"	Dr. W. Budach (Leiter Unikontakt)
7	Technische Universität Carolo-Wilhelmina zu Braunschweig Pockelsstraße 14 3300 Braunschweig	Technologietransferbeauftragter im Hauptamt	Dr. J.-M. Wenzel
8	Universitat Bremen Bibliotheksstraße 2800 Bremen 33	Zentrale Transferstelle beim Rektorat "Arbeitsstelle zur Förderung des Technologie- u. Wissenschaftstransfers zwischen Universitat und Region Bremen" (UniTransfer)	Dr. R. Vogt (Leiter)
9	Technische Universitat Clausthal Adolf-Romer-Straße 2A 3392 Clausthal-Zellerfeld	a) Technologietransferbeauftragter im Nebenamt b) Einrichtung einer zentralen Transferstelle für Ende 1986 geplant	a) Prof. Dr.-Ing. P. Funke (Fak. f. Bergbau, Hutten- und Maschinenwesen) b) N.N.
10	Technische Hochschule Darmstadt Schloß 6100 Darmstadt	Technologietransferbeauftragter im Nebenamt	H. Stöcker (Referent f. Forschung u. Technologietransfer)
11	Universitat Dortmund August-Schmidt-Straße 4 4600 Dortmund 50	Zentrale Transferstelle Dienstleistungseinrichtung der Universitat	K.-P. Priebe (Leiter)
12	Universität-Gesamthochschule Duisburg Gebäude LF/248-250 Lotharstraße 65 4100 Duisburg 1	Zentrale Transferstelle beim Konrektor fur Forschung "Transferstelle Hochschule-Praxis"	H. Tenbrink (wiss. Mitarb.)
13	Friedrich-Alexander-Universität Erlangen-Nurnberg Cauerstraße 9 8520 Erlangen	Zentrale Transferstelle "Kontaktstelle f. Forschungs- u. Technologie-Transfer" (FTT-Kontaktstelle) (betreuender Lehrstuhl: Apparatetechnik u. Chemiemaschinenbau)	H. Kraus (Prof. Vetter: betreuender Lehrstuhl)
14	Universität-Gesamthochschule Essen Universitätsstraße 2 4300 Essen 1	Zentrale Transferstelle "Zentralstelle f. Forschungs- u. Entwicklungstransfer" (FET)	Dr. A.-A. Pourzal Dr. W. Schöll

Appendix 1: Continuation

Scientific University	Model of Organisation	partner for Requests
15 Johann Wolfgang Goethe-Universität Frankfurt a.M. Senckenberganlage 31 6000 Frankfurt/M. 11	Zentrale Transferstelle "Beratungsstelle f. Wissenschaftstransfer"	Dr. O. Schöller (Leiter)
16 Albert-Ludwigs-Universität Freiburg im Breisgau Heinrich-von-Stephan-Str. 25 7800 Freiburg i.Br.	Transferbeauftragter im Nebenamt	Dr. K. Herzog (Abt. Hochschulstatistik)
17 Justus-Liebig-Universität Gießen Ludwigsstraße 23 6300 Gießen 11	Transferbeauftragter im Nebenamt	Dr. W. Dürr (Forschungsreferent)
18 Georg-August-Universität Göttingen Wilhelmsplatz 1 3400 Göttingen	Transferbeauftagter im Nebenamt	G. Gizler (Leiter des Presse- u. Informationsamtes)
19 Fernuniversität-Gesamthochschule Hagen Feithstraße 152 Postfach 940 5800 Hagen 1	Zentrale Transferstelle, Stabsstelle beim Rektor "Zentrale Forschungstransferstelle"	A. Kajdan A. Schneider
20 Universität Hamburg Edmund-Siemers-Allee 1 2000 Hamburg 13	Transferbeauftragter im Nebenamt	W. Mustroph (Mitarb. im Planungsstab b. Präs., Ber.: Techn. u. Inf.transf.)
21 Technische Universität Hamburg-Harburg Eißendorfer Str. 38 2100 Hamburg-Harburg 90	Zentrale Transferstelle "Technologievermittlung"	Dr. Helmut Thamer
22 Hochschule der Bundeswehr Hamburg Holstenhofweg 85 2000 Hamburg 70	Transferbeauftragter im Nebenamt	N.N.
23 Universität Hannover Wilhelm-Busch-Str. 18 3000 Hannover 1	Zentrale Transferstelle, Stabsstelle beim Präsidenten "Technologie-Kontaktstelle"	N.N.
24 Ruprecht-Karls-Universität Heidelberg Schröderstr. 90 6900 Heidelberg	Transferbeauftragter im Nebenamt	Dr. K.-H. Hall (Dezernent für Haushalts- u. Forschungsangelegenheiten)
25 Hochschule Hildesheim Marienburger Platz 22 3200 Hildesheim	Transferbeauftagter der Landesregierung im Nebenamt	Prof. Dr.-Ing. Norbert Wegner (Inst. f. Maschinenbau)
26 Universität Hohenheim Schloß 7000 Stuttgart 70	Transferbeauftragter im Nebenamt	Dr. K.H. Grabowski (Leiter d. Informations- u. Pressestelle)
27 Universität Kaiserslautern Geb. 48 Erwin-Schrödinger-Str. 6750 Kaiserslautern	Zentrale Transferstelle beim Vizepräsidenten "Kontaktstelle für Innovations- u. Technologie-Beratung" (KIT)	Udo Liedtke (Leiter)
28 Universität Fridericiana Karlsruhe (T.H.) Kaiserstr. 12 7500 Karlsruhe 1	Zentrale Transferstelle "Information, Beratung, Kontakte" (IBK)	Dr. U. Lindner (Leiterin)
29 Gesamthochschule Kassel Mönchebergstr. 7 3500 Kassel	Zentrale Transferstelle, Referat beim Präsidenten "Technologie- u. Innovationsberatung" (TIB)	Dr.-Ing. Peter Kayser (Leiter)

Appendix 1: Continuation

	Scientific University	Model of Organisation	partner for Requests
30	Christian-Albrechts-Universität Kiel Olshausenstraße 40-60 2300 Kiel	Transferbeauftragter im Nebenamt	Prof. Dr. K. Brockhoff (Inst. f. Betriebswirtschaftslehre)
31	Universität zu Köln Albertus-Magnus-Platz 5000 Köln 41	Zentrale Transferstelle beim Rektor "Arbeitsstelle Forschungstransfer"	Dr. Ch. Labude Roland Frieling
32	Universität Konstanz Universitätsstraße 10 7750 Konstanz	Transferbeauftragter im Nebenamt	Dr. H. Rohl (Referent f. Forschungsfragen)
33	Hochschule Lüneburg Wilschenbrucher Weg 84 Postfach 24 40 2120 Lüneburg	Transferbeauftragter im Nebenamt	Prof. Dr. E. Kahle (Inst. f. Betriebswirtschaftslehre)
34	Johannes Gutenberg-Universität Mainz Saarstraße 21 6500 Mainz	Transferbeauftragter im Nebenamt	Dr. G. Spath (Abt. Planung u. Struktur, Ref. f. Forschungsförd. u. Wissenstransfer)
35	Universität Mannheim Schloß 6800 Mannheim 1	Transferbeauftragter im Nebenamt	Dr. G. Feigenbutz (Leiter des Dezernats I: Sachgebiet Wissenschafts- u. Forschungskontakte)
36	Philipps-Universität Marburg Biegenstraße 10 3550 Marburg a.d. Lahn	Transferbeauftragter im Nebenamt	Dr. H. Jungclas (Leiter des Referats Forschungskontakte)
37	Ludwig-Maximilians-Universität München Geschwister-Scholl-Platz 1 8000 München 22	Transferbeauftragter im Nebenamt	Dr. H. Burckhard (Planungsstab der Universität)
38	Technische Universität München Gabelsberger Str. 49 8000 München 2	Zentrale Transferstelle "Technologie-Transferstelle"	Dr.-Ing. D. Steffen
39	Westfälische Wilhelms-Universität Münster Schloßplatz 2 4400 Münster	Zentrale Transferstelle, angelagert beim Dezernat f. Haushalts- u. Forschungsangelegenheiten, Teil der Abt. Forschungsförderung "Arbeitsstelle Forschungstransfer"	M. Bornefeld-Ettmann (Leiter) W. Bauhus W. Kuban
40	Universität Oldenburg Ammerländer Heerstr. 67-99 2900 Oldenburg i.O.	Zentrale Transferstelle "Arbeitsstelle Dialog"	Dr. J. Seeber (Leiter) H.J. Schmidt
41	Universität Osnabrück Neuer Graben-Schloß 4500 Osnabrück	Transferbeauftragter im Nebenamt (Stand: Mai '86; ab 01.07.86 ist gemeinsam mit der Fachhochschule die Einrichtung einer zentralen Transferstelle geplant)	Prof. Dr. H. Dötsch (Fachbereich Physik)
42	Universität-Gesamthochschule Paderborn Warburger Str. 100 4790 Paderborn	a) Transferbeauftragter im Nebenamt für den gesamten Universitätsbereich b) Transferbeauftragter im Hauptamt, jedoch spez. im FB Wirtschaftswissenschaften c) Transferbeauftragter im Hauptamt, jedoch spez. im FB Maschinenbau	Dr.-Ing. B. Friedel (Forschungsreferent) R. Schmidt (Anwendung von PCs in Wirtschaftswiss.) A. Fornefeld (Kunststofftechnik)
43	Universität des Saarlandes Im Stadtwald 6600 Saarbrücken	Transferbeauftragter im Nebenamt	W. Lorenz (Planungsdezernat)
44	Universität-Gesamthochschule Siegen Technologiezentrum Sankt-Johann-Str. 18 5900 Siegen	Zentrale Transferstelle; räumlich angesiedelt im Technologiezentrum Siegen GmbH "Forschungstransfer-Stelle"	Dipl.-Ing. W. Baersch

Appendix 1: Continuation

Scientific University	Model of Organisation	partner for Requests
45 Universitat Stuttgart Keplerstr. 7 7000 Stuttgart 1	Zentrale Transferstelle "Beratungsstelle f. Technologietransfer"	F. Kleiner
46 Eberhard-Karls-Universität Tubingen Wilhelmstr. 5 7400 Tübingen 1	Zentrale Transferstelle "Arbeitsstelle Forschungs-Kontakte"	U. Mittag (Leiter; zugl. Leit. der Abt. E II - Forschungsangelegenheiten)
47 Universität Ulm Oberer Eselsberg 7900 Ulm	Transferbeauftragte im Hauptamt, beim Rektor u. Pro-Rektor angesiedelte Stelle	Dr. D. Stiller (Technologiereferentin)
48 Bayerische-Julius-Maximilians-Universität Würzburg Sanderring 2 8700 Würzburg	Transferbeauftragter im Nebenamt	W. Katzschmann (Studienberatung)
49 Bergische Universität-Gesamthochschule Wuppertal Gaußstr. 20 5600 Wuppertal	Transferbeauftragter im Nebenamt	Dr. M. Paul (Dezernat f. Planung u. Entwicklung, Sachgebiet Grundsatzfragen d. Forschungsbetriebs)

GERMAN/CANADIAN WORKSHOP
DECEMBER 2,3,4, 1986
UNIVERSITY OF WATERLOO

COMMERCIALIZATION OF THE RESULTS OF PUBLICLY FUNDED RESEARCH

A B S T R A C T

Dr. Michael Farley
Department of External Affairs and Science Council of Canada
Science, Technology and Communications Division

University Office for Technology Transfer in Canada: Overview and Perspectives.

