Implant intelligent gene to automation:

An interview with ITRI MSL Deputy General Director

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ITRI MSL Lai-Sheng Chen talks about 2W1H (What, Why, How) of Intelligent Automation.

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Most people associate the concept of automation with conventional robots, such as humanoid robots and the mechanical arms used in industry. However, the concept of *intelligent automation* has gradually evolved and taken shape over the past few years. ausMT editors have therefore specially interviewed Dr. Lai-Sheng Chen, deputy director of the Mechanical and Systems Research Laboratories, Industrial Technology Research Institute (ITRI MSL), to share his international viewpoints to *intelligent automation*, and provide academic researchers with new research directions. His point of view will give readers a brand-new perspective on automation.

ausMT: How do you define "intelligent automation"?

Lai-Sheng Chen: We began promoting the concept of intelligent automation since summer 2010. The great advances in computing power and the steadily dropping price of memory have created an environment in which intelligent technologies can thrive, and there have also been external stimuli such as the increasing cost of labor and the aging population. As a result, firms in Taiwan – primarily Small and medium enterprises (SMEs) – have begun to see automation as an urgent need, which has accelerated the development of intelligent automation.

Intelligent automation can be defined as the integration of hardware, software, and technical services. It involves a cycle of intelligent processes: sensing, processing, reasoning, and reacting. Intelligent automation researchers and firms are developing environmental sensing, safe human-machine interaction, and autonomous decision-making equipment and systems in response to *multifaceted, diversified manufacturing and service needs*. Intelligent automation also encompasses

interdisciplinary integration and innovative applications, and consists of the three main categories of intelligent automation products and equipment, intelligent robots, and automated engineering and technical services.

Current technology development efforts at the Mechanical and Systems Research Laboratories of Industrial Technology Research Institute (ITRI MSL) emphasize three directions: *green energy, intelligence, and miniaturization*. Of these, intelligence has been a focal point of machinery development efforts during the past few years, which reveals that intelligent automation will have great importance in the future.

ausMT: There have been efforts to promote automation in Taiwan for some years. Compared with traditional automation, what features or key developmental directions do you feel distinguish intelligent automation?

Lai-Sheng Chen: In the 1970s, the Taiwan government began promoting industrial automation in response to the economic environment of the times. This automation was used primarily for the purpose of

Lai-Sheng Chen

Vital statistics

Born 1961
Married, with 2 children

Education

Graduated with a Ph.D.
in Mechanical
Engineering in 1990
from the University of
Chiao Tung at Hsinchu

Career highlight

ITRI MSL

Mechanical and
Systems Research
Laboratories, Industrial
Technology Research
Institute
(1990-present)

(2010-present)
Deputy General
Director

(2006-2010)
Director of Intelligent
System Division

(2004-2006)
Deputy Director of
Micro-Nano Mechanics
Division

(2002-2004)
Project Manager at
Nanotechnology Center

(1997-1999)
Manager at Mechanical
Research Department

Fast facts

Holds 11 patents for
innovations including
those related to
collision detection
sensors, waveguide
biosensor, vacuum
robot, nano-imprinting
and machine tool.

Winner of numerous
invention rewards at
Nuremberg
International Invention
Exhibition, Pittsburgh
Invention New Product
Exposition and Geneva
International Exhibition
of Inventions

Inventor of smart
vacuum robot, V-BOT®.

improving efficiency, and it emphasized low costs, fixed products, process integration, and mass production. Industrial automation did indeed bring abundant economic benefits at that point in time.

Nowadays, in the wake of many changes in the environment, traditional production lines must be rethought in order to respond to demand in a flexible and intelligent manner. Furthermore, with the rapid development of technology, the *integration of hardware, software, and services* can provide a basis for the development of intelligent products, equipment, and services embodying the intelligent cycle concept.

The new wave of intelligent automation will bring us closer to the goals of **Manufacturing as a Service (Maas)** and **Service Industrialization**. With regard to the use of technology in the service industries, intelligent automation can be used in the development of value-added innovative applications in such service industries as healthcare and tourism. Intelligent automation can also play a big role in the emerging energy industry, including the PV/LED areas. Adding value to integrated applications services will stimulate the large-scale improvement of manufacturing and services, and diversified interdisciplinary applications can also create better lives.

Manufacturing as a Service chiefly emphasizes improvement of product added value, production of

small batches of diverse products, flexibility, and modularization. The Taiwan government is currently funding projects at ITRI, that are developing key parts and components such as core control systems, controllers, and electromechanical motors. In addition, programs with three-year phases during the last few years have sought to develop industrial and service robots, and basic applications are being used to accelerate industrial promotion. The Taiwan government also plans to initiate a robot program focusing on *human-machine interaction*.

