An Outline of
Smart Manufacturing Scenarios 2016
Smart Manufacturing Scenarios 2016

The Industrial Value Chain Initiative (IVI) is targeting to turn linked factories and connected manufacturing into reality. To achieve this goal, representatives of IVI member companies bring present situations in real industrial scenes into discussion to identify issues 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 addressed by 15 Business Scenario Workgroups (BSWGs) out of 25 groups in the Japanese fiscal year 2016 will be introduced. In each workgroup, members from different enterprises brought in ideas and executed demonstration experiments to achieve a realisation of the smart manufacturing scenario. In 2016, under a new framework of platform ecosystems, 12 IVI platforms were registered to be applied in verification experiments of BSWGs. The provided solution platforms are divided into eight categories shown in the table below. As they can be also regarded as areas where BSWGs have concerns, the 25 groups are classified in the eight categories.

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IVI Ecosystem

In 2016, IVI extended the framework of activities in order to foster an ecosystem of connected manufacturing. In the ecosystem, BSWGs create use cases from real-life scenarios. Meanwhile, platformers play a role to provide them with solutions by “IVI platforms”. Platform WGs develop a reference model specifying items that a platform should fulfill and evaluate IVI Platforms based on it.

Platform Categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
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<tbody>
<tr>
<td>Production Engineering Information PF</td>
<td>Considers the configuration of production lines based on design information as well as manages technical data on processes from prototyping to mass production.</td>
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<tr>
<td>Quality Management Information PF</td>
<td>Continuously improves QCD by data on quality, technologies and operations at plants.</td>
</tr>
<tr>
<td>Production Planning and Control PF</td>
<td>Makes dynamic control of production lines according to a change in plan, specification or shop floor condition possible by managing manufacturing progress data.</td>
</tr>
<tr>
<td>Supply Chain Management PF</td>
<td>Exchanges data necessary for supply chain or engineering chain among companies in a secure manner.</td>
</tr>
<tr>
<td>Small Sized Enterprise Information PF</td>
<td>Integrates significant functions for production management of SMEs by combining “selling”, “purchasing” and “manufacturing”.</td>
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<tr>
<td>Preventive Maintenance PF</td>
<td>Manages data for failure prognosis of equipments beyond boundaries of companies/plants to take countermeasures as needed.</td>
</tr>
<tr>
<td>Asset and Equipment Management PF</td>
<td>Utilizes equipment operation data for production management, quality control and improvement of overall equipment effectiveness.</td>
</tr>
<tr>
<td>Maintenance Service Management PF</td>
<td>Monitors utilization of products after selling in order to provide service such as repairing support and preparing spare parts.</td>
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IVI Platform

AN IVI PLATFORM IS A SYSTEM OF SYSTEMS FOR CONNECTED MANUFACTURING, CREATING VALUE FOR END-USERS BY MAINTAINING INTEROPERABILITY AMONG PLATFORM COMPONENTS CONSISTING OF “APPLICATION”, “DEVICES”, “INFRASTRUCTURE”, AND “TOOL”.

✓ The primary aim of IVI Platforms is to enhance the value for manufacturers.
✓ The platform is an open basis to create an ecosystem by providing profile specifications of each component.
✓ Data is owned by the enterprise, so that bottom-up system improvements are possible for the enterprise by itself.
Original Concern
Although a lot of companies make use of checklists and procedure manuals, in reality there are problems such as (1) estimation and process design are dependent on the manufacturing know-how of individual workers, (2) Some public know-how including JIS and ISO standards are described in a literary language, (3) the three charts of manufacturing (process tree, QC process chart and work instruction) are a compilation of Japanese-style manufacturing with optimizing techniques, different from enterprise to enterprise, and (4) checklists are not completely utilized because their operation is considered an inefficient increase in man-hours.

Verification Experiment, Verification Experiment
The workgroup aims to develop a BOP (bill of process) which is a manufacturing requirement model enabling accurate transmission of requirements. By using the BOP, estimation at high accuracy becomes possible. Process designing requiring inspections will be addressed in “upstream management”. The point of the reform is to enable automatic chart checking by managing each unit of product item as BOP in linkage with the operation procedure and inspection items. The project verifies that the automatic chart checking ensures manufacturing products at a constant quality regardless of the level of workers. In the experiment, a BOP was developed based on manufacturing information collected from a broad range of processes on the shop floor including cleaning and fastening operations in an assembly process and a board mounting process. In addition, automatic chart checking of BOP by “BOP CHECKER” was verified. It was proved that regardless of the size or form of the enterprise, a unification of a data system by creating BOP with manufacturing information would enable automatic chart checking in competitive and cooperative areas as well as contribute to reduction of man-hours and improvement in quality.
Connection of Information on Production Preparation at Design Change

Members
FUJITSU
FUJI ELECTRIC
Sony Global Manufacturing & Operations Corporation
IHI
Computer Engineering & Consulting
Toyo Business Engineering

Original Concern
In conventional manufacturing practices, each worker's skill was decisive to collect necessary information for linking design and production preparation operation at the right time, or to take countermeasures upon change of designs. Thus, omissions and errors were unavoidable. The causes are problems in (1) transmission and management of information and (2) operations to react to design change.