This presentation reviews the current state of these offices in Canada. It raises a number of basic issues surrounding their development, including the need for offices for technology transfer, their position within the university, their functions, their effectiveness, their impact on the university, and their implications for science and technology policy in Canada.

OVERVIEW OF UNIVERSITY OFFICES FOR TECHNOLOGY TRANSFER IN CANADA

Michael Farley
Technology and Investment
Development Bureau
External Affairs Canada

4 December 1986

1. INTRODUCTION

One of the more novel and significant forms of university-industry linkage has been the establishment within universities of offices for technology transfer. Technology transfer in this context can be broadly defined as an interaction between the university or its faculty and industry or the community that results in the transmittal of intellectual property in any of its forms.

The existence of these offices signals the value universities are attaching to interaction with the private sector. Their proliferation, particularly within the last five years, shown how well Canadian universities can respond to a changing economic environment. (Appendix A)

The function of university offices for technology transfer includes facilitating and managing the transfer of new discoveries to industry so that they can be commercially applied and result in the return of value to the university (usually in the form of royalties). An office for technology transfer can also include other services such as managing contracts, providing information, and putting faculty and companies in touch with one another.

This paper reviews the current state of the offices in Canada. It describes their development including the need for offices, their position within the university, their function, their impact and the role of government.

2. DEVELOPMENT

Many offices for technology transfer have evolved from earlier research management structures. Other offices have grown out of different

*This paper is adapted from the Science Council Discussion Paper by Michael Farley and Philip Enros.

aspects of the university's research planning. They have resulted from rethinking the university's research policy, especially in its relationship to business. Guelph, Laval, Calgary, and the Ecole Polytechnique, for example, have published documents on university-industry interaction for research.

Most offices have appeared at large research-intensive universities, but there are also offices at smaller institutions such as Ryerson and Cape Breton. At the same time, a number of larger institutions do not have such offices. The special characteristics of each university clearly play a major role in determining the presence or absence of such offices. Guelph's history as an agricultural college, the Ecole Polytechnique 's as an engineering school and Waterloo's tradition of cooperation with industry were important factors leading to the establishment of their offices for technology transfer.

In all but one case, the offices have been established within the university itself. The one exception is the University of Toronto's Innovations Foundation. a fully-owned but separate corporation situated off campus. Almost all the others are found within the central administration and are usually connected to the office of research administration or research services. These offices may simply take the form of new positions set up to deal with liaison and commercialization within offices of research administration, such as those at Guelph and Laval. Still others, for example, those at Queen's McGill, Calgary and the Ecole Polytechnique, are more independent, specialized, and diversified.

The provision of technology transfer services may also be found at more decentralized levels of the university. Some medical faculties have set up offices of research whose main function is to process grants. The special linkage problems associated with commercialized medical research (for example, the state of Canada's health care industry, the relations of hospitals to universities, the need for clinical trials) require, perhaps, that technology transfer experts be more closely associated with faculty in this area. The Medical Research Office at Toronto has made it a goal "to encourage a more entrepreneurial mindset" among researchers. Administrators at Toronto are currently attempting to place liaison activities on a more formal footing.

Offices also exist at the departmental level. This often enables a very close relationship between the offices and faculty members. Departments in the faculty of engineering at Manitoba have advisory committees composed of faculty and business people. Together these committees form the Faculty-Industry Liaison Committee. Perhaps the best example of an office at this level is the Waterloo Centre for Process Development. It is located in Waterloo's department of chemical engineering and offers independent liaison, contract, and commercialization services to the faculty. The centre also formulates and implements some policies, such as charging outside contracts 100 per cent overhead.

Although all offices for technology transfer have the same objective (to transfer technology), the ways in which they attempt to achieve that goal vary. Their activities in general encompass the full spectrum of technology transfer services both inside and outside the university. Inwardly oriented activities include increasing faculty awareness of the value of interaction with the private sector by identifying commercially significant research, advising or assisting faculty in commercialization, screening inventions, providing expertise in marketing, or by getting involved in the the development of innovations or the establishment of spin-off companies.

Outwardly oriented activities include liaison, brokerage functions, or maintaining links with external groups for advice and services. This last activity includes connecting with the existing network of expertise provided by federal agencies, such as the National Research Council or Canadian Patents and Development Limited; by provincial research organizations or programs such as the Centre de recherche industrielle du Québec; or by the two industrial innovation centres at Montreal and Waterloo. It can also mean involving private groups. Calgary, for example, has a technology transfer advisory group and Queen's makes use of a group of retired business people.

Offices for technology transfer have not only a wide range of functions but also a broad range of organizational structures. Laval's new office includes all aspects of technology transfer services: liaison, contracting, patenting, licensing, supporting new businesses, implementing policies, and so forth. McGill and the Ecole Polytechnique provide the same services in specialized units. McGill has one office for contracting, a second for commercialization, and a third for liaison in the area of biotechnology. The Ecole Polytechnique has one office for contracts, commercialization, and support of spin-off firms and another for cooperative ventures. The offices at Guelph, Queen's, and Calgary all specialize in liaison and commercialization, which their central research offices continue to handle contracts.

A number of factors have influenced the development of offices for technology transfer, one of which is the complexity of technology transfer itself. Technology transfer is a time-consuming exercise and requires the talents of rather special individuals who are equally acceptable to faculty and the business community. Such people are hard to find. Another problem has been that offices must not only produce but must also work to become self-supporting within a limited time. In addition, their development has often been hampered by the particular culture of the university or by suspicious or hostile attitudes toward such offices.

Other factors, however, have played a positive role in developing the offices. As faculty have become more alert to the commercial potential of their work and more interested in interacting with external groups, their demands for assistance have increased and the volume and range of office activities have grown. The foresight of university research managers has also been a positive factor. Many of them have attempted to provide technology transfer services, to gain control over technology transfer efforts, or to better realize the potential of these efforts.

3. IMPACT

Determining the impact of university offices for technology transfer is a difficult and complex task. An evaluation would require reviewing the effectiveness and efficiency of the offices, determining their major consequences, and interviewing all involved, from students to business people. The task would be further complicated by the newness and diversity of the offices. It is perhaps too soon to determine their impact in a final way. But it is worthwhile to point out some achievements.

The offices have shaped attitudes toward the university and changed its organization and activities. Although the offices are still fragile and somewhat marginal to the main functions of the university, they have the potential to help redefine that institution. Perhaps more than other mechanisms for technology transfer, they are creating an environment within the university that is conducive to redefining its mandate and "'lowering the threshold' to commercial interaction at all levels". Thus the impact of the offices on the teaching and research programs, as well as on the attitudes of faculty and students toward interaction with industry, needs to be explored. These results of the offices may well turn out to be the most significant.

Some outcomes of the offices for technology transfer are already quite visible. All universities that have introduced such offices have increased industrial services to faculty and registered a rise in demand for these and other services. The offices have contributed significantly to improving industrial liaison and to commercializing faculty research. Since the establishment of a contracts office in 1971 at McGill, the number of contracts awarded to professors has grown from 23 to over 100 annually.

The offices have produced financial returns as well. Guelph's office of industrial services (established in 1983), for example, is largely responsible for a 147 per cent increase in research funds from the business sector. Royalties from eight licences held by the Waterloo Centre for Process Development (WCPD, established in 1978) bring in over $500,000 a year to support faculty research at the university. Calgary's office of computing technology, the Innovations Foundation at Toronto, the Waterloo Research Institute and McGill's inventions and patents office are self-supporting.

4. GOVERNMENT SUPPORT

Over the past few years many government policies and programs for university research or economic development have emphasized the need to make faculty research efforts more focused and to transfer results to the marketplace. Originating from both the federal and provincial governments, these policies and programs have been a major stimulus and a great aid in establishing university offices for technology transfer.

The federal government has created a number of programs aimed at fostering industrial research and development. The most important programs, from the standpoint of university offices for technology transfer, are known collectively as technology centres. These were offered by Industry, Trade and Commerce (II&C) and later by the Department of Regional Industrial Expansion (DRIE). Technology centres are intended to encourage innovation and technological development in Canadian industry.

The National Research Council's Industrial Research Assistance program (IRAP) was established in 1962 to encourage R&D in Canadian industry. One element of this program, the field advisory services, can help foster university-industry linkages. Many of its field representatives are located at universities where they often deal with university technology transfer offices, thereby strengthening the university's research outreach infrastructure. Another element of IRAP is the laboratory network program, formaly a part of the Program for Industry/laboratory projects (PILP). It has contributed to establishing or extending several university offices for technology transfer across the country. The NRC representative attending the workshop has spoken on this subject already.

All provincial governments also have their own programs to help industry respond to technological change. Some of these are aimed at better equipping the provinces' universities to transfer their research. The Centre de recherche industrielle du Québec (CRIQ) has technology transfer agreements with some universities. Mr Baumans described some of these in his talk on Tuesday.

Ontario's IDEA Corporation established in 1984 a commercial development officer's program funded at $3 million over three years to help Ontario universities identify and commercialize early-stage research. As of November 1985, 10 universities had signed agreements under this program: Carleton, Guelph, Lakehead, McMaster, Ottawa, Queen's, Toronto, Waterloo, Western, and Windsor. Several other provinces have provided funds for these initiatives in universities in there regions.

5. CONCLUSION

University offices for technology transfer are being set up across Canada. In this simple yet significant way the univesity is attempting to respond to a changing economic environment. The significance of its response lies not simply in the success of these offices or of other forms of linkage in transferring technology, but in what it expresses about changes in the university itself, especially in its attitudes toward an association with business.

Just as the research university emerged in Canada at the start of the twentieth century, perhaps a new species, the service university, is evolving in its last decades. In such an institution teaching and research would not be displaced so much as they would be reoriented. The essence of such a univesity would be a dynamic, integral relationship with society.

APPENDIX "A"

TECHNOLOGY TRANSFER OFFICES AT CANADIAN UNIVERSITIES

University of Alberta
University of British Columbia
University of Calgary
University College of Cape Breton
Ecole Polytechnique
University of Guelph
Université Laval
University of Manitoba
McGill University
Université du Québec
Queen's University
Ryerson Polytechnical Institute
Simon Fraser University
University of Toronto
University of Waterloo
Memorial University
Université Sherbrooke
Technical University of Nova Scotia (TUNS)

GERMAN/CANADIAN WORKSHOP

BIOGRAPHIES OF PARTICIPANTS

BIOGRAPHY

October 7, 1986

DOUGLAS WRIGHT

President and Vice-Chancellor

University of Waterloo

Douglas Wright grew up in Toronto and, while still in his teens, entered the University of Toronto's engineering school at Ajax, just after World War II.