While production line testing can safeguard quality, machine vision still remains constrained by speed limits, and identification ability must also be improved. In current applications, robots typically perform routine, unchanging tasks, while human beings handle more changeable tasks or jobs in which fine discrimination is needed. Cooperation between robots and human beings can therefore achieve optimal effectiveness. Furthermore, the *robot safety issue* must be taken into consideration when robots and human beings work in the same spaces. Safety measures must be taken when robots and humans work together in close proximity in the future. For instance, robots should be able to reason whether their actions could injure humans, and force control technology intended to prevent injuries could be integrated in future robots.

3C products are another focal point of intelligent automation development efforts. Most 3C products in China are assembled by hand. It is not currently possible to use robots and automation technology to assemble modularized parts, especially soft parts that are currently assembled by human beings. However, robots and other relevant technologies could be developed to perform the assembly of large machinery. In particular, because there are only relatively small differences between different models of vehicles, robots can be developed to assemble and weld different types of customized vehicles. Since one of the key issues is to find ways to *quickly change production lines, robots and modular systems* can be used to ensure the greatest possible effectiveness of production lines.

The main reason that robots are not used more widely is *cost*. Because companies are often intimidated by the high cost of initial deployment, Taiwan government projects are also focusing on the development of reasonably-priced domestic parts and components. Looking ahead to the future, it will be possible to use intuitive, guided instruction to shorten the time needed to get robot-operated production lines up and running and thereby cut costs. When that time comes, robots will be able to quickly learn their complete operating paths, and fine adjustments can be made to correct less-than-perfect segments. In addition, in the future we expect that personnel will be able to use vision and voice to demonstrate normal working actions once and a robot will then be able to perform the task on its own. Finally, intelligent automation will be applied in machinery maintenance in the future. When that time comes, technology will be used to forecast possible malfunctions or detect loss of precision, and back-end computerized service systems will perform active maintenance via a network. This method may be able to resolve the cost issues of SMEs that must currently hire professional engineers.

aUSMT: *Does Taiwan lag behind other countries as far as intelligent automation is concerned? Compared with other countries, where does Taiwan hold an advantage or need to play catch-up?*

Lai-Sheng Chen: As far as foreign progress is concerned, firms in Europe and the US are chiefly applying intelligent automation in industry, factory automation, and production technology, etc. Japan is also using intelligent automation in these applications, but is notably also using intelligent automation in various

household applications, including humanoid robots and service robots, etc. These applications have started to appear in various national forums. Taiwan's development of intelligent automation is actually quite closely aligned with the development strategies adopted overseas. And like in other countries, we in Taiwan hope to use robots to assist manufacturing and achieve major improvements in quality of life.

However, Taiwan lags behind other countries to a certain degree in such areas as products, equipment, robots, and technical services. This is primarily because the leading industrialized countries possess the most mature technologies, which gives them a competitive edge in automation and whole-plant project services, thus enabling their firms to develop superior brands. Nevertheless, Taiwan has its own advantages in information and communications technology (ICT) and in its well-developed machinery industry, as well as convenient access to the Chinese market. These strengths will facilitate the development of Taiwan's intelligent automation industry. Taiwan can rely on innovation and added value to expand the scope of intelligent automation applications, boosting domestic industrial output.

As for where we need to apply more effort, some domestic SMEs are still hesitant to adopt intelligent automation, and many leading technical services firms lack overseas marketing experience; as a result, domestic firms have been quite slow to commit themselves to intelligent automation. Furthermore, more effort must be put into developing key components in Taiwan, and integrated interface standards must be unified. These are areas where Taiwan's international competitiveness is still inadequate.

aUSMT: *In your opinion, what areas or companies in Taiwan can serve as models of intelligent automation?*

Lai-Sheng Chen: One of the most successful types of service robots is the *automated vacuuming robot*, and we anticipate that this product will continue to grow in value. Vacuuming robots combining a vacuum cleaner with robotic technology can make manual cleaning unnecessary. These robots

V-BOT®, automated vacuuming robot developed by IZTRI

possess many human-like intelligent characteristics, such as the ability to avoid falls (such as by avoiding stairways), avoid obstacles (including walls and other obstacles), and escape from dead ends (such as from under beds and chairs), and can automatically recharge themselves (the robots will return to their recharging location and recharge themselves when low on power). These abilities represent a very successful case of the application of intelligent automation.

While automation has been applied successfully on a large scale to manufacturing, electromechanical integration, and some intelligent applications in Taiwan, there have been few attempts to apply intelligent automation to interactive human-machine systems. To give one successful case, the controller technology for automated electric discharge machines was previously controlled by other countries, and Taiwanese firms could not produce these machines independently. Now however, ITRI has been able to develop control technology in conjunction with the industry, enabling domestic firms to autonomously manufacture and assemble electric discharge machines; the value of Taiwan's electric discharge machines is currently on a par with that of Swiss and Japanese machines.

Another example involves Taiwan's *flat panel display industry*. In the past, almost all process equipment, especially IC wafer equipment, had to be imported. Responding to this issue, the Taiwan government actively promoted measures to boost the domestic manufacture of this equipment, and hoped to achieve a domestic production rate of 50%. Today, more than 60% of Taiwan's flat panel displays are domestically made, and much of this equipment is for mid- and back-end processes. But because IC manufacturers demand high stability for front-end equipment, they have retained a high degree of brand loyalty and still prefer to obtain this equipment from major international producers.