Final Goal, Verification Experiment
By developing a “digital obeya/big room (IVI_PLM Platform)”, it becomes possible to shorten time for collecting information by unified management of information on design changes, as well as to extract outputs at the same quality by enabling confirmation of the changes on the platform. Moreover, realtime connection of production information with design information enables to provide feedback information to optimize manufacturing for the design. The goal of the project is to synchronize all the instruction changes on the shop floor by reflecting a design change in the production preparation system. The verification experiment aims at a reduction of man-hour by 40% in the targeted operations.
**Utilization of Robot Program Assets by CPS**

**Original Concern**
To date, it was not easy to operate industrial robots from multiple vendors efficiently together since methods for adjustment and teaching were different depending on the enterprise. The reason was that it was necessary to learn different operations and programming methods for each vendor in order to adjust and maintain peripherals devices (vision, aesthesia sensors, etc.) that provide robots with multiple functions as well as to teach robots.

**Final Goal, Verification Experiment**
By utilizing a CPS (Cyber Physical System), adjustment and teaching after introducing robots will be simplified. The workgroup develops a system to store data on digitized program information of robot motions in a database by using a common simulator on the CPS. The system enables reuse of the data. When robot motion programs are created with a common simulator, targeting motions which are not dependent on each vendor and such programs are accumulated in a database, they can be distributed in an enterprise, or more broadly, among multiple enterprises. In the project, it was verified that the common simulator could significantly reduce man-hours to launch multiple robots. It became clear that extracting common motions of robots and developing a database are future tasks to be addressed.

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**Members**
YASKAWA ELECTRIC
Mitsubishi Electric
Hitachi Industry & Control Solutions
Computer Engineering & Consulting
HONDA TSUSHIN KOGYO
NEC
Mitsubishi Research Institute
Konica Minolta
Panasonic
ASAHI GLASS
**Original Concern**

Upon inquiries about a product defect from customers or market, it used to take time and effort to react because every operation process and quality information had to be examined to identify the cause.

**Final Goal, Verification Experiment**

Utilization of trace of quality data is an effective method to solve such a problem. In the (desktop) experiment, a system to connect “traceability of quality data” of parts with product compositions, operation process and quality information was developed. Then effectiveness of the system was verified. (1) It was proven that upon inquiries about sudden defects from customers, the system utilizing IoT could improve efficiency and effectiveness of measures. (2) Moreover, relation/correlation to improve quality were analyzed by matching quality data of multiple parts. The result was used in simulation of kitting parts to improve product quality and efficiency of parts usage (cost reduction). Through such demonstration, the project will show how the system can be utilized.
Original Concern
It takes time for shop floor workers to understand the condition of production lines and optimize it. It is difficult to react to dynamic changes in situations like an urgent order. This sets limits to the efficiency of the production process planning.

Final Goal, Verification Experiment
The production lead time can be shortened by utilizing IoT for collecting realtime data on workers and things, as well as changing production schedules timely, by a dynamic management simulation. In the project, the dynamic management of a supply chain was verified through data collection of production results and application of a production simulator with IoT technologies. Shortening dispatching time and production lead time was achieved, as well as a productivity improvement in assembly.
Position Control System for Things at Low Cost

**Original Concern**
When multiple products are produced in variable quantities on the shop floor, kinds and amount of materials flowing into the plant change every month. In case of materials with large size, a place to store (such as a transit warehouse between processes and a temporal storage space) is decided each time depending on the situation at the discretion of workers, since it is difficult to set up a fixed storage. Therefore, workers in the post-process waste time to locate the materials. Position management tools for free location systems are costly.

It is difficult to expand a storage space suddenly and temporarily since it will be required to develop communication infrastructure, deploy a large amount of sensors, spend more man-hours to manage the storage, and ensure space for temporal storage.

**Final Goal, Verification Experiment**
The workgroup develops a system to share image information of storage locations of products which the previous process finalized with the next process. A location information management system of things with image information will be developed through an experiment using real data and examining the results. It will be also considered how effort to take photos can be saved and how locations with similar views can be distinguished.
Original Concern
Any abnormality of logistics used to lead to serious loss of production since manufacturers were dependent on forwarders for transport of materials and could not take countermeasures immediately by themselves. The cause of the problems is that the whole supply chain is not visualized due to fragmentation of information in the supply chain and lack of shared logistics information among different parties.