He was graduated, in civil engineering, in 1949, and became a structural engineer with a consulting engineering firm. Later he attended the University of Illinois where he completed a master's degree, in 1952. In 1954 he received a Ph.D. from Cambridge University, where he attended on an Athlone Fellowship.

He taught civil engineering at Queen's University until 1958 when he became the first professor and the first chairman of the Department of Civil Engineering at the fledgling University of Waterloo. A few months later he became Waterloo's first dean of engineering.

In 1967 he moved to Toronto to become the chairman of the Ontario Committee on University Affairs and in 1969, chairman of the Ontario Commission on Post-Secondary Education. In 1972 he became a deputy minister at Queen's Park, in the social development policy field, and later in the Ministry of Culture and Recreation. He returned to Waterloo to become the university's third president and vice-chancellor, in 1981.

Dr. Wright continues to maintain an interest in engineering. He has served on technical committees and as a consulting engineer in Canada and abroad. Some of the projects with which he has been involved include the Ontario Place Cinesphere and Forum, the sports palace for the 1968 Mexican Olympics, and the proposed domed stadium in Toronto.

Following his service as chairman of the Task Force on Federal Policies and Programs for Technology Development, in 1983-84, he has frequently served as an unofficial spokesman for the university research community in Canada and has attempted to bring to the attention of his fellow Canadians the potential of our universities to contribute to our industrial and economic well-being in an era of high technology, rapid change and innovation.

He is a director of Electrohome Limited, Bell Canada, Westinghouse Canada, and the Stratford Shakespearian Festival.

BIOGRAPHY

PROFESSOR E. L. HOLMES

Professor Holmes graduated in Physics from the University of Bristol in England and obtained his Master's Degree in Metallurgical Engineering and his Ph.D. in Physical Metallurgy from the University of Toronto. Before joining the University of Waterloo in 1964, Professor Holmes was on the staff of Orenda Engineers at Malton, Ontario, the University of Nottingham and the University of Toronto. He was Associate Dean of Engineering at Waterloo for about 7 years, during which time he was particularly interested in the various aspects of the university/industry/government interface.

He was involved in the initiation of the Waterloo Research Institute in 1967 and since 1974 has been involved in research policy and administration on a university-wide basis as Director for Research. He is a former member of the SCITEC Executive, a current member of the Association of Professional Engineers of Ontario and the Canadian Research Manager's Association. He is a member of the Board of the Waterloo Process Development Centre, Waterloo Computer Systems Group and the Waterloo Business Development Committee. He is Past President of the Canadian Association of University Research Administrators and is also a member of the Natural Sciences and Engineering Research Council's task-force on industry-university interaction. Among his current concerns is the development of the Industrial Research/ Technology Park on the University of Waterloo Campus.

June 1986

National Research Council Canada
Conseil national de recherches Canada

Industry Development Office
Industrial Research Assistance Program
(Laboratory Network)

Bureau du développement industriel
Programme d'aide à la recherche industrielle
(Réseau laboratoire)

File Référence

MAUREEN LOFTHOUSE - Biographical Notes

Maureen Lofthouse is a Senior Project Manager in the National Research Council's Industrial Research Assistance Program. Since January 1984 she has worked in IRAP's Laboratory Network which assists private sector firms to access and commercialize technology originating in government or university laboratories. She now heads a group focussing on transfer of advanced materials and advanced manufacturing technologies. She also has special responsibility for IRAP's support to technology transfer efforts in Canadian universities.

Miss Lofthouse was previously Manager, Technical Services in the R&D Division of KHD Canada Inc., a subsidiary of the world's largest producer of air-cooled diesel engines, where she spent seven years as a member of the project management team responsible for development of a new family of air-cooled diesel engines for the North American truck market.

Prior to that, she was at Pratt & Whitney Canada for eight years where she worked on the development of various models of the PT6 turboprop engine, particularly the PT6A-50 engine for de Havilland's Dash-7 STOL aircraft.

Born in England, Miss Lofthouse graduated with a B.Sc. in Mechanical Engineering from the University of Glasgow, Scotland, in 1963. After two years work in a hospital design team and three years in the R&D labs of a steel-making/engineering consortium in the U.K. she immigrated to Canada in 1968. She gained an M.B.A. degree from McGill University in 1975.

She chairs the Women Engineers' Committee of the Engineering Centenial Commission which, in 1987, will celebrate one hundred years of engineering as an organized profession in Canada. In 1984, she chaired the founding board of a new women's resource centre for Ottawa, Women's Place, which opened in 1986. In 1983 she co-chaired the 2nd Convention of Women Engineers of Canada, held in Montreal.

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Canada

PROFESSIONAL CAREER

DR. PETER TONN

1982 -	Head of R&D Transfer Office at Deutsche Forschungs - und Versuchsanstalt fur Luft- und Raumfahrt e.V., DFVLR (German Aerospace Research Development Establishment)
1978-1981	Transportation research at DFVLR
1974-1978	Transportation research at Battelle Lab of Frankfurt/Germany
1970-1973	Transportation research at Northwestern University Transportation Centre (1970/71) and Darmstadt Technische Hochschule
1965-1970	Economic Planning research and teaching at Darmstadt Technische Hochschule; PhD
1959-1965	Education in Engineering and Economics at Darmstadt Technische Hochschule

BIOGRAPHY

JUSTINA KURYLLOWICZ

Justina Kuryllowicz graduated from McGill University in 1978 in Mining Engineering. Prior to joining the Federal Government, she worked for Inco Ltd. in Thompson, Manitoba, Gibralter Mines in British Columbia and Algoma Ore in Wawa, Ontario.

She is currently the Director, Office of Technology Transfer, at the Canada Centre for Mineral and Energy Technology (CANMET), Energy, Mines and Resources Canada, in Ottawa.

BIOGRAPHY

ROBERT B. NALLY, P.ENG.

President, Ethos Consulting Ltd., Technology Management Consultants to: the University of Waterloo, over ten high-tech start-up and small businesses and two major U.S. high-tech corporations. Member of the Board of Directors of four high-tech companies and two community organizations. Over ten years experience with NCR Corporation in R&D; five of these in senior R&D management positions. Business training through AMA and NCR corporate programs. BASc in Electrical Engineering and MASc in Systems Design Engineering from the University of Waterloo. Memberships in APEO, IEEE, SRA, LES. Twelve patents to date.

July 1986

L E B E N S L A U F

Vorname, Name:	Dr. Klaus Landfried
Adressen:	Albert-Ueberle-Str. 9, 6900 Heidelberg Am Harzhübel 40, 6750 Kaiserslautern
Geburtstag, -ort:	26.01.1941, Heidelberg
Berufliche Daten:	1960 Abitur
	Studium der Volkswirtschaftslehre, Geschichte, Öffentliches Recht und Politikwissenschaft an den Universitäten Basel und Heidelberg
	1970 Promotion "summa cum laude" an der Philosophisch-Historischen Fakultät der Universität Heidelberg
	1968 bis 1971 Lehrbeauftragter am Institut für Politische Wissenschaft der Universität Heidelberg
	1969 bis 1972 Leiter der Forschungsgruppe "Wahl der Parlamente" (DFG-Projekt Ste 40/6) zusammen mit D. Nohlen am Institut für Politische Wissenschaft der Universität Heidelberg
	1972/73 John-F.-Kennedy-Memorial Fellow an der Harvard University in Cambridge/Massachusetts, USA
	Seit 1974 Professor für Politikwissenschaft im Fachbereich Sozial- + Wirtschaftswissenschaften der Universität Kaiserslautern
	Seit 1981 Vizepräsident der Universität Kaiserslautern
	Seit 1982 Aufbau der Kontaktstelle für Innovation und Technologieberatung an der Universität Kaiserslautern
Mitgliedschaft in Gremien:	Stellvertretender Vorsitzender der Deutschen Vereinigung für Politische Wissenschaft (1981-84)
	Sprecher der Rheinland-Pfälzisch/Saarländischen Regionalgruppe der o. g. Vereinigung (1978-85)
	Mitglied des Beirats des Staatlichen Instituts für Lehrerfortbildung in Speyer (1978-85)
	Mitglied des Landesbeirats für Weiterbildung in Rheinland-Pfalz seit 1978

Kaiserslautern, 26.09.1986

- Möglichkeiten der Zusammenarbeit zwischen Hochschule und freien Trägern der Erwachsenenbildung, in: K. Sensky u.a. (Studienkonferenz am 20. und 21. März 1980 in Bensberg): Universitäre Erwachsenenbildung. Sind unsere Hochschulen dafür geeignet ? Bergisch-Gladbach 1980 (Bensdorfer Protokolle Nr. 31).

- mit M. Hildenbrand, St. Fuchs: Innovationsförderung durch Hochschulen. Zur Regionalentwicklung und Hochschulstabilisierung am Beispiel Kaiserslautern, in: Bundesforschungsanstalt für Landeskunde und Raumordnung: Informationen zur Raumentwicklung, H. 5, 1983

- Hochschulen auf dem Weiterbildungsmarkt - Weiterbildung zwischen Wissenschaft und Wettbewerb, in: J. Münch, H.J. Müller, Hrsg.: Weiterbildung in den 80er Jahren, Schriftenreihe der Universität Kaiserslautern 2, Kaiserslautern 1985

- Markt und Wettbewerb in Wissenschaft und Forschung, in: Trend - Zeitschrift für soziale Marktwirtschaft, Nr. 22, März 1985

- Wettbewerb - Chance oder Gefahr für die Universitäten ? Vortrag im Süddeutschen Rundfunk am 10. November 1985, Heidelberg 1985 (Mskr.)

- mit St. Fuchs: Technologietransfer - mehr als nur ein Modewort, in: IHK-Magazin, H. 6, 1985

- mit U. Liedtke: KIT knüpft Kontakte mit der Wirtschaft, in: IHK-Magazin, H. 6, 1986.

BIOGRAPHICAL SKETCH

James W. Murray

Present Position:	DIRECTOR, UNIVERSITY-INDUSTRY LIAISON, and PROFESSOR OF GEOLOGICAL SCIENCES
Address:	Office of Research Services and Industry Liaison University of British Columbia Vancouver, B. C. V6T 1W5
Telephone:	(604) 224-8580
Education:	UNIVERSITY OF ALBERTA, Edmonton, Alberta, Canada B.Sc. (Hons.) Geology, 1957 PRINCETON UNIVERSITY, Princeton, New Jersey, USA M.A., Geology, 1963 Ph.D., Geology, 1964 UNIVERSITY OF BRITISH COLUMBIA, Vancouver, B.C. Postdoctoral Fellow, 1964-65
Experience:	TEXACO EXPLORATION COMPANY, Calgary, Alberta 1957-60 - Petroleum geologist UNIVERSITY OF BRITISH COLUMBIA 1964-present - Professor ROYAL COMMISSION ON URANIUM MINING 1978-1980 - Commissioner (part time) GREAT WESTERN PETROLEUM CORPORATION 1980-83 - Vice President (part time)
Interests:	• UNIVERSITY-INDUSTRY-GOVERNMENT RESEARCH COLLABORATION • TECHNOLOGY TRANSFER • SPIN-OFF COMPANIES FROM UNIVERSITY-GOVERNMENT FUNDED RESEARCH

Professional Agenda

Rolf Dalheimer

Prof. Dr.-Ing.