Yet another successful application of intelligent automation was in the mechanical flowers in the *Pavilion of Dreams* at the Taipei International Flora Expo. In this case, intelligent automation was used to painstakingly control 120 servo motors simulating the rhythmic movement of flowers. This novel combination of mechanical technology with cultural creativity achieved a new level of artistry.

Pavilion of Dreams at the Taipei International Flora Expo

ausMT: *What are your views concerning the Taiwan government's current strategies for promoting intelligent automation?*

Lai-Sheng Chen: The Taiwan government's current strategies for promoting intelligent automation are based on the strategic framework drafted with the participation of the ITRI MSL and we consequently have a very positive and supportive attitude toward these strategies. Recently, the Taiwan government has been actively promoting the **A-PLUS development strategy**. The name of this strategy is derived from machine tools: most machine tools made in Taiwan are considered medium grade (roughly B to B-plus), but firms are currently attempting to develop A-PLUS machines. The Taiwan government's A-PLUS strategy is intended to support the industry's efforts to boost the grade of its machine tools.

The following are the key themes of the Taiwan government's A-PLUS intelligent automation development strategy:

1. **Automation:** The Taiwan government is targeting the automation industry's weak points, particularly in the areas of key parts and components, and has embarked on full-scale implementation after selecting outstanding firms.
2. **Paradigm:** The Taiwan government will extend successful models in key industrial areas to domestic SMEs. In the future, the strengths of ITRI, the Industrial Development Bureau, financial holding centers, and technology centers will be harnessed to help firms establish successful cases targeting the needs of different industries.
3. **Leverage:** The Taiwan government will integrate resources, promote corporate operating capabilities, and establish blueprints for Taiwanese industries.

From B-plus to A-PLUS

4. **User Oriented:** The strategy emphasizes the development of automated products and services focusing on everyday applications and possessing commercial appeal (high quality and acceptable cost), and seeks to strengthen SMEs' core and export capabilities.

5. **Service:** competitiveness. Emphasis is placed on diverse, crossover applications geared to improving life and increasing service value. From the angle of manufacturing as a service, equipment suppliers will seek to provide total solutions to problems. With regard to the use of technology throughout service industries, firms will provide value-added services in such areas as cost control, logistics, and information technology; successful examples include supply systems used by the restaurant industry and online home viewing systems used by real estate brokers.

The following four implementation strategies are being used to realize these five development themes, establish a comprehensive framework encompassing manpower, funds, and technology, and achieve the country's intelligent automation industrial development vision through the promotion of intelligent automation products, equipment, robots, and automation project services aimed at industry and homes:

1. **Improvement of the intelligent automation industry environment:** Establishment of a promotional office, strengthening of manpower training, promotion of integrated applications standards, and provision of financing channels.
2. **Promotion of value-added intelligent automation industry applications:** Emphasis is placed on automation engineering services, including the establishment of demonstration application models, promotion of interdisciplinary service teams, and extension of successful experiences.
3. **Industrialization of intelligent automation:** Following an inventory of automated equipment/product gaps and market survey to analyze industry trends, the Taiwan government will promote the establishment of demonstration platforms to assist in SME upgrade in order to boost their international competitiveness. In addition, the establishment of industry alliances

will expand the scale of applications. The active training of interdisciplinary manpower will enable intelligent automation to become one of Taiwan's distinctive and internationally competitive industries.

4. **Forward-looking technology R&D in the intelligent automation industry:** The development of key intelligent automation industrial technologies will proceed in two directions: the Industrial Technology Department's commitment of technological resources and the National Science Council's promotion of academic R&D efforts. The National Science Council is proposing projects addressing individual focal areas, and is emphasizing the development of autonomous, forward-looking core technologies, strengthening of manpower training, engagement in foreign cooperation to acquire technology, and improvement of the R&D environment.

The ITRI MSL is chiefly engaged in promoting industrial automation and supporting the A-PLUS strategy. It is currently establishing an application verification laboratory, which will conduct whole-line and single-machine experiments. Experiments will begin from collecting companies' needs, and will employ various methods to test process capabilities. After the stability of production results has been confirmed, and the two parties have reached an understanding, a production line can be established on the basis of experimental results, and may serve as a demonstration model.

With regard to manpower training, intelligent automation requires many procedural links, all of which are very important. In addition, the development of intelligent automation or robots also requires a high degree of interdisciplinary integration; while it would be ideal if universities can train personnel who are expert in many areas, training individuals who are expert in just a certain field also provides a solid foundation for future interdisciplinary cooperation. In addition, future research should allow students to pursue fields that are closely aligned with their interests. Finally, training technical personnel with global perspectives will require international cooperation. The Industrial Development Bureau's dedicated promotion and industrialization efforts are gradually sketching out a blueprint for the development of intelligent automation in Taiwan. 🦉

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