An Outline of
Smart Manufacturing Scenarios 2015

20 February, 2017
Industrial Value Chain Initiative
Smart Manufacturing Scenarios 2015

The Industrial Value Chain Initiative (IVI) is targeting to turn linked factories and connected manufacturing into reality. To achieve this goal, present situations in real industrial scenes are brought into discussion by representatives of member companies to identify the problem and specify an ideal situation to be pursued. In some cases, the discussion comes to the result that developing a new system at the enterprise as a whole or at its manufacturing site is needed. In other cases, the challenge may be solved through small improvement efforts (kaizen) by applying IoT tools.

For both, the perception of present situation, and setting tasks, it is significant that they are led by middle managers or experienced engineers who have profound knowledge on the manufacturing site, as a bottom-up process. It is required to describe scenarios in a realistic manner for both the current and the desired states.

In this paper, the themes of the 20 Business Scenario Workgroups (WGs) addressed in FY 2015 will be introduced. In each workgroup, members from different enterprises brought in ideas and made demonstration experiments to achieve the goal of a smart manufacturing scenario discussed in detail among themselves.

The topics of the work groups are divided into four areas. Area 1 focused on developing networks: Among equipment, enterprises in a value chain or networks beyond a value chain. The work groups proved such connection can reduce operational losses and enable agile control of a supply chain. Area 2 worked on improvement of production line efficiency by utilization of production data via IoT or cloud technologies. Experiments on data collection from equipment, monitoring lifetime of equipment, failure prognosis and operational simulation for recovery from troubles were conducted. Area 3 put emphasis on development of platforms covering processes in a whole value chain. Systems were developed connecting manufacturing plants with design through BOP, with procurement through MES, or with suppliers and customers through custom specifications. Area 4 created systems to connect manufacturing processes and operational units including human beings from a plant centric and human centric perspective. Part of the results are also featured on the IVI website.

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Area: Reaction on changes in globally and locally connected factories
Cloud enabled monitoring platform for global distributed factories

Original Concern
The operational status of equipment at overseas plants, local factories and other facilities cannot be checked. It takes time to examine the output and daily work reports. If such examinations are carried out by humans, the reliability of the collected data could suffer as well. Even when such information is digitized, there is a time lag of at least a half day or a day between the real-time conditions of those facilities and data collected from the production control and process management departments. Thus such data cannot be reflected in instructions to be issued the following day or in the next work shift. In case a serious problem happens, the reporting process is significantly delayed, making it impossible to take company-wide countermeasures before it is too late.

Final Goal
Make it possible to monitor real-time conditions of plants and other facilities (every minute or hour, or on demand). By constantly comparing the planned production with the actual output, establish a system to issue an alarm when any anomalies are detected or if there is a wide gap between the planned and actual figures. Shift from remote monitoring to autonomous growth. Each plant will separately make efforts to improve its quality, cost, delivery (QCD) performance and enhance its manufacturing capacity through competition with other factories.
One-stop portal and collaborative quotation management by connected SMEs

Members
KONNO corporation
NISHIKAWA SEIKI
SEISAKUJO
AIS
RKC INSTRUMENT
Izu Giken Kogyo
FUJITSU
IT Coordinators Association
Mitsubishi Research Institute

Original Concern
Requests for manufacturing diversify as consumer needs diversify. Large companies and research institutes also currently make more complex requests, instead of just ordering a single part. Requests that a single company could not fulfill alone from a technical perspective will be able to be met, if multiple firms accept the orders and produce the ordered goods together. That could offer companies more opportunities to receive orders. Small and midsize companies engaged in the same business (in different fields), firms involved in different businesses, suppliers, and business partners (including large companies) will work together as a community and integrate their data needed for production. Even small and midsize companies will be able to easily leverage information and communication technology (ICT).