President of Fachhochschule Hamburg

	1940	born in Grevenbroich/Rheinland
	1959	study of mechanical and production engineering at the University of Hannover
	1966	scientific work in metal forming at the University of Stuttgart
	1970	doctor's thesis
	1971	lecturer/professor at Fachhochschule Hamburg
	1972	Vice Chairman in the department of production and chemical engineering
since	1975	President of Fachhochschule Hamburg
	1978	Chairman of the Conference of West-Germany Fachhochschulen

BIOGRAPHY

EDWARD B. CROSS

ADDRESS:	113 Sandy Ridge Place Waterloo, Ontario, N2T 1C5
TELEPHONE:	519-884-4352
MARITAL STATUS:	Married with three daughters
EDUCATION:	B.A.Sc. Chemical Engineering University of Toronto, 1957
BACKGROUND:	25 years in Canada's Chemical Industry 1957-1982 - 4 years Lever Bros. in Toronto Research Engineer - 4 years at Hart Chemicals Ltd., Guelph Plant Engineer - 17 years as a founding Shareholder, Vice-President Operations, through to President and General Manager of Chinook Chemicals Co. in Sombra (near Sarnia) and Toronto, Ontario. Continue today as a Director and Major Shareholder of Chinook's Holding Company. April 1982 to present, Executive Director, Waterloo Centre for Process Development, University of Waterloo, Ontario.
MEMBERSHIPS:	Association of Professional Engineers of Ontario The Licensing Executives Society The Society of Chemical Industry
OTHER ACTIVITIES:	
1957-65	Pilot in the RCAF Reserve, retired Squadron Leader
1978-82	Toronto Big Brother Association
	Enjoy racquet sports, skiing, sailing.

October 30, 1986

J. PETER SPRUNG

BIOGRAPHY

EDUCATION:	B.A.Sc. (Electrical Engineering) University of Toronto
	M.A. (Mathematics) University of Waterloo
PREVIOUS POSITIONS:	Officer, Royal Canadian Navy 1957-64
	Assistant Director, Computing Centre, University of Waterloo 1966 - 69
	Computer Operations Manager, Air Canada 1969 - 71
PRESENT POSITIONS:	Associate Director, Computing Services, University of Waterloo 1971 -
	Software Coordination Manager, Office of Research, University of Waterloo 1980 -
	President, WATSOFT Products Inc. 1984 -
Professional Associations	Canadian Information Processing Society
Related Activities	Institute for Computer Research Copyright Law Amendment Project 1985 -

TECHNOLOGIE-
VERMITTLUNGS-
AGENTUR

Jürgen ALLESCH, graduated engineer

Technologie-Vermittlungs-Agentur Berlin e.V.
Kleiststraße 23-26
1000 Berlin 30

Jürgen Allesch, born in 1943 in Salzburg, Austria, studied aviation and space technology at the Technical University of Berlin, where he graduated in 1971.

He started his professional career as an independent consultant in the field of transportation planning and implementation of innovative transportation systems.

Between 1973 and 1979 Jürgen Allesch directed the pilot programm "Continuing education courses - planning and problem solving methods for engineers in the civil service" at the Technical University of Berlin. In this programme new forms of co-operation between universities and industry were developed. The experience gathered resulted in the establishment of a Technology Transfer Department at the Techincal University of Berlin.

Parallel to these activities Jürgen Allesch is the head of the research group PROWIS, which - since 1979 - has carried out several empirical investigations about technology transfer and its relationship between German universitites and research institutes.

Up to 1986 he was head of the Technology Transfer Department of Berlin's Technical University.

Since February 1986 he is managing director of the Technology Transfer Agency, a regionally operating institution that provides information, equipment and experts as a contribution to solve the innovation problems of the regional economy, especially the small and medium-sized enterprises.

Jürgen Allesch is author and co-author of several books, expertises, reports and articles on the subjects of continuing education and technology transfer.

MICHAEL FARLEY

BIOGRAPHICAL SKETCH

Michael Farley works for the Technology and Investment Development Bureau of the Department of External Affairs. He is on secondment from the Science council of Canada where he developed the University-Industry Program. His responsibilities at External include S&T policy (Europe and the USSR), technology acquisition and investment. He is also Secretary of the Interdepartmental Committee on International Science and Technology Relations (ICISTR).

Dr. Farley holds degrees from Concordia University and the Université de Montréal. He has taught courses on S&T Policy and the History of Science and Technology at univesities in Montreal and Ottawa.

GERMAN/CANADIAN WORKSHOP

APPENDICES

1. University of Waterloo - Office of Research
   - Responsibilities
   - Organization Chart
2. Model Contract - Corporate Higher Education Forum, Canada
3. Samples of Educational Software Agreements, University of Waterloo
4. A Directory of Project Managers and Technology Transfer Officers in the National Research Council, Government Departments and Universities
5. NRC Technology Advisors - A Canada-wide Contact Network

UNIVERSITY OF WATERLOO

BASIC RESPONSIBILITIES OF THE OFFICE OF RESEARCH

The prime responsibility of the Office of Research is to assist in furthering the research capability of the University. The office has a responsibility for assisting in locating support for research both in the form of grants and contracts. The Office of Research also provides administrative, liaison and other services to individuals or research groups, and, also provides appropriate service to industry, governments or other agencies sponsoring research in the University.

The office has a responsibility for keeping faculty informed of research policies, goals and objectives of all levels of government and of major sectors of Canadian industry, and for keeping key personnel in government and industry informed of the University's research capabilities in their particular spheres of interest. The office also provides, as required, a focus and coordinating function with respect to University comment and briefs to governments concerning research and related policies.

The office has the responsibility for ensuring that approved University policies and procedures are followed, relating to all research activity in the University involving agreement between the University and any client or granting agency, and in all other cases where University resources are being used. The office also ensures that the corporate responsibilities of the University are met in terms of legal, financial and various liability considerations.

Office of Research - Staff Functions

1. To develop and disseminate information on sources of research funding and other support.

2. To make personal contacts with such sources and to seek to open up opportunities for University researchers by maintaining active liaison between faculty and appropriate personnel in government, industry and other sectors of society.

3. To bring promptly to the attention of the appropriate faculty

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all calls for research proposals, bids on research projects, contract opportunities and so on.

4. To develop and disseminate knowledge of faculty expertise. A continued liaison with Department Chairmen, Deans and faculty generally is seen as essential in order that this goal be met.

5. To be cognisant of changing attitudes and priorities in government at both federal and provincial levels, such that appropriate and prompt action can be taken in response to new approaches to research and its funding by government.

6. To assist technology transfer to industry, including promotion of joint industry/university, government/university and industry/university/government research efforts.

7. To make available administrative services and other aid as stipulated by University policy or as requested by academic staff in the planning and implementation of research. It is recognized that the principal investigator exercises technical management of the research with the overall management being subject to audit and joint responsibility with the Office of Research, particularly in the case of contracts, within the constraints imposed by the corporate responsibility of the University to a client or sponsor. It is the function of the staff of the Office of Research to provide assistance and relieve the investigator of as much administrative detail as possible. It is the responsibility of the staff to make known the range of services available through the Office of Research.

8. To aid individual faculty and groups in the preparation of research proposals and to be aware of sources of information about current research elsewhere.

9. To undertake on behalf of the University, negotiations of research contracts between the University and other parties and provide for the servicing, verification of reporting and closing of active projects.

10. To ensure that in research being undertaken under University contract, effective liaison is maintained with the client and that commitments are being met. To arrange meetings and exchange of information with clients or sponsors during the life of a grant or contract as appropriate.

11. To ensure that effective management of group activity, such as might occur on interdisciplinary projects, is arranged and agreed upon with the supporting agency.

12. To maintain a continuous survey of research activities and potential in the University.

13. To provide assistance on patent matters.

14. To ensure that all research proposals are in accordance with University policy and have received the necessary approvals.

15. To provide Department Chairmen periodically with information regarding faculty research proposals or early negotiations regarding contracts and the extension of contracts.

16. To maintain continued liaison with other departments in the University (e.g. Departments of Co-ordination and Placement, Information Services, in addition to academic departments) with regard to the dissemination of information regarding the research capability of the University.

17. To assist faculty and the University Research Grant Sub-Committee in the administration of University of Waterloo Research Grants, including provision of the Secretary to the University Research Grant Sub-Committee.

18. To assist faculty and to ensure fulfillment of all University obligations in matters concerning human subjects involved in research. To this end the Committee on Research Involving Human Subjects has been established to advise the Co-

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ordinator of Human Research.

19. To assist faculty and the University Committee on Animal Care in matters concerning animals used in research and teaching.

20. To present and publish an Annual Report.

21. To perform general public relations with respect to University research.

22. To carry out such tasks, ad hoc and otherwise, as shall be designated by the Academic Vice-President, or any such advisory committees or councils the University may establish with respect to research in the institution.

23. To provide financial reporting to the principal investigators, the departments, faculties, government agencies and clients.

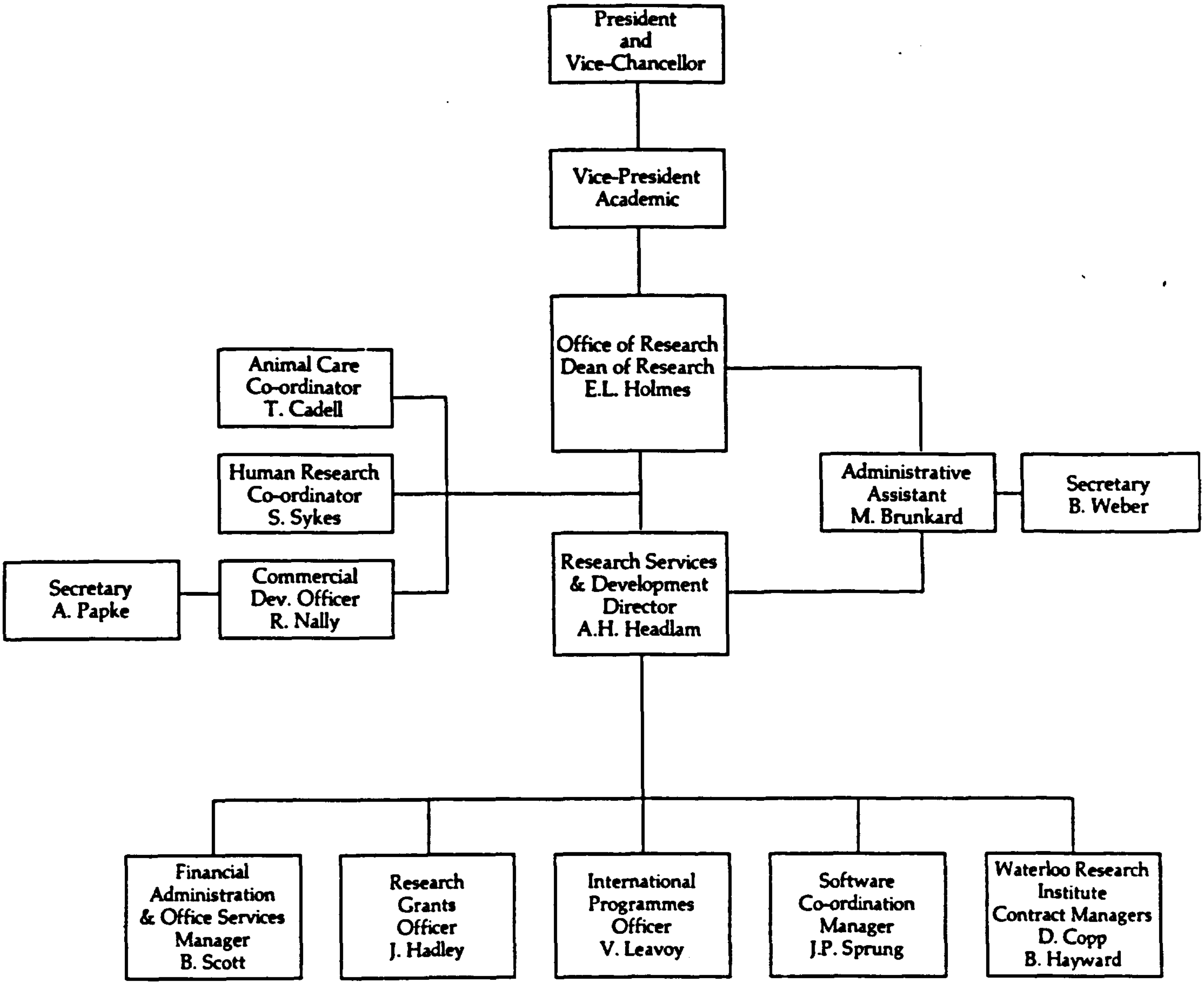
24. To provide the necessary audit function, to ensure adherence to University policies and to financial conditions imposed by governments, agencies and clients.

