successful tourist submarine operations, are discussed below.

One- and two-person submarines are currently required to have a mother ship or some type of support system similar to a larger class tourist submarine. This narrows potential users to corporations or resort-related developments with support operation capabilities.

Demand for remote operated vehicles (ROVs) is expected to rise steadily as users and uses increase. End users include fishing companies and researchers using ROVs to inspect fishing grounds, fish ranches and "fish apartments" without raising them for ship-top inspection; marine construction companies for inspection and construction of pilings and other underwater structures such as dams; communications companies for inspection and repair of undersea cable; offshore oil companies for rig, platform and pipeline inspection; and general salvage and research activities.

Leisure Submarine Joint Ventures

Coral Marine. This 46-passenger, three-crew tourist submarine with a 50-m depth capacity is currently operating off the coast of Amami Oshima, Japan. The Coral Marine began operating in August 1989 and is expected to attract 45 000 passengers annually. The price of a 30-minute ride is ¥9 000.

Manufactured by Wartsila Marine Industries of Finland, the purchasing price of the Coral Marine was approximately ¥600 million. However, ¥1 500 million total investment was necessary before preparatory stages were fully completed.

After importation by Uemura Gumi Co. Ltd., the joint venture Coral Marine Co. Ltd., was established. Current shareholders are Uemura Gumi, with a 50 per cent share, and Matsushita Electric Co. Ltd., Time Associates, Navics Line, Hitachi Zosen Corp. and Oshima Transportation, each with a 10 per cent share.

The five new shareholders were included to cover different tasks related to the general tourist operations. The allocation of tasks are general management by Uemura Gumi; food and other concessions by Matsushita Electric; import procedures by Time Associates; maintenance and supply of mothership and shuttle by Hitachi Zosen; and vehicle operation and support activities by Navics Line and Oshima Transportation. Japan Air Service (JAS), currently the company's official air carrier, takes care of related ticketing, air packages and marketing.

Moglyn. This is a 40-passenger, three-crew tourist submarine, with a depth capacity of 50 m. It was manufactured and is maintained by Mitsubishi Heavy Industries. The submarine is currently operating in Okinawa out of a tourist submarine centre at the Submarina Hotel, managed by the Japan Golf Association. Operations began in September of 1989, with initial investment totalling ¥1 000 million. Moglyn's list price was ¥500 million. The cost per ride is ¥10 000 for 35 minutes.

Similar to the Coral Marine, Moglyn operations are also handled by a joint venture company – Japan Submarine Tourism Co. Ltd. The joint venture includes Mitsubishi Heavy Industries, Japan Travel Bureau (JTB), Japan Air Lines (JAL), Japan Golf Association and Tokio Marine & Fire Insurance Co. Ltd.

Japan Submarine Tourism is planning several other developments utilizing similar methods in Singapore and Malaysia. A subsidiary of Matsushita Electric (Matsushita Kosan) is also planning an operation similar to the Coral Marine and Moglyn. Both of these offer possibilities for creating further opportunities for both submarines and the import of related equipment.

Robotics and Technology

The Ministry of Transportation's engineering division is using an underwater robot called Aqua-robo for inspection of irregular mounds used for piling and structural foundations in harbours and other construction. Aqua-robo is a six-legged insect-like robot possessing sensors and DC motors in each of its legs. It is controlled by a microcomputer and is mobile enough to walk in any direction without turning around.

The Ministry of Transportation has also recently developed an undersea foundation construction machine. This system works with the Aqua-robo and accomplishes tasks previously performed by divers such as laying rock on the ocean floor.

MITI has also been developing a robot since 1983 that is expected to take the place of divers in maintenance and inspection-related work on oil production platforms. This robot was scheduled for demonstration by the end of 1990.

Japan's international telegram and telephone company, KDD (Kokusai Denpo Denshin) employs ROVs with underwater cable installation, inspection and maintenance capabilities. For example, the Marcas-2500 ROV is able to raise sections of cable to the surface for major repairs and has a maximum depth of 2 500 m. The Marcas-2500 costs