Final Goal
A community to be formed by linking plants should include not only companies engaged in the same business (in different fields) but also firms involved in different businesses, suppliers, and business partners. If the community consists of members from different areas of expertise and differing machining fields, even relatively small companies will be able to prepare all necessary processing facilities by themselves, helping improve their competitiveness. When community members cover multiple machining processes, their processing ability can be improved to a level equivalent to that of large companies by better designing process management and quality control processes. Furthermore, a flexible production system should also be established, so that member companies of the community can better deal with fluctuations in production associated with demand fluctuations.
**Original Concern**

Each company builds a supply chain management (SCM) system separately to visualize inventory information made up of production and logistics data, so that it can optimize inventories in its global supply chain. Transportation information in the logistics data covers most parts of the supply chain, so the information can be provided in a consistent manner at lower costs, if such data is combined with production information. To realize services to provide information in such a way, the following have to be prepared: A system to integrate production and logistics data, the standardization of the information interface, and a cloud service to provide information.

**Final Goal**

As information services provided by logistics companies become increasingly sophisticated thanks to the recent advancement of ICT technology, an SCM system should be built using those services. Logistics companies currently not only track transported freight but also provide services to visualize the amount of stock at storage centers during transportation. Thus, if the ID assigned to each freight package - a unit of transportation - is used for both production and logistics operations, orders that manufacturing companies receive, as well as freight transported by logistics firms, can be linked, making it possible for manufacturing companies to check its stock of products globally based on the ID information. Overstock warning and other programs, as well as services to send inventory data and delivery status, are available, helping speed up the demand and supply control process. Using those services, inventories in the global supply chain can be optimized.
Risk management by connected production information in global SCM

Members
FUJITSU
Sony Global Manufacturing & Operations Corporation
Fuji Xerox
Oki Electric Industry
TRIFORCE CONSULTING

Original Concern
Most production data concerns competitive fields, so companies often change orders that are made or received, not knowing other firms' production situations. It is also unclear how to reflect order information in manufacturing data. Because of that, certain problems, such as unrealistic changes in plans and negative effects of excess production on manufacturing of other necessary products, arise. Workers routinely make efforts to deal with those problems, but only simple arrangements are typically made because it takes time to adjust the delivery schedule. Thus, the challenges are, (1) redefinition of competitive and cooperative fields as for production information, (2) dynamic data integration between manufacturing and order making and receiving systems, and (3) establishment of a system to adjust the delivery schedule between companies so that the lead time can be shortened.

Final Goal
Target is the establishment of a system to enhance the effects of data integration exerted by linking plants. To achieve that goal, not only systems should be provided, but also the quality of information used for those systems should be improved. Furthermore, a production cooperation platform should be built that can be used easily at lower costs, so that a stable cloud environment that many companies can use simultaneously can be developed and an ecosystem can be established to develop apps.

Verification Experiment, Business Scenario, Results
Redefine the border between competitive and cooperative fields. Can estimate the production situation by sharing stocktaking information and data on goods to be soon received. The production situation can be estimated if linking facilities dynamically.

The possibility of plants being effectively linked by redefining competitive and cooperative fields and establishing a system that causes fewer delays could be confirmed.
Global B2B After-sales service for remote location with call center

Companies will be able to offer high-level after-sales services even to customers in remote areas, if multiple manufacturers jointly set up and run a call center and use ICT to deal with problems. They also need to work together in order to detect problems in the early stages, gather information and offer repair services in remote areas.

The feasibility of an IoT-based call center was confirmed from a technical perspective. However, what is the most important is to gain an understanding of connecting customers’ machines to a network from customers.

Original Concern
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Members
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OHTAKE NOODLE MACHINE MFG
Mitsubishi Electric
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IHI
Sumitomo Electric Industries
CCS
Area: Emerging IoT technologies for production line management

Interoperable life cycle management for equipment and production line

Members

Yazaki Parts
Nikon
T.B.TECH
Towada Electronics
NEC
Hitachi Solutions
Mitsubishi Electric

Surveyed product: Wiring harness for automobiles
- Surveyed plant: Wiring harness assembling plant
- Surveyed processes: Process to install electric wires constituting a wiring harness as well as processes to cut the wires and apply pressure to bond them

Original Concern
Equipment users cannot estimate the costs needed to address issues associated with the life of devices (equipment life cycle). (Amount and proper time of investment, actual production capacity, frequency of maintenance, and other factors.) On the other hand, equipment makers cannot figure out how customers use the equipment. It means that data on actual capacities of equipment is not gathered or managed. Thus, the challenge is: The “equipment life cycle management” activities need to be designed to help improve the total cost performance of the equipment in its whole productive life.