1983/09/20

University of Waterloo Organization

Number: 5J
Effective Date: July 1, 1986
Cancels: May 29, 1984

Office of Research



MODEL

RESEARCH AGREEMENT

BETWEEN

____
name and full address of university

hereinafter referred to as "University" and

____
name and full address of company

hereinafter referred to as "Company", herein acting and represented by

____

Company and University hereby agree as follows:

Article 1 — Objective

University shall perform the work described in Article 2 (referred to as "Project") upon the terms and conditions hereinafter set forth.

Article 2 — Scope of Work
The scope of work is as follows: (or see Appendix __)

Article 3 — Deliverable(s)
Deliverable(s) are defined as follows:

They shall be submitted to Company by the following dates:

Unless University is notified to the contrary by Company in writing within 25 working days following receipt of the deliverable(s), these will be deemed to have been accepted by Company according to the terms and conditions of this Agreement.

Article 4 — Principal Investigator
The Principal Investigator of the project shall be ______________________________ of University's Department of ______________________________, who is responsible for the technical content of the Project.

Article 5 — Basis of Payment
In consideration of University carrying out the Project, Company shall pay University the cost of the work in accordance with the attached budget (Appendix ___), or a firm sum of ___________ Canadian Dollars.

Article 6 — Method of Payment
The sum stipulated in Article 5 hereof shall be paid by Company by cheque made payable to ______________________________ within 30 days of receipt of invoice(s) according to the following schedule:

Invoice(s) shall be sent to:

Interest may be charged at the rate of ___ percent per month on amounts not paid within 30 days of submission of invoice.

Article 7 — Limitation
The total financial obligation of Company is limited to ________________ which said amount shall not be exceeded without the written authorization of Company, given by one of its duly authorized representatives. University shall not be obliged to perform any work beyond the Scope of Work (see Article 2) which

would cause this obligation of Company to exceed such sum, unless University receives written authorization to the contrary.

Article 8 — Period of Agreement
The present agreement shall have an effective date of ________________ and shall terminate on ____________________.

Article 9 — Amendments to Agreement
The terms herein stipulated may not be modified in any way without the mutual consent of the parties in writing.

Article 10 — Assignment
No right or obligation related to this Agreement shall be assigned by either party without the prior written permission of the other. University shall not subcontract any work to be performed except as specifically set forth in this Agreement.

Article 11 — Equipment
Any equipment or materials purchased by University as part of the Project shall remain the property of University unless otherwise specified in Article 17.

Article 12 — Confidentiality
Company and University may disclose confidential information one to the other to facilitate work under this Agreement.

Such information shall be safeguarded and not disclosed to anyone without a "need to know" within the Company or the University. Each party shall also strictly protect such information from disclosure to third parties.

Unless otherwise agreed to in writing, the terms and conditions of this Agreement are confidential.

The obligation to keep confidential shall however not apply to information which:

(a) is already known to the party to which it is disclosed;

(b) becomes part of the public domain without breach of this Agreement;

(c) is obtained from third parties which have no obligations to keep confidential to the contracting parties.

Article 13 — Publicity
Company will not use the name of University, nor of any member of University's staff, in any publicity without the prior written approval of an authorized representative of University.

University will not use the name of Company, nor any employee of Company, in any publicity without the prior written approval of Company.

Article 14 — Publication

The parties agree that it is part of University's function to disseminate information and to make it available for the purpose of scholarship. They further recognize that the publication of certain technical information may destroy its commercial value.

Company shall be furnished with copies of any proposed disclosure relating to this Agreement at least ninety (90) days in advance of presentation or publication. Dissemination of such copies shall conform to Article 12. If Company does not object in writing to such disclosure within thirty (30) days of receipt, University shall be free to proceed. In the event written objection is made, the parties shall negotiate an acceptable version of the proposed disclosure, including the release date, within the original ninety (90) day notice period.

Disclosure includes theses, articles, seminars and other oral and written presentations.

The University shall be free to publish ____ months after termination of this Agreement subject to confidentiality requirements.

Article 15 - Ownership and Commercial Exploitation of Intellectual Property

Intellectual property may include: technical information, know-how, copyrights, models, patterns, drawings, specifications, prototypes, inventions, etcetera.

OPTION I - The deliverables specified in Article 3 and any other intellectual property described above shall be owned by Company, including assignment of any rights to inventions. University shall have the following rights:

a) A royalty-free non-exclusive license for research and educational purposes only, subject to confidentiality requirements.

b) In the event the deliverables or project results contain patentable inventions, copyrighted software or know-how which is commercially exploited, a reasonable royalty or other financial recognition shall be negotiated in keeping with industry norms.

c) In the event Company does not exploit certain deliverables or project results within a specified time to be agreed upon, the right to commercially exploit them shall be reassigned to University, subject to a royalty-free non-exclusive license to Company.

OPTION II - Deliverables as specified in Article 3 shall be owned by Company. In the event the deliverables contain patentable inventions, copyrighted software or know-how which is commercially exploited, a reasonable royalty or other financial recognition shall be negotiated in keeping with industry norms.

Intellectual property other than that included in the deliverables shall be owned by University and Company shall have the following rights:

(a) University hereby grants Company a non-exclusive license to use and modify such other intellectual property with the right to sublicense to affiliated companies as agreed upon, subject to confidentiality requirements.

(b) University hereby grants Company a right of first refusal to an exclusive, royalty bearing license to use, sell and modify such other project results with the right to sublicense at a royalty to be negotiated.

Notwithstanding the licenses granted hereunder, University shall retain the right to use the other project results for research and educational purposes, subject to confidentiality requirements.

Article 16 — Liability and Indemnity

Unless otherwise stipulated in Article 17:

(a) Company shall indemnify University against all costs, suits, or claims resulting from the use by Company or its customers or licensees of any deliverable or project results developed by University under this Agreement.

(b) University shall indemnify Company against all costs, suits or claims on account of injuries (including death) to persons participating in the Project or damage to University property during the performance of this Agreement.

Article 17 — Special Conditions

Article 18 — Termination for Default
Either party may terminate this Agreement thirty (30) days after written notice of default is given to the defaulting party and if the defaulting party does not take immediate action to correct such default within such period. Default on the part of the University shall include the death or departure of the Principal Investigator. Company shall pay for all expenses up to termination and for reasonable commitments made by the University related to the Project, prior to date of notice of default, for which the University is financially responsible.

Article 19 — Notices
Notices under this Agreement shall be sent by registered mail, return receipt requested or delivered by hand, return receipt requested to the following address of either party unless changed by written notice.

Company:
Hitec Company
Avenue
Anytown
Attention:

University:
Knowledgefount University
Avenue
Anytown
Attention:

Article 20 — Force Majeure
Neither party to this Agreement shall be liable to the other for any failure or delay in performance caused by circumstances beyond its control, including but not limited to, acts of God, fire, labor difficulties or governmental action.

Article 21 — Entire Agreement
This Agreement shall supersede all documents or agreements, whether written or verbal, in respect of the subject matter thereof.

Article 22 — Survival of Articles
Articles 12 (Confidentiality), 13 (Publicity), 14 (Publication), 15 (Ownership and Commercial Exploitation of Intellectual Property) and 16 (Liability & Indemnity), shall survive the termination of this Agreement for any reason in addition to those articles surviving by operation of law.

Article 23 — Language
For the Province of Quebec only

This agreement is drawn up in English at the request of Company.

In witness whereof the parties hereto have signed as of the effective date shown in Article 8 above.

For University

____

____
Name & Title

____
Witness

For Company

____

____
Name & Title

____
Witness

Acknowledgment

I, the Principal Investigator, having read this Agreement, hereby agree to act in accordance with all the terms and conditions herein and further agree to ensure that all university participants are informed of their obligations under such terms and conditions.

____
Principal Investigator

Optional:

Other Participants

____

____

____

____

____

Guidelines to Model Agreement

GENERAL COMMENTS

These guidelines developed for industry-university agreements are intended to serve as a model contract. In some circumstances the negotiating parties may wish to alter the model to reflect their particular situation. In the most contentious area, namely, ownership of the results, we have provided a choice of options giving either the company or the university ownership of the fruits of the labour of the project. However, regardless of the ownership, both parties share in the downstream benefits of the intellectual property developed during the course of a research contract.

Although an option is not provided for ownership by both parties, it is recognized that there may be circumstances wherein joint ownership of all or part of the project results may more accurately reflect the input of both parties. It is expected that these agreements will be negotiated on a case by case basis.

It may first be useful to review the distinction between grants and contracts. While this distinction may not always be clear cut, there are basic differences:

A grant is financial support for an investigator, or investigators, conducting research in a particular subject area or field, without any formal detailed stipulations as to the direction of such research. The following characteristics are normally also present -

- no direct or indirect reimbursement to the principal investigator
- no stipulation as to deliverables
- no limitations on publication
- no specific transfer of results to the grantor
- payment to the university in advance of expenditures

A contract is an agreement between two corporate bodies, namely the company and the university, to provide financial support for an investigator, or investigators, to conduct research in a particular subject area or field under specific stipulations and conditions. These conditions may -

- specifically outline the scope and nature of the research

- set the time period(s) for the activity
- define the deliverables
- establish ownership, patent rights and licensing arrangements
- provide for confidentiality of information supplied and created
- establish budget approvals and payment schedules
- establish considerations for acceptance and/or termination
- limit liability of participants,

and other matters that may be appropriate to the circumstances.

