

combined into such machines). An off-shoot of the PACS is the Laser Gear Inspection Machine. It is touted as offering a revolutionary way of quantifying gear dimensions in minimal time.

Diffrauto has devoted considerable effort to R&D activities and has received support in this area from the National Research Council of Canada, and the Department of Industry, Trade and Commerce. Current projects exist in the following areas:

- Electro-optical flaw detection
- E/O sorting machine development
- High resolution sensor development (profile image and triangulation)
- Robot guidance sensor development
- Fiber optic dimensional and CMM probe development
- Electro-optical sensors for machine tool feedback

In addition to the above, there are numerous customer sponsored projects and smaller internal projects. It should also be noted that a large percentage of their custom inspection machines delivered have substantial sensor R&D components. The company currently performs over one million dollars of R&D per year directly aimed at laser and electro-optical sensor development for measuring, inspection and robot guidance. Major applications for this type equipment within private industry and possibly within the USAF are as follows:

- Inspection and automatic adaptive control of turbine blade manufacture and rework.
- Inspection of turbine assemblies and components. For example, they have projects underway with General Electric for inspection of rotor shaft internal defects. Previous projects were concerned with tip clearance on rotors and for the automatic ultrasonic inspection of disks (laser/optical sensor control portion).
- Air frames and components.
- Diffrauto has participated to a small degree with Boeing in the ICAM sheet metal center development program. Much of the hardware needed to actually implement such a center from the inspection and robot control point of view, already exists at Diffrauto. They are currently in discussions with Lockheed Georgia on this same subject.
- Structural Integrity – Diffrauto has completed laser-based, miniaturized strain gage for aircraft fatigue strain history monitoring for the Canadian Department of National Defense. This gage can be used for highly stressed air frames and gives real time as well as stored data directly in digital form. It can exist in a fiber optic based version having very low weight and freedom from electrical noise.
- Manufacturing Technology – applications include the inspection of parts on flexible machining centers and the inspection of tools in the changers. A line of "RoboGage" vision based inspection machines has been developed, which are being incorporated in flexible lines
- Ordnance – Diffrauto inspection systems can be used for the inspection of ordnance. These normally high volume, high tolerance items require both dimensional and defect inspection, and are therefore ideally suited for electro-optical inspection. Some Diffrauto sensing systems operate with fiber optics and can be utilized in remote areas, e.g., loaded munitions areas, etc. Sensors already exist for large caliber barrel straightness determination. Barrel bore dimensions and flaws are other areas for which sensors have been developed. Miniaturization of this technology to small caliber barrels (5.56mm to 40mm) has proved

successful.

- Inspection of rivet and fastener holes in aircraft skins – Diffrauto has a bore probe system that can contour holes optically without requirement for all the channels of information needed in a capacitance probe. A unit has been provided to Grumman.

- Robot Guidance – A major project is currently underway to utilize the vision guidance system of the Canadarm used on the Space Shuttle to guide robots in plants. This project, in conjunction with the Government of Canada and a major automobile manufacturer, is expected to result in improved robots capable of much higher accuracy. A principle goal of the project is dynamic, flexible assembly and material handling. A project submission in this area applied to the F-16 has been jointly made with General Dynamics to the USAF.

Diffrauto standard products include:

- *Standard Laser/Electro-Optical Sensors*
  - 'MAXAN' Matrix Array Computer Vision Units
  - Series S and D High Resolution Outer Diameter Sensors
  - 'LaserProbe' High Resolution Laser Triangulation Sensors
  - LaserSurf In-line Microfinish Sensors
  - Model SF and BF Surface and Bore Flaw Detection Equipment
  - K-Series Microcomputer Based Controller for Optical Sensors and Machines
  - Contact Optical Digital Bore Size Probes
- *Standard Machines*
  - PACS – Programmable Laser Airfoil Contour Systems
  - Laser Gear Inspection Machine
  - 'RoboSorter' Computer Vision Bolt Sorting Machine
  - 'RoboGage' Programmable Robotic Inspection Machine (vision-based)
- *Computer Controlled Marking Units*
  - Model 400 Laser Marker for Part Identification
  - 'TurboJet' Ink Printer

**Average Work Force:** Total – 100 (5 PhDs)

**Gross Sales:** FY 82 – \$5.0M  
FY 83 – \$6.0M (Projected)

**Plant Size:** 66,000 sq ft

**Experience:** Diffrauto has performed one contract with the USAF (AFWAL Materials Laboratory) through the Defense Development Sharing Program. They have worked with the US Army (Picatinny Arsenal) as well as with US industry, e.g., General Electric Co., Boeing Aircraft Co., Union Carbide, Uniroyal, Westinghouse, Bunker-Ramo, Battelle, and others. They also work with the Canadian Department of National Defense and National Research Council of Canada.

**Keywords:** 1 = Aircraft; 6 = Computers; 7 = Electronics; 10 = Image Processing & Optics; 12 = Machining; 19 = Testing/Test Equipment; 20 = Miscellaneous; Measurement & Control Systems = 7, 19; Laser Optics = 10, 19; Optics = 10, 19; Automated Precision Measuring = 12, 19; Precision Measuring = 12, 19; Inspection Equipment = 6, 10; Ordnance Inspection Equipment = 6, 10; Sensors = 19; Turbine Blade Inspection = 1, 7, 10, 19; Gear Inspection = 10, 19; Flaw Detection = 10, 19; Structural Integrity = 1, 10, 19; Robotics = 20; Robot Guidance = 20; Manufacturing Technology = 6, 10, 20; ICAM = 20; Machine Vision = 6, 10.

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