Final Goal
Improve the total cost performance of equipment by promoting equipment life cycle management activities and take advantage of it in various scenes in corporation activities.

Workers and maintenance staff will be able to monitor the conditions of equipment and provide maintenance quickly wherever they are. For officials who make decisions on capital investment, it becomes possible to make proper decisions about capital investment based on actual capacities of equipment and estimates. And equipment makers will be able to design features that users want to be added to the equipment.
Dynamic production optimization by simulation integrated CPPS

Quickly revise the plan to maintain the productivity of manufacturing based on the real-time production line conditions and dynamic simulation, when equipment problems or other issues occur.

Original Concern
When certain changes, such as ones in customer demand and equipment problems, arise in the production line, (1) it takes a long time for relevant departments to hold discussions and reach an agreement before deciding countermeasures, and (2) whether the countermeasure is the optimal way to maintain the ideal conditions of the production line is still unclear.

Final Goal
Maintain the ideal conditions of the production line by continuously updating the implementation plan, detailing which machines to use in the very hour and which production lines to use to manufacture the product, based on the operational status of the plant. Also make it possible to devise mid- to long-term plans to produce items while ensuring the feasibility of operations of the production facility, using such production control data. Furthermore, phenomena that cannot be predicted through separate efforts by each plant will become able to be forecast. To achieve that goal, data on multiple different plants that have the same production model as integrated facilities, or similar equipment, should be collected and integrated instead of each facility or plant gathering data separately.

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Tokyo University of Science
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MITSUBISHI HITACHI
POWER SYSTEMS
Kawasaki Heavy Industries
Real-time sensor data acquisition and analysis using multi-vendor network

A verification experiment system for assembly lines was built to evaluate the feasibility of the business scenario to control changing points.

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Toyota Motor
Nakamura-tome Precision Industry
NISSAN MOTOR
JAPAN AUTOMATIC MACHINE
Hitachi
Honda Motor
YAMAZAKI MAZAK

Original Concern
When an equipment problem happens, suspending the production line and causing a huge financial loss, relevant staff have to work to handle the emergency.
To identify signs of equipment failures, minimize the quality variation and ensure the quality of processing, (1) data on changes in equipment and products should be collected during the production process; (2) data should be gathered in a way relations between machines and workers in the processing and assembly lines are maintained, as machines and humans interact with each other in those lines.

Final Goal
Not depending on the equipment maker, it will become possible to gather necessary and sufficient data to identify signs of equipment failures without developing a new system each time, even when it later becomes necessary to collect additional different data. It will also be possible to detect signs of equipment and product abnormalities by taking advantage of the high quality big data to figure out mutual relations and conduct an analysis. The analysis results will be shared and effectively used by relevant departments so that they can prevent equipment failures and defects. Such efforts will lead to the improved efficiency of measures to reduce the down time to zero as well as the enhanced product quality and the improved yield rate.
Introduction of IoT and data analysis for old equipment

Theme of verification experiment:
Predictive maintenance for accessories of old equipment

Original Concern
Production sometimes stops due to abrupt equipment suspension (long-time breakdown). Many people have to make efforts to quickly repair the equipment and cover the production loss. The challenge is to address unclarity when equipment breaks down or defects arise.

Final Goal
If predictive maintenance becomes possible based on the real-time data analysis, the down time caused by abrupt, long-time break downs can be reduced drastically, or to zero, allowing workers to stick to the production plan. The maintenance process will be able to be conducted according to plan, so the time and costs needed for maintenance could also be reduced. Maintenance work is equalized and it becomes possible to assign maintenance personnel in the optimal way. As a result, more workers will become able to be dispatched to productivity improvement activities and other efforts.