It should be noted that provision of operating funds to universities is to support the academic endeavors of the university; diversion of these funds to subsidize research for a private corporation would be an inappropriate use of those funds.

DISCUSSION OF SPECIFIC ARTICLES

Formalities

It is important that a contract be signed by the persons who have the legal authority to do so, and any amendments should be signed by either the same person or other persons with the same level of authority. It is not advisable to put the expression "officer" into the paragraph before the signature, because in many cases this will not accord with the practice in either the corporation or the university. The principal investigator should sign the Acknowledgement as the person responsible for the technical aspects of the project.

Often a contract bears several dates leading to confusion as what the "date of the contract" really is. In this Agreement, there is only one date and it is the effective date. No date is provided for the signatories because they sign "as of the effective date". This procedure takes into account that almost all agreements are signed before or after they take effect. This sometimes bothers people and leads to unnecessary delays, explanations etc. A contract must be executed by both parties but the date of signature should have no direct bearing on its effective date. A reference to "seal" is also undesirable because many companies and universities do not utilize this formality. Obviously if organizations prefer to show dates of signature or prefer to utilize a seal, then the suggested model can be altered.

A proposal should include a reference as to the period of time for which it is effective. Similarly, the covering letter submitted with an agreement should mention how long the offer is open for acceptance and the manner in which acceptance is to be indicated. For example: kindly return one signed copy by (date) along with your cheque for (first payment) as our authorization to proceed with the project.

Article 3 - Deliverables

It is important that the deliverable(s) be clearly understood by both signators to a research agreement, particularly in the light of which option in Article 15 - Ownership and Commercial Exploitation of Intellectual Property - is being followed. In most instances the deliverable will be a report but may also be software, a prototype, model or technical drawings, patterns or maps, photographs, etc. Ownership of the deliverable(s) normally is vested in the company but the rights to any invention described therein may remain with the university.

Both parties should be aware that what they are attempting to define implies a legal liability to deliver this at the completion of the project. The definition of the deliverable(s) should be as accurate as possible in order to avoid potential accusations of breach of contract at a later date.

During negotiations for a research project it is not uncommon to have a budget reduced from that originally submitted by a principal investigator. Caution should be made that such a reduction also should be reflected in the scope of work; hence, also in the deliverables.

Article 5 - Basis of Payment

When the Basis of Payment is to be in accordance with a budget, it is useful to provide an estimate of the level of effort of personnel and the unit rate i.e. 5 man-months at $1200/month; 100 hours at $27.50/hr. Rates which are firm should be indicated (for example; supervision fees, use of equipment, etc.) as opposed to those which are estimates. The budget should include a statement retaining the right to shift money from item to item (with the exception of firm rates) as long as the total financial liability of Company is not exceeded.

Frequently a Plan of Work and Costs is included as an appendix. This sets out the order of tasks anticipated and the related costs, along with milestones of achievement - often marked by a deliverable.

Article 6 - Method of Payment
It is expected that contractual research would be self-financing to the extent that full direct and indirect costs are recovered as well as being forward financed. Universities are not profit centers and do not have resources other than their operating funds for covering any bad debts should a company default in its payment.

An agreement for research carries an obligation by the university to produce a deliverable, most frequently in the form of a report, by a given time. It is common that 10% of the cost of the work will be held back by the company until the final report has been accepted.

A typical schedule of payments negotiated would be as follows:
- a sum due upon signing
- monthly or quarterly invoices (or payments if it is a firm fee contract)
- final payment (10% upon acceptance of the final report)

For contracts which are not based on a firm fee adjustment should be made in the final invoice for actual expenses incurred against monies received. Any funds remaining uncommitted at the end of the contract period should be returned to the sponsor.

Article 8 - Period of Contract
One caveat for all to remember is: a contract is not a contract until it is signed by both parties. While this is true, it is sometimes difficult to coordinate available equipment, staff and facilities to commence on short notice for a specific date. Ideally all parties should sign the contract sufficiently in advance to allow for an orderly start up; in practice this is difficult to orchestrate and rarely occurs. If a Plan of Work and Costs is part of the contract, the first tasks are frequently itemized as hiring staff and ordering supplies.

Occasionally a university will be asked by the sponsor to undertake certain tasks while negotiations relating to a contract are still on-going. At this point the university would be well advised to remember the caveat! However, there are several options which may be utilized in order to not impede the progress of the project. If it is equipment that is to be ordered, the sponsor may wish to purchase the equipment and arrange for delivery to the university. The contract can address the transfer of ownership at a later date. Alternatively one may consider drawing up a letter of intent to cover the limited obligations and compensation to be undertaken prior to the effective date of the contract.

Usually the date of termination will coincide with the scheduled date for the final deliverable. When applicable, allowance should be made for an appropriate period between the end of the Project work and the preparation of the final report.

Notice also should be taken of Article 22 - Survival of Articles.

Article 12 - Confidentiality

It is important to pay close attention to the principle of confidentiality because information which is not produced as a result of the research agreement should be safeguarded and the ownership of such confidential information should continue with the company or the university as the case may be. This applies equally to much of the information developed as a result of the agreement.

Some confidentiality provisions specify that information is not confidential, unless it is specifically designated as such by the disclosing party. This sounds very reasonable but does not always correspond to the real world. In many situations confidential information is transmitted orally and is mixed with nonconfidential material.

Depending on the type of research being done, it may be advisable to have all persons including students involved with the project at the University sign a simple confidentiality agreement - or the Acknowledgement of the Agreement (page 7).

Article 14 - Publication

It is acknowledged that universities exist to increase the total fund of knowledge in our society, and to provide for the free exchange of ideas between scholars.

At the same time commercially useful technical information in many cases loses all its value if it is made public. This applies particularly to non-patentable technical information, including software. However even in the case of patentable inventions, secrecy gives the potential patentee a lead time of at least two (2) years while the patent is being considered at the Patent Office. Some people are not aware that only a patent can be infringed, and that pending the grant of a patent, there is no protection for the inventor. It is critical that this information not become available to a competitor. Moreover, publication or presentation at symposia releases the information into the public domain. Patents can only be obtained for inventions within a very limited time after such disclosure.

An attempt has been made to balance the conflicting interests of industry and universities in this article. It should also be noted that if the university is allowed to participate to some extent in the commercial exploitation of an idea generated by the research agreement, there will be more incentive to keep commercially useful information secret. At the same time non-commercial information can be dealt with in a more traditional academic manner. If technical information which has to be kept secret is incorporated into a thesis, then it is published for all practical purposes. As a consequence, should the research involve the possibility of commercially useful information, the

Principal Investigator should be aware that there may be restrictions on theses and other publications; thus is cautioned in considering the employment of graduate students.

Article 15 - Ownership and Commercial Exploitation of Intellectual Property

The question of who has the right to so-called "intellectual property" in a research endeavour is a very complex one. In the first place, the particular project may be a portion of a large body of knowledge which resides in the university or in the corporation or both. It is obviously important for both the corporation and the university to limit disclosure to the project at hand. One should also anticipate that the work may trigger ideas or open up paths of investigation for the researchers. Instead of trying to capture some of these rather ephemeral aspects of the transaction, Option I is structured in such a way that the results spelled out in the "Deliverables", and any other Intellectual property belong to the company. Sharing between the corporation and the university to some degree in the commercial profits derived from the research is provided.

Option II gives title of the deliverables to the Company but the other Intellectual property generated by the research agreement belong to the university which in turn grants extensive licenses to the sponsoring company. Again attention has to be paid as to what the "deliverables" are and to what extent they are included in the provisions governing intellectual property.

Reference is made to negotiating a royalty in keeping with industry norms. In these negotiations consideration should be given to the contribution of both parties, the scope of the protection afforded by patents, coypyright or other intellectual property rights, exclusivity or non-exclusivity of the license, the amount and duration of the royalty, the rights to sublicense, performance obligations of the company and other relevant matters.

Since conditions of joint ownership vary so considerably, no option for such circumstances is provided for in this model. However, the possibility of joint ownership is recognized and it is expected that details of such an arrangement would be identified in a manner similar to Options I&II.

Article 17 - Special Conditions

Each situation is likely to produce problems and solutions beyond any general guideline. The Article on Special Conditions could cover some of the following:

1. Accommodation of employees of Company in performing R&D on university premises or vice versa;

2. Delivery of materials, information or equipment by Company, in accordance with a schedule.

3. Special insurance or permit requirements.

4. Access to University prior know how, patents, etc. (This may be the subject of a separately negotiated agreement).

5. Company liability for Company owned equipment on University premises.

University of Waterloo
Waterloo, Ontario

WATFIV-S EDUCATIONAL AGREEMENT

Between:

UNIVERSITY OF WATERLOO, a University incorporated by special act of Legislature of the Province of Ontario having its head office at the City of Waterloo, in the Regional Municipality of Waterloo.
herein called the "Licensor".

—and—

herein called the "Licensee".

IN CONSIDERATION of the general covenants and agreements herein contained, the Licensor doth hereby grant to the Licensee a non-exclusive licence to use the WATFIV System or Program (hereinafter called "the Program"), produced by the licensor, this licence to be subject to the terms and conditions hereinafter set out:

1. This Licence shall run for a term of years from the day of 19 ; provided that if the Licensee shall not then be in default with respect to the terms of this Agreement, the term hereof, at the option of the Licensee, may be extended, upon giving written notice to that effect to the Licensor, and provided that the Licensor consents in writing, this Agreement shall be extended for an additional period of one (1) year and, at the option of the Licensee, and with the written consent of the Licensor, the term hereof may be further extended, in similar manner and provided that the Licensee shall not then be in default, from year to year during each renewal year thereafter. Such notice of renewal shall be given by the Licensee to the Licensor at least forty-five (45) days prior to the date of expiration of the then current licence year and the Licensor shall give notice of consent to the renewal within thirty (30) days of the expiration of the then current licence year. Each renewal shall be upon the same terms and conditions as herein set out.

2. The Program shall be used by the Licensee only at the location and on the computers (herein referred as the "CPU's") hereinafter referred to:
(i) Computer Models ....
(ii) C.P.U. Serial Numbers ....
(iii) Installation Location ....

In context of this paragraph, use shall mean the copying of any portion of the instructions or data in the program and/or any material associated therewith from storage units or media into the CPU's or other central processing units referred to above for processing.

The Licensee, upon giving written notice to the Licensor, shall be permitted to use the Program on a back-up central processing unit, until the CPU's are restored to operative status and processing of the data already entered into the back-up central processing unit shall be completed, firstly, if the CPU's above referred to, shall be inoperative due to malfunction, or be unavailable due to the performance of preventative maintenance, engineering changes, or changes in features or model, or secondly, if the specifications of the CPU's, above referred to, are such that the said Program cannot be assembled or compiled on those CPU's.

Should the CPU's, above referred to, become inoperable or unavailable as aforesaid, the Licensee shall cause the above specified CPU's to be made operable or available as expeditiously as possible.

