Shinwa Controls Reduces Product Footprint by 50% with Breakthrough Air Conditioning Equipment

Based on its advanced fluid and temperature control technologies, Japan-based Shinwa Controls has developed highly durable and reliable solenoid valves and valve devices for versatile applications, and precise air/liquid conditioning equipment which is mandatory for semiconductor and flat-panel display (FPD) manufacturing processes.

Addressing Process Challenges and Driving Innovation

In the development of the semiconductor and FPD manufacturing equipment, it is essential to effectively realize the voice of customers (VOC) throughout product development. Most of the VOC requirements are related to lower equipment prices, higher control precisions, and other functional improvements.

At Shinwa, while working on the VOC requirements, the person in charge of managing the company’s product development processes felt that Shinwa needed to:

- Improve the productivity of fundamental product development processes to shorten time-to-market
- Internally share the development know-how that each individual engineer has built over the years

To achieve these goals, the product development process manager and human resources development manager worked together to find out how they can train their engineers on effective product development methodologies.

Shortly after they started working on this initiative, Shinwa found that IDEA Inc., a leading TRIZ-based product development methodology consulting firm had helped many Japanese manufacturing companies successfully apply systematic development methodologies, and more specifically one of IDEA’s clients, Koganei, had developed an innovative solenoid air valve product line by effectively applying IDEA’s integrated QFD-TRIZ-Taguchi methodologies.

Takuji Yamamoto, deputy general manager at Shinwa, convinced by Koganei’s case, decided to apply IDEA’s systematic methodology and the IHS Goldfire software to:

- Identify and solve development challenges in its new air conditioning control equipment
- Innovate its entire product development process

Setting Product Development Goals

The very first step the Shinwa team took was to “clearly identify the key product development goals to generate attractive values for customers in the new product”. To achieve this goal, they used QFD (Quality Function Deployment) – a methodology to understand the product’s (technical) properties which are important to meet the critical needs (quality requirements) of target users in target applications.

The development team, together with sales representatives, categorized a large set of customer needs into five (5) categories. The team finally set a very challenging development goal of downsizing their existing product by 50 percent.
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Midway through the project, two customers came to Shinwa Controls and asked if the installation footprint area of this air conditioning equipment could be downsized dramatically. Since the ‘downsizing’ goal was given high priority from the project team’s QFD session done by the project team, and was now backed by these customers’ request, the project was accelerated. More than 300 ideas had been generated for various root causes identified in the previous problem analysis session.

One of the project members commented after the project was done, “It was not like one extreme idea suddenly appears in our mind to solve our problem. Instead, we piled up many modest ideas such as changing component layouts and removing unnecessary features, which finally led us to the achievement of our goal. But this project freed us from our perceptions (past experience and common sense) as we had built up in ourselves as engineers, and helped us feel that we could push our engineering ability and creativity much further”.

The solution concept generated by leveraging TRIZ methodology finally made it possible to downsize the footprint of this equipment by half. The development goal which was initially thought to be impossible was achieved, along with the confidence that the engineers gained.

Achieving Success by Delivering Value

The new air conditioning equipment developed through this project resulted in 50 percent downsizing of the product. This dramatic downsizing has created significant value for customers (users of semiconductor manufacturing equipment), much more flexibility in production line layout, and highly improved space-utility of the semiconductor manufacturing clean-rooms, which is naturally a very expensive facility. In addition, this downsizing has two valuable side-effects: the power consumption was cut by two thirds, and the time required to assemble the equipment was also shortened by 15 percent because the system is smaller. Now, Shinwa Controls’ development teams are utilizing the same methodology utilizing QFD-TRIZ and IHS Goldfire for the new two development projects for new solenoid and motor valves.

Identifying Root Causes of the Problem

Downsizing by half was a very aggressive goal, and initially engineers in the development team did not believe that they would have been able to make it. However, as they started applying TRIZ methodology and IHS Goldfire software to their problem, the mood of the development team started to change.

The first step in this radical downsizing challenge was to identify the causes which had made this equipment as large as it was. In this step, they did function modeling/analysis and cause-effect analysis for the existing air conditioning unit using IHS Goldfire. The function analysis helped the team break down the system into its components and clearly describe the interactions among various components, to precisely understand the system’s status and behavior to identify problem areas. Then, for the identified problem areas, the team used cause-effect analysis to analyze the mechanism for the problem – how it happened.

Using these two problem analysis approaches, they found that one of the causes which prevented this equipment from being downsized was its piping structure. The pipe needs to be strong enough for high-pressure refrigerant. However, increase in its strength resulted in larger space being required for bending – a major factor in the sizing problem.

Generating Innovative Solution Ideas

The project team generated many solution ideas for the piping problem. They needed to make the pipe-bending angle smaller while maintaining its strength. TRIZ Inventive Principle approach was utilized for this technological contradiction (trade-off) problem.

Inventive Principles are a database of laws and generic rules for solving product design problems, based on TRIZ methodologies. They stimulate the thinking of engineers and scientists in their quest to find ways to modify a product or process to resolve or overcome contradictory performance requirements (i.e. a need for a product to be both light and strong). Using IHS Goldfire’s knowledge-enabled Inventive Principles, the project team generated many ideas which were simple but beyond fixed perception.

Among the VOCs in the 5 categories, the team picked ‘downsizing’ as the key development goal for two reasons: 1) it would go well with today’s trend of environment-friendliness, and 2) it would create high value for customers’ critical issues. Also, downsizing would lead to “flexibility in production-line layout implementation” which satisfies the customer’s fundamental needs as ‘attractive quality’.