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Interface
Honda Motor
Mitsubishi Heavy Industries
Sony Global Manufacturing & Operations Corporation
National Institute of Advanced Industrial Science and Technology
Cloud based simple monitoring scalable for legacy production line

**Business scenario** Identify real-time abnormalities in test results and provide maintenance in a timely manner. Accumulated data is also analyzed to determine the causes of the problems.

**Results** A camera-based simple equipment data gathering system, along with a cloud-based technology to quickly detect abnormalities and signs of failures and to analyze the causes of problems, were tested. The feasibility and challenges of those systems could be confirmed.

### Data provider
- 3-dimensional measuring instrument display
- Web camera
- PC for image processing

### User of data
- PC to check cloud data
- Web check
- Smartphone
- E-mail check

**Original Concern**
Equipment maintenance data is expected to be combined with IoT and cloud technologies to maintain and improve the production capacity of plants, but it is difficult for manufacturing facilities to collect and share data from equipment in terms of stable operations and costs. The challenges are early detection of production failures, simple methods to gather data on equipment operations, and prevention of a recurrence through the accumulation and analysis of data on equipment operations.

**Final Goal**
Data gathering will become possible with a simple external system, promoting the digitization of equipment maintenance data even at production facilities where manufacturing lines are frequently altered because of the shorter product life cycle as well as old plants where it is difficult to directly collect such information. Consequently, early responses to problems will become possible by detecting abnormal trends before anomalies emerge.

By analyzing and using the accumulated data, the causes of problems and signs of failures will be identified, so that periodic checks and maintenance work will be improved, manufacturing conditions will be optimized and abnormal trends will be detected much more accurately. The plan-do-check-act (PDCA) cycle of data gathering, detection and maintenance, analysis, and improvement, will be established to further improve equipment maintenance services.

### Members
- NEC
- Sumitomo Electric Industries
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- ASAHI GLASS
- Sony
- Hitachi Industry & Control Solutions
- Mitsubishi Heavy Industries
- Sony Global Manufacturing & Operations
Area: Platform for connected world in design and manufacturing

Communication robot for autonomous MES connected among factories

- Production direction MES transcending borders of companies: Timely instructions issued by customer to supplier
  Companies can cooperate with each other and take countermeasures in a timely fashion by linking their plants and sharing information about production directions.
  → MES data shared among two plants
  Data useful to quickly modify the production plan during accidents was collected for a verification experiment (experiment now under way). "Quality check equipment errors" (detection of abnormal values) and other MES data were used as leading indicators for production plan modification at linked plants.

- Use of robots at plants: Use of robots to help share information and reduce the manpower
  Help reduce the manpower at plants by combining cloud technology with robots
  → Developed apps using Pepper and used them in the verification experiment
  1. App that can manipulate Pepper: Can order Pepper to utter certain words or do specific actions
  2. Remote control app: Can manipulate Pepper on tablet devices remotely. Work with highly accurate location measurement data on UWB devices.
  3. Line tracer app: Pepper can run on lines autonomously
  4. Links of equipment - Company cooperation app: Companies can share and integrate their information through Pepper

Original Concern
At manufacturing facilities of small and midsize companies, fewer manufacturing execution systems (MES) have been introduced and automation has not been promoted sufficiently, forcing humans to handle most of work management operations by themselves. Because of that, various operations from handling of abnormalities in the company to production directions for suppliers take much time. Under such a situation, companies need to take countermeasures together by sharing and combining data transcending borders of corporations.

Final Goal
Problems that occur at manufacturing facilities of small and midsize companies will be quickly solved by connecting multiple factories and processes and sharing and combining their information, although handling of accidents used to require a huge amount of work. A reference model will be established to share necessary information in a timely manner and combine such data, so that the "visualization at plants" that covers multiple factories and processes will be realized.
It is said that plant data integration transcending borders of companies will highly likely be essential to expand business globally in the future. With that in mind, verification experiments on linked plants (smart factory) will be conducted, while technologies in Japan's realm of expertise (such as artificial intelligence and robots) will be used to expand knowledge about methods to establish and use new systems. Through such efforts, a wide range of verification data will be gathered and evaluated.