3. The Licensee shall pay to the Licensor yearly and every year during the said term, for the use of the said Program, a licence fee of Nine Hundred Dollars ($900.00), the first of such payments to be made in advance on the date of the commencement of the licence term referred to above and the subsequent yearly payments of Nine Hundred Dollars ($900.00), shall be made in advance within thirty (30) days of the date of commencement of each year of the date of commencement of each year of the said licence term or any renewal thereof.

4. The Licensor and the Licensee agree that the content of the WATFIV Program is fully defined in the Source Listing, in card image form, on the WATFIV Distribution Tape to be delivered by the Licensor to the Licensee: the said parties hereto also agree that there are no understandings, agreements, warranties or representations, express or implied, between the said parties with respect to or relating to the content of the WATFIV Program other than as defined by the said Distribution Tape.

5. The Licensor agrees to furnish and provide such maintenance, without charge, at such time or times, and for such period of time, as the Licensor in its absolute discretion shall deem necessary and advisable.. Any communications regarding Program Maintenance shall be addressed to the WATFIV Co-ordinator, Computing Centre, University of Waterloo, Waterloo, Ontario N2L 3G1.

6. This Licence shall be non-exclusive and the Licensor shall have the right to grant any further and additional licences or to make such other use of the said Program as it shall desire.

7. Title to the Program and any material associated therewith shall at all times remain in the Licensor.

8. The Licensee may modify the said Program and/or any material associated therewith, in machine readable form, to adapt the same for the Licensee's own use having regard to the Licensee's own peculiar requirements and to this extent may merge the program into other program material to form an updated work, provided that upon termination of this licence, the program and material associated therewith shall be removed from the updated work and shall be destroyed as provided in the within Agreement. The Program, though merged with any other program material, shall be used only on the CPU's above referred to and shall remain subject to the terms of the within Agreement.

9. The Licensee shall acquire no right, title or interest in, to or with respect to, the name "WATFIV" or to the Program itself and Licensee agrees that the name WATFIV and the Programs are and shall at all times be the sole property of the University of Waterloo.

10. The Licensee shall at all times hereafter keep secret and confidential, the Program and all technical information, data or materials relating to the Program.

11. The Licensee shall permit, subject to limitations which may be imposed by federal, state, provincial, municipal or other government security regulations, representatives of the Licensor to enter and inspect any location in which the Program is being used, at all reasonable times, for the purpose of determining that the Licensee is not in default with respect to the terms of this Agreement.

12. Subject to Paragraph 22, the Licensee shall not assign, sublet or transfer the within Licence, nor, shall the Licensee for purposes of financial gain, offer a service to any person, corporation or entity, which service includes the use of the said Program.

13. The Licensee shall restrict the use of the Program to its own computers at the location above referred to and by its own students, faculty members, administrative staff and research personnel. The Licensee may also authorize the use of the Program to external users provided that the gross revenue received by the Licensee from the use of the Program for commercial purposes shall not exceed, during any one year of the term of the within Agreement the "one year licence fee" stipulated in the Licensor's "WATFIV Commercial Agreement", which fee is Eighteen Hundred Dollars ($1,800.00) per year. If the said gross revenue shall exceed the said licence fee, the Licensor shall have the option, upon giving to the Licensee thirty (30) days written notice, to terminate the within Agreement and to request that the Licensee enter into a "WATFIV Commercial Agreement" for the continued use of the Program.

The Licensee shall keep accurate records relating to the use of the Program which shall indicate to whom its use has been authorized and shall indicate the revenue received by the Licensee from the use of the Program for commercial purposes. The Licensee shall at the written request of the Licensor, expeditiously as possible, provide the Licensor with copies of such records, certified under the hand of a duly authorized officer of the Licensee. Upon the failure of the Licensee to provide copies of such records, the Licensor shall have the option, upon giving thirty (30) days written notice to the Licensee, to terminate the within Agreement.

14. Upon the happening of any of the following events, there shall be deemed to be a breach of the terms of the within Agreement and without intending to waive, remove, limit or restrict any legal or equitable right and remedy otherwise available to the Licensor, attendant upon such breach the Licensor shall have the right and option to terminate the within Agreement and upon the written request of the Licensor, the Licensee shall return the Program and all material used in connection therewith belonging to the Licensor within ten (10) days of receipt of the written request of the Licensor terminating the Agreement:

(a) failure of the Licensee to pay in full, in accordance with terms of this Agreement, the licence fee above referred to;

(b) violation of or failure of the Licensee to perform any of the other covenants or agreements herein contained;

(c) the Licensee becoming insolvent, or making an assignment for the benefit of creditors, or if a petition in bankruptcy is filed by or against the Licensee, or proceedings for the appointment of a receiver for the Licensee is filed or if proceedings for a re-organization or for composition with creditors be instituted by or against the Licensee, or if real or personal property of the Licensee shall be sold or levied under a Writ of Execution.

The parties hereto agree that the Licensor would have no adequate remedy at law upon the Licensee's threatened or actual violation of its obligations under the terms of this Agreement and accordingly the parties hereto agree that the Licensor may apply to a Court of competent jurisdiction for an injunction restraining any such threatened or actual violation.

The Licensor shall under no circumstances be under an obligation to refund to the Licensee any amount paid by the Licensee by way of licencing fees upon the happening of any of the events hereinbefore referred to.

15. If, within ninety (90) days after the receipt by the Licensee of the said Program, the Licensee establishes to the satisfaction of the Licensor that the Program, because of its content, has not been beneficial to the Licensee, the Licensee may, by returning to the Licensor the Program and any materials associated therewith, elect to terminate this Agreement and in such event the Licensor shall return to the Licensee the licence fee paid to the Licensor.

16. The Licensor shall have the right, at any time during the term of the within licence or during any renewal thereof, of terminating the said licence, at its absolute discretion, by giving the Licensee ninety (90) days' written notice to that effect, provided that the Licensor shall, upon the expiration of such ninety (90) day period, return to the Licensee that portion of the yearly licence fee related to the unexpired portion of the year of the said licence term.

17. Upon the termination of the within Agreement, whether pursuant to the terms hereof, or by effluxion of time, or otherwise, the Program and any materials associated therewith shall be removed from any location in which the Program is being used and all materials, duplicates and copies relating thereto shall be destroyed by the Licensee. The Licensee, upon such termination, shall provide the Licensor with such reasonable evidentiary information and material as shall enable the Licensor to satisfy itself as to such removal and destruction of the said Program, materials, duplicates and copies relating thereto. Without intending to limit the generality of the foregoing, upon any such termination the Licensee shall complete, execute and give to the Licensor the "Termination of the WATFIV Agreement" form provided by the Licensor.

18. (a) Whenever any representation, written, printed or oral, shall be made by the Licensee relating to the said Program, such representation shall be accompanied by a reference to "WATFIV and the Applied Analysis and Computer Science Department, University of Waterloo", as the originator of the Program.

(b) Any reference to the term WATFIV shall be accompanied by appropriate notice stating that WATFIV is a trademark of the University of Waterloo.

19. Any notice given under the terms of the within Agreement shall be in writing and shall be delivered in person to the addressee, or, shall be forwarded by prepaid post to the respective parties hereto as follows:

University of Waterloo,
Waterloo, Ontario,
N2L 3G1.

Any such notice mailed as aforesaid shall be deemed to have been given on the next business day following that upon which the letter containing such notice is posted.

20. There are no understandings, agreements, representations or warranties, express or implied, other than as herein set forth or incorporated by specific reference in this Agreement. This Agreement constitutes the entire agreement and understanding between the parties concerning the subject matter hereof and any modification or amendment shall not be binding upon either party unless in writing and signed on behalf of each by a duly authorized representative.

21. This Agreement and any questions concerning its validity, construction or preformance shall be governed by the laws of the Province of Ontario.

22. Notwithstanding the terms of the within Agreement, and with regard to the computers herein specified, the Licensor hereby grants to the Licensee permission to allow the following educational institutions to use the Program for educational purposes only:

23. The Licensee agrees to indemnify the Licensor, its successors and assigns, against any and all loss, cost, charge, claim, demand, fee, damage or expense of every nature or kind which may at any time hereafter be sustained by the Licensor by reason of or in consequence of having executed or performed all or any part of this Contract.

24. The Licensor shall not, by reason of termination or nonrenewal of this Agreement, be liable to the Licensee for compensation, reimbursement or damages on account of the loss of prospective profits on anticipated sales or on account of expenditures, investments, leases or commitments in connection with the business or goodwill of the Licensee or otherwise.

25. If any term, clause or provision of this Agreement shall be judged invalid for any reason whatsoever, such invalidity shall not affect the validity or operation of any other term, clause or provision and such invalid term, clause or provision shall be deemed to have been deleted from this Agreement.

IN WITNESS WHEREOF the parties have this day of 19 affixed their corporate seals, attested by the hands of their duly authorized officers in that behalf.

UNIVERSITY OF WATERLOO

Per:

Per:

Per:

Per:

University of Waterloo

Waterloo, Ontario

WATBOL EDUCATIONAL AGREEMENT

BETWEEN:

UNIVERSITY OF WATERLOO, a University incorporated by special act of the Legislature of the Province of Ontario, having its head office at the City of Waterloo, in the Regional Municipality of Waterloo,
herein called the "Licensor",

— and —

herein called the "Licensee".

IN CONSIDERATION of the general covenants and agreements herein contained, the Licensor doth hereby grant to the Licensee a non-exclusive licence to use the WATBOL System or Program (hereinafter called "the Program"), produced by the Licensor, this licence to be subject to the terms and conditions hereinafter set out:

1. This Licence shall run for a term of ONE years from the 1st day of October 1982 ; provided that if the Licensee shall not then be in default with respect to the terms of this Agreement, the term hereof, at the option of the Licensee, may be extended, upon giving written notice to that effect to the Licensor, and provided that the Licensor consents in writing, this Agreement shall be extended for an additional period of one (1) year and, at the option of the Licensee, and with the written consent of the Licensor, the term hereof may be further extended, in similar manner and provided that the Licensee shall not then be in default, from year to year during each renewal year thereafter. Such notice of renewal shall be given by the Licensee to the Licensor at least forty-five (45) days prior to the date of expiration of the then current licence year and the Licensor shall give notice of consent to the renewal within thirty (30) days of the expiration of the then current licence year. Each renewal shall be upon the same terms and conditions as herein set out.

2. The Program shall be used by the Licensee only at the location and on the computers (herein referred to as the "CPU's") hereinafter referred to:

(i) Computer Models
(ii) C.P.U. Serial Numbers
(iii) Installation Location

In the context of this paragraph, use shall mean the copying of any portion of the instructions or data in the program and/or any material associated therewith from storage units or media into the CPU's or other central processing units referred to above for processing.

The Licensee, upon giving written notice to the Licensor, shall be permitted to use the Program on a back-up central processing unit, until the CPU's are restored to operative status and processing of the data already entered into the back-up central processing unit shall be completed, firstly, if the CPU's, above referred to, shall be inoperative due to malfunction, or be unavailable due to the performance of preventative maintenance, engineering changes, or changes in features or model, or secondly, if the specifications of the CPU's above referred to, are such that the said Program cannot be assembled or compiled on those CPU's.