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Mitsubishi Electric
Frontier-One
ITOCHU Techno-Solutions
Beckhoff Automation
Ritsumeikan University
Konica Minolta
Toyo Business Engineering
**Cyber dashboard for design and engineering of unexpected design change**

**Put heads together to quickly solve issues**

The results of the verification experiment showed it is important to prepare an MES (BOM) in early stages of production preparations and that it took 3 minutes to identify affected equipment and relevant officials in this case. Meanwhile, some working group (WG) members said they "want to use the suggested 'kaso obeya dashboard' at manufacturing sites if it is commercialized."

**Original Concern**

Manufacturing workers routinely deal with many unexpected incidents. How to handle accidents heavily depends on the person’s knowledge and experience, so accidents could lead to omissions in discussions or setbacks that could eventually result in huge losses in labor and time.

A method called "obeya katsudo" (large room activity) is a way to concentrate resources on efforts to address unexpected problems so that they can be promptly settled. Meanwhile, the MES includes bills of materials (BOM) and other various important information that could be used to help solve problems. It is becoming increasingly difficult to concentrate plants and other facilities on a single site, as the globalization of business advances. Within that environment, a place is essential where people can make full use of the MES and digital technology as well as put heads together to solve problems.

**Final Goal**

The MES, used for executing manufacturing operations at sites of mass production, includes BOM and other various important information that could be used to help solve the problems mentioned above. With that in mind, we propose the "kaso obeya" (digital large room) method. Under the method, the concept of "obeya katsudo," the MES and the latest digital technology will be combined to offer a "place where people can put heads together so that they can quickly settle issues that are difficult to predict in advance."

Even people working away from each other can be linked, realizing a plant environment where mass production and preparations for manufacturing will be integrated and promoted in a seamless manner.
Agent based location free manufacturing in dynamic supply chain

Original Concern
When companies are abruptly requested by their customers to increase the production so drastically that the requested production exceeds their existing capacity, (1) it takes time to seek new suppliers that can help address the situation. (2) Even when prospective suppliers can be found, it also takes time to evaluate and confirm whether they have sufficient mass-production capacity. The challenge is to establish a system to quickly and flexibly respond to various requests from customers based on a proper supply chain.

Final Goal
If non-confidential information on suppliers that purchase departments of customer companies currently have is stored in an open database, and quick access to it is provided for anyone, companies will not need to seek and evaluate suppliers by themselves, which will help improve their business efficiency. Using agents as a mediator, companies will share digitized information on suppliers. Through such efforts, customer companies will be able to select the appropriate supplier easily from many candidates.
Knowledge of bill of production process for E-BOM to M-BOM traceability

Original Concern
Today, companies are in an environment of: (1) life cycle time reduction, (2) fiercer cost competition, (3) responses to diversification of markets and rapid changes, and (4) growing needs for traceability.
The challenge of the WG is that engineering data (BOM) on processes ranging from design to manufacturing is not linked. As a result, companies frequently suffer setbacks in the design process but the experience is not used to improve the future design work; the standardization of equipment, jigs and tools is not promoted, requiring more time and costs; the data on traceability is not used to improve the design process.

Final Goal
The details of the setback handling design, including traceability data, will be associated with the engineering BOM (E-BOM) - the results of design work - through the BOP, making it possible to use the revised information for improving the future design process. As a result, a system will be established that will reduce the number of the same setbacks and after-sales problems as in the past every time the design process is repeated. Furthermore, it will also become possible to compare machining data with the BOP and to use the machining data to improve the design process, if the E-BOM, the BOP and the manufacturing BOM (M-BOM) are combined and the MES is used in a coordinated manner.

Members
TOYOTA CENTRAL R&D LABS
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NEC
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MITSUBISHI HITACHI POWER SYSTEMS
Keio University
ITOCHU Techno-Solutions
Toyo Business Engineering
Nihon Unisys
Mass-customization for end users directory connected to factories

Original Concern
To date, efforts have been made to design and produce each product separately in order to fulfill requests from individual users. But the method is inferior to the conventional make-to-stock system in terms of the operating rate for equipment and the delivery lead time. Companies normally separate the fundamental components from optional parts, so that they can manufacture a large variety of customized products just by replacing the optional components. Meanwhile, if those optional parts available cannot meet customers’ needs, firms design and produce new products each time they receive such orders.

Final Goal
Deliver “the unique product specially designed for the user” to customers by making customization proposals based on the users’ preferences, accepting tailor-made orders and producing such goods in the shortest lead time without having inventories. In the series of processes, an environment will be realized where customers can place orders after checking the delivery date of products and manufacturers can provide original parts designed by customers. As for after-sales services, we are looking to provide a sense of pleasure and excitement for users of our products by monitoring how our goods are used and offering proper after-sales services based on the way customers use them.

Members
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MISUMI
Mitsubishi Research Institute
Area: New era of human centric manufacturing powered by IoT

Proactive machine communicating with workers in IoT environment

1. Make a numerical estimate based on data that shows how process delays could affect the future operations if no proper measures are taken.
2. A verification experiment on a system to automatically monitor changeovers and processing work by Kinect-based machining equipment.
3. Consider gathering operational information and sensor data in an integrated manner from computer numerical control (CNC) processing machines made by different companies.

[Results]
1. The feasibility of a motion sensor (Kinect)-based system to monitor the activities of machine operators at machining plants could be confirmed through a verification experiment.
2. A data use scenario and a data model designed for that purpose could be examined to make full use of machining equipment information.

Members
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Original Concern
An increasing number of numerical control (NC) processing machines and other automated production devices have been introduced, but transfers, changeovers and other operations by humans are not managed properly. As a result, the total control level has not improved significantly. The challenges are, (1) at machining plants, the progress and burdens of human operations are not managed properly, and appropriate planning and progress control is not ensured, (2) the efficiency of automated equipment has not been sufficiently improved due to the involvement of humans in monitoring and maintenance operations. To solve the issues above, an integrated management system to promote communication between humans and equipment should be considered.

Final Goal
(1) The productivity will be further enhanced by the possibility to monitor the real-time conditions of various equipment and workers, and enabling equipment and humans to share information at a higher level to cooperate with each other. (2) It will become possible to always detect gaps between planned results and actual figures and conditions, allowing workers to quickly respond when a certain problem occurs. (3) The quality of judgments and decisions by humans will be improved and humans will be allowed to be involved in equipment and other operations in a more efficient fashion, if data is analyzed properly in a timely manner and presented to humans. (4) It will become possible to properly control operations even when a problem happens, if conditions of plants are monitored through data so that the real-time conditions of remote plants and multiple factories can be figured out.
Remote consulting service of production engineering by bill of process information

A verification experiment was carried out to remotely gather production data of facilities in distant areas and to digitize the manufacturing knowledge.

**Original Concern**

"Employees frequently misunderstand work instructions. Although the managers believe their subordinates correctly understand what they said, they sometimes misunderstand the directions." Even when the instructions are very simple, there are communication gaps, such as tacit consent, between the sender and the receiver of the message. Thus problems arising from misunderstanding and changes in decisions routinely occur in manufacturing plants and facilities outside Japan. Companies have been working to make their instructions properly understood (P: Plan) (D: Do), so the challenges are how to check if the directions are correctly understood (C: Check) and what countermeasures to take (A: Act). To make instructions correctly understood, efforts will be made to improve the bill of process (BOP) and to properly control QCD risks.

**Final Goal**

1. Even when the master information is changed due to job-order production or for other reasons each time, the core information will always be properly managed and conveyed.
2. Even when products are made in different ways from usual or the produced items are customized ones, the manufacturing information will be accumulated and used to improve the future production and development processes.
3. Data on production and improvement efforts by workers will also be collected, making it possible to learn from such data and obtain new knowledge semi-automatically.
4. Tacit knowledge, such as how skilled engineers operate machines and conduct changeovers, will be identified and converted into information available to anyone.
5. Categorize the BOM and BOP into master data and data on customized products so that they can be managed in accordance with product types.