Should the CPU's above referred to, become inoperable or unavailable as aforesaid, the Licensee shall cause the above specified CPU's to be made operable or available as expeditiously as possible.

3. The Licensee shall pay to the Licensor yearly and every year during the said term, for the use of the said Program, a licence fee of Nine Hundred Dollars ($900.00), the first of such payments to be made in advance on the date of the commencement of the licence term referred to above and the subsequent yearly payments of Nine Hundred Dollars ($900.00), shall be made in advance within thirty (30) days of the date of commencement of each year of the said licence term or any renewal thereof.

4. The Licensor and the Licensee agree that the content of the WATBOL Program is fully defined in machine readable form on the WATBOL Distribution Tape to be delivered by the Licensor to the Licensee; the said parties hereto also agree that there are no understandings, agreements, warranties or representations, express or implied, between the said parties with respect to or relating to the content of the WATBOL Program other than as defined by the said Distribution Tape.

5. The Licensor agrees to furnish and provide such maintenance, without charge, at such time or times, and for such period of time, as the Licensor in its absolute discretion shall deem necessary and advisable. Any communications regarding Program Maintenance shall be addressed to the WATBOL Co-ordinator, Computing Centre, University of Waterloo, Waterloo, Ontario, N2L 3G1

6. This Licence shall be non-exclusive and the Licensor shall have the right to grant any further and additional licences or to make such other use of the said Program as it shall desire.

7. Title to the Program and any material associated therewith shall at all times remain in the Licensor.

8. The Licensee may modify the said Program and/or any material associated therewith, in machine readable form, to adapt the same for the Licensee's own use having regard to the Licensee's own peculiar requirements and to this extent may merge the program into other program material to form an updated work, provided that upon the termination of this licence, the program and material associated therewith shall be removed from the updated work and shall be destroyed as provided in the within Agreement. The Program, though merged with any other program material, shall be used only on the CPU's above referred to and shal remain subject to the terms of the within Agreement.

9. The Licensee shall acquire no right, title or interest in, to or with respect to, the name "WATBOL" or to the Program itself and the Licensee agrees that the name WATBOL and the Programs are and shall at all times be the sole property of the University of Waterloo.

10. The Licensee shall at all times hereafter keep secret and confidential, the Program and all technical information, data or materials relating to the Program.

11. The Licensee shall permit, subject to limitations which may be imposed by federal, state, provincial, municipal or other government security regulations, representatives of the Licensor to enter and inspect any location in which the Program is being used, at all reasonable times, for the purpose of determining that the Licensee is not in default with respect to the terms of this Agreement.

12. Subject to Paragraph 22, the Licensee shall not assign, sublet or transfer the within Licence, nor, shall the Licensee for purposes of financial gain, offer a service to any person, corporation or entity, which service includes the use of the said Program.

13. WATBOL is a limited purpose system, intended to improve efficiency of a certain class of program and to provide more diagnostic information than do conventional compilers. However, the system is somewhat experimental in that it involves unconventional translation procedures, and it has not been exhaustively tested by years of use in a data processing or computing environment; and, therefore, the Licensor makes no representation with respect to its adequacy of this Program for any particular purpose or with respect to its adequacy to produce any particular result. The Licensee agrees that the Licensor or any of its employees, agents or contractors shall not be liable under any claim, charge or demand whether in contract, tort (including negligence), criminal law or otherwise, for any and all loss, cost, charge, claim, demand, fee, expense or damage of every nature and kind arising out of, connected with, resulting from or sustained as a result of executing this Contract or for performing all or any part of this Contract. In no event shall the Licensor be liable for special, direct, indirect or consequential damages, losses, costs, charges, claims, demands, fees or expenses of any nature or kind.

14. Upon the happening of any of the fo[illegible]ing events, there shall be deemed to be a brea[illegible] of the terms of the within Agreement and without intending to waive, remove, limit or restrict any legal or equitable right and remedy otherwise available to the Licensor, attendant upon such breach the Licensor shall have the right and option to terminate the within Agreement and upon the written request of the Licensor, the Licensee shall return the Program and all material used in connection therewith belonging to the Licensor within ten (10) days of receipt of the written request of the Licensor terminating the Agreement:

(a) failure of the Licensee to pay in full, in accordance with terms of this Agreement, the licence fee above referred to;
(b) violation of or failure of the Licensee to perform any of the other covenants or agreements herein contained;
(c) the Licensee becoming insolvent, or making an assignment for the benefit of creditors, or if a petition in bankruptcy is filed by or against the Licensee, or proceedings for the appointment of a receiver for the Licensee is filed or if proceedings for a re-organization or for composition with creditors be instituted by or against the Licensee, or if real or personal property of the Licensee shall be sold or levied under a Writ of Execution.

The parties hereto agree that the Licensor would have no adequate remedy at law upon the Licensee's threatened or actual violation of its obligations under the terms of this Agreement and accordingly the parties hereto agree that the Licensor may apply to a Court of competent jurisdiction for an injunction restraining any such threatened or actual violation.

The Licensor shall under no circumstances be under an obligation to refund to the Licensee any amount paid by the Licensee by way of licencing fees upon the happening of any of the events hereinbefore referred to.

15. If, within ninety (90) days after the receipt by the Licensee of the said Program, the Licensee establishes to the satisfaction of the Licensor that the Program, because of its content, has not been beneficial to the Licensee, the Licensee may, by returning to the Licensor the Program and any materials associated therewith, elect to terminate this Agreement and in such event the Licensor shall return to the Licensee the licence fee paid to the Licensor.

16. The Licensor shall have the right, at any time during the term of the within licence or during any renewal thereof, of terminating the said licence, at its absolute discretion, by giving the Licensee ninety (90) days' written notice to that effect, provided that the Licensor shall, upon the expiration of such ninety (90) day period, return to the Licensee that portion of the yearly licence fee related to the unexpired portion of the year of the said licence term.

17. Upon the termination of the within Agreement, whether pursuant to the terms hereof, or by effluxion of time, or otherwise, the Program and any materials associated therewith shall be removed from any location in which the Program is being used and all materials, duplicates and copies relating thereto shall be destroyed by the Licensee. The Licensee, upon such termination, shall provide the Licensor with such reasonable evidentiary information and material as shall enable the Licensor to satisfy itself as to such removal and destruction of the said Program, materials, duplicates and copies relating thereto. Without intending to limit the generality of the foregoing, upon any such termination the Licensee shall complete, execute and give to the Licensor the "Termination of the WATBOL Agreement" form provided by the Licensor.

18. (a) Whenever any representation, written, printed or oral, shall be made by the Licensee relating to the said Program, such representation shall be accompanied by a reference to "WATBOL and the Applied Analysis and Computer Science Department, University of Waterloo", as the originator of the Program.
(b) Any reference to the term WATBOL shall be accompanied by appropriate notice stating that WATBOL is a trademark of the University of Waterloo.

19. Any notice given under the terms of the within Agreement shall be in writing and shall be delivered in person to the addressee, or, shall be forwarded by prepaid post to the respective parties hereto as follows:

University of Waterloo,
Waterloo, Ontario.
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Any such notice mailed as aforesaid shall be deemed to have been given on the next business day following that upon which the letter containing such notice is posted.

20. There are no understandings, agreements, representations or warranties, express or implied, other than as herein set forth or incorporated by specific reference in this Agreement. This Agreement constitutes the entire agreement and understanding between the parties concerning the subject matter hereof and any modification or amendment shall not be binding upon either party unless in writing and signed on behalf of each by a duly authorized representative.

21. This Agreement and any questions concerning its validity, construction or performance shall be governed by the laws of the Province of Ontario.

22. Notwithstanding the terms of the within Agreement, and with regard to the computers herein specified, the Licensor hereby grants to the Licensee permission to allow the following educational institutions to use the Program for educational purposes only.

23. The Licensee agrees to indemnify the Licensor, its successors and assigns, against any and all loss, cost, charge, claim, demand, fee, damage or expense of every nature or kind which may, at any time hereafter be sustained by the Licensor by reason of or in consequence of having executed or performed all or any part of this Contract.

24. The Licensor shall not, by reason of termination or nonrenewal of this Agreement, be liable to the Licensee for compensation, reimbursement or damages on account of the loss of prospective profits on anticipated sales or on account of expenditures, investments, leases or commitments in connection with the business or goodwill of the Licensee or otherwise.

25. If any term, clause or provision of this Agreement shall be judged to be invalid for any reason whatsoever, such invalidity shall not affect the validity or operation of any other term, clause or provision and such invalid term, clause or provision shall be deemed to have been deleted from this Agreement.

IN WITNESS WHEREOF the parties hereto have this 12th day of August 1982 affixed their corporate seals, attested by the hands of their duly authorized officers in that behalf.

UNIVERSITY OF WATERLOO

Per:

Per:

Per

Per

National Research Council Canada
Conseil national de recherches Canada

Industry Development Office
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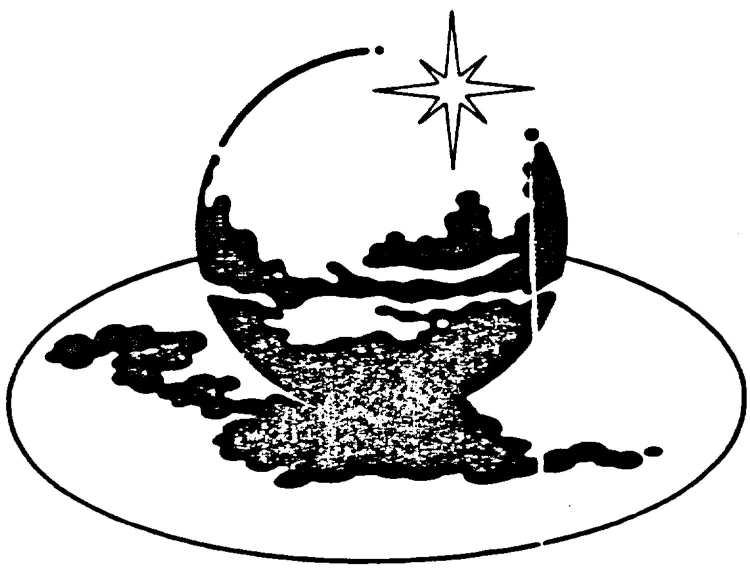
The IDO Laboratory Network

A Directory of Project Managers and Technology Transfer Officers in the National Research Council, Government Departments and Universities

Prepared by: Nicole Booth and Earl Maser



Canada

October 1986

THE INDUSTRIAL RESEARCH ASSISTANCE PROGRAM

IRAP LABORATORY NETWORK

DIRECTORY OF PROJECT MANAGERS

IE = Informatics and Electronics
BAF = Biotechnology, Agriculture, Food
MAM = Materials, Advanced Manufacturing
ITT = International Technology Transfer

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A CANADA-WIDE CONTACT NETWORK

Prepared by: Line Gour and Earl Maser

Canada

October 1986

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