**Results**

Confirm that the identified problems are consistent with reported defects. The results showed what is important is to introduce lax categorization criteria.

**Members**

Hitachi
BROTHER INDUSTRIES
Okuma
Mitsubishi Heavy Industries
Computer Engineering & Consulting
JTEKT
Advanced quality assurance by connecting data - Toward 0 failure production

Quality assurance based on data integration has huge repercussions and benefits a wide range of people.

<table>
<thead>
<tr>
<th>S1</th>
<th>Process / department</th>
<th>S2</th>
<th>Final check site</th>
<th>S3</th>
<th>Meeting site</th>
<th>S4</th>
<th>Process that caused problem</th>
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<tbody>
<tr>
<td>As-is</td>
<td>Data stored by each department</td>
<td>DB</td>
<td>DB</td>
<td>Meeting</td>
<td>Suspension of line</td>
<td>Identify cause</td>
<td>Countermeasure verification</td>
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<td>Format not unified</td>
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<td>Checker</td>
<td>Group leader</td>
<td>Procurement official</td>
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<td>To-be</td>
<td>Format unified to combine data</td>
<td>Obtain chronological data</td>
<td>Meeting</td>
<td>Suspension of line</td>
<td>Identify cause</td>
<td>Countermeasure verification</td>
<td>Restart of line</td>
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<td>Checker</td>
<td>Group leader</td>
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<td></td>
<td>Establish model to identify correlation between cause of defects and chronological data</td>
<td>Establish model to identify correlation between signs of defects and chronological data</td>
<td>Meeting</td>
<td>Suspension of line</td>
<td>Identify cause</td>
<td>Countermeasure verification</td>
<td>Restart of line</td>
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<td></td>
<td>Checker</td>
<td>Group leader</td>
<td>Procurement official</td>
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<td>Group leader</td>
<td>Engineer</td>
<td>Group leader</td>
<td>Worker</td>
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<td>Group leader</td>
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<td>Quality assurance official</td>
<td>Worker</td>
<td>Quality assurance official</td>
<td>Worker</td>
</tr>
</tbody>
</table>

- A reference model for the business scenario (products, value, information and activities) was defined.
- Possible cooperative areas were identified under the considered business scenario.

Members
Canon
FUJITSU ADVANCED ENGINEERING
Canon IT Solutions
JTEKT
Nikon
NEC
Hitachi
Bosch

Original Concern
It takes time to gather and analyze information needed to identify the causes of product defects, because workers from various departments are involved in the defects reported in a production line. The difficulty is due to situations such as, (1) needed information is not managed in an integrated manner, (2) it is difficult to find a correlation between the cause of defects and the gathered data.

Final Goal
(1) It will become possible to drastically reduce the time and personnel needed to identify the causes of defects and take countermeasures against them. (2) The optimal machining conditions will be presented if data on materials to be processed (parts and ingredients) is combined with information on machining equipment operational conditions and status. (3) The number of orders and inquiries will increase if the system can ensure high quality, low costs and quick delivery. (4) Even when high-level quality control is required, the custom production of high quality products meeting customer needs will be ensured.
Robotics line building for SMEs using cloud knowledge database

Establishment of a database (DB) containing design information on past manpower reduction and automation projects using robots

1. From the database, small and midsize companies obtain data on the introduction cost, the effects and relevant contact information gathered in past similar projects.
2. Line builders and system integrators use design information collected in similar projects to reduce the man-hours needed for the planning and design processes.

The significance of the key point (database establishment) has been clarified through the consideration of the business scenario.

- It has been confirmed that a loose connection between companies that is formed through a database, where digitized data is prepared and accumulated, can offer great convenience.
- It will become important to improve the database and its usability from now on. To achieve that, we have started cooperating with another group (RRI-WG2).

Original Concern
While small and midsize enterprise (SMEs) without own production technology departments expect robots to help them meet requests for productivity improvement, personnel securement, production of multiple models in smaller lots and other topics, sufficient robots have yet to be introduced by those companies.

The reasons for that are, (1) there is demand for robots designed to reduce the manpower, but companies do not have knowledge and information needed when introducing robots, (2) design information on past similar instances is not shared in discussions and design talks between line builders and system integrators (SIer), so the man-hours (cost) cannot be reduced for the system integration (SI) process.

Final Goal
As part of efforts to improve the productivity, even small and midsize companies that do not have their own production technology departments will become able to easily consider the effectiveness of the introduction of robots in a one-stop manner, if they outsource work to line builders that partner with system integrators specializing in various different fields. As common information infrastructure, the database will not only help promote the business efficiency of all companies in the industry but also urge new system integrators to enter the business. Standardization will also be promoted through the process of establishing the database. Data on the layout of robots and other production equipment, as well as other various information, will be accumulated in the database. By reusing such information, it will become possible to reduce the man-hours needed for system integration after the introduction of equipment.

Members
YASKAWA ELECTRIC
Computer Engineering & Consulting
Towada Electronics
JAPAN AUTOMATIC MACHINE
Mitsubishi Electric
Honda Motor
Mitsubishi Research Institute
HONDA TSUSHIN KOGYO
Nihon Foresight Robo
Hitachi Industry & Control Solutions
**Standardization of working styles in “Man-Machine collaborative factories”**

**Means 1** Prevent product defects with a timeline, visualization of operations and monitoring of human movements

**Means 2** Equalize burdens by learning exceptional techniques of skilled workers based on a production plan that combines the work skill database with information on equipment operations

**Means 3** Personnel assignment based on the work skill database

<table>
<thead>
<tr>
<th>Prevention of product defects</th>
<th>Results of verification experiment</th>
<th>To do</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Timeline</td>
<td>Management of signs of problems and prevention of accidents through combining databases for personnel, materials and maintenance</td>
</tr>
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<td></td>
<td>Visualization of operations</td>
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<tr>
<td></td>
<td>Monitoring of human movements</td>
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<tr>
<td>Equalize burdens by learning exceptional techniques of skilled workers</td>
<td>Production plan (home position) that combines work skill database with data on equipment operations</td>
<td>Handing down of skills and equalization of work burdens through creation of database of exceptional techniques of skilled workers</td>
</tr>
<tr>
<td>Assignment of workers</td>
<td>Person assignment based on work skill database</td>
<td>Health management (Measure health conditions, morale)</td>
</tr>
<tr>
<td>Improvement of work environment that takes into account movements of humans</td>
<td>Motion analysis, monitoring of moving objects</td>
<td>Cooperation between robots, humans (Enable robots to replicate exceptional techniques of skilled workers)</td>
</tr>
</tbody>
</table>

**Members**

Toyota Motor  
Nihon Unisys  
JTEKT  
SHINWA  
OMRON  
Kawasaki Heavy Industries  
MEIJI ELECTRIC INDUSTRIES  
Hitachi

**Original Concern**

Sufficient things and services related to "person to person" (P2P) and "machine to person" (M2P) have not been prepared. A common interface (I/F) should be developed to support the floor management (personnel, quality, operations, skills, health management, personnel development and other factors).

**Final Goal**

(1) Support human efforts to analyze the causes of problems by integrating databases for materials, machines and human resources and providing information on their correlations, so that signs of problems can be properly managed and problems can be prevented. (2) Enable even unskilled workers to replicate difficult machining operations by identifying conditions for good quality products with various sensors and creating a database of skilled workers' excellent techniques. (3) It will become possible to quickly assign personnel in the optimal way, if various information for personnel placement is combined with the personnel assignment system.

By achieving the goals above, the WG aims to establish a model system where humans and machines help each other enhance their capabilities at plants, so that the factories can become places where humans play a leading role in realizing the "dantotsu" (outstanding) manufacturing system.
An Outline of Smart Manufacturing Scenarios 2015

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