Final Goal, Verification Experiment
In case of a vertically integrated enterprise group, information from each location such as overseas plants and suppliers is converted in an EDI base to standardized I/F (EDIFACT) data and integrated in a unique logistics database, so that a whole supply chain can be visualized. This project aims at enabling visualization of logistics for enterprises which are not vertically integrated by developing a “loosely defined standard” of an EDIFACT specification and a CSV data specification as its basis. Using a component for data conversion developed for the project, shipping data (such as data on export documents) by a overseas plant (the sender) is converted from CSV to EDIFACT, and it is collected in a system of distributors such as logistics companies and ocean shipping companies. The receiver can get the information when they need, and it enables to promptly react to a sudden accident by connecting the information to identifier of the manufacturer. By this experiment, it should be verified that EDIFACT data is easily produced by a system in an enterprise and information for production and logistics can be linked.

Members
TOSHIBA
NSK
Toshiba Logistics
Collaboration Among Companies Through Shared Process Information

WG No. 2G01

Image of a platform composition: It enables visualization of plan change and its history immediately responding to an interruption production instructed by order receiving staff or a change in specification.

Visualization between plants: Responding to plan changes or troubles, process information can be acquired and shared in realtime. MES data collection, unified management and utilization

Procedure of the verification experiment
1. Prepare a system and actual data based on the scenario.
   ① Kojima Industries, Scene of inventory shortage: Prepare parent-child data and material inventory data.
   ② Maruwa Electronic, Scene of inventory checking: Decide what kind of information should be displayed.
   ③ Maruwa Electronic, Scene of production schedule change (PSI): Modified production schedule of each of forming, coating, implementation and assembly will be displayed.
   ④ Maruwa Electronic, Report the experiment result of solutions by the combination of AI (IBM Watson) and Pepper for cases of troubles.

2. Conduct a verification experiment at targeted plants (Kojima Industries and Maruwa Electronic).
   ⑤ Actual data will be collected, analyzed and visualized by applying a platform and components.
   ⑥ The result and visualized information (such as charts and graphs) will be shared among the workgroup members.
   ⑦ Repeat the experiment process. New realizations and occurrence of unexpected situations will be recorded so that the information can be utilized in future.

Original Concern
In consignment production, delivery sometimes got delayed e.g. when a schedule changed. Process information such as production progress was not shared among enterprises or plants, and it was not clarified what information should be shown to others and what should be concealed. Due to that, enterprises were not able to swiftly react to meet the delivery date. To solve the problem, rules and a system to share information like production progress and process information are necessary. It is significant to develop a system for automatic collection of process information from equipment and operation processes on the shop floor, as well as a system visualizing plants by connecting such data among enterprises or plants.

Final Goal, Verification Experiment
The workgroup addressed visualization of information of plants by developing a cloud system and automatically collecting data from equipment and operation processes on the shop floor. In addition, process information to be shared with purchasers and suppliers including production progress, inventory and quality was discussed. The enterprises got one step closer to realization of “connected plants” by utilizing shared MES data.

Members
KOJIMA INDUSTRIES
Toyo Business Engineering
Frontier-One
Maruwa Electronic & Chemical
WingArc1st
Hitachi Industry & Control Solutions
ABeam Systems
IT Coordinators Association
Canon IT Solutions
ITOCHU Techno-Solutions
FUJITSU
Original Concern
Under the condition that domestic orders for mass production are decreasing, a key for SMEs to improve competitiveness is how well technical information can be shared and transmitted in irregular repeated production for trial manufacturing and development of new products or in acceptance of order for similar products. For example, in the aerospace industry, needs for the order entry form are changing from the conventional style each company in charge of a production process delivers products to orderers, to an integrated production style that a combination of SMEs taking charge of processes collectively receive orders and deliver completed products.

Final Goal, Verification Experiment
This project, with an aims to realize both conditions described above, develops a system enabling management of “open” information shared among companies and “closed” information to be accumulated within a company at the same time in a manner security is ensured. Firstly tacit knowledge on the shop floor is listed so as to extract information that needs be shared. In turn, it is planned to define “shared items” that should be open among companies and “individual items” such as manufacturing know-how that need to be closed.

Members
YUKI Precision
KONNO corporation
Denkaimakukougyou
Amauchi Industry
Econosupport
ABeam Consulting
Horizontal Integration of SMEs and Visualization of Process Information

Original Concern
In SMEs, information is mainly managed manually and the production progress is not reported and managed sufficiently since it becomes considerable workload for the shop floor. Every time there is an inquiry from a customer, administrative staff has to look for a responsible staff in the plant to get an answer. Thus, it takes time to provide a response to the customer. When it comes to an issue beyond the border of enterprises, the situation tends to get worse.

Final Goal, Verification Experiment
By introducing IoT (RFID), the project aims at enabling SMEs to automate management of production progress information of each firm, each process as well as outsourced productions. As a result, it becomes possible to respond to customers’ inquiries promptly and to make workers conscious about progress by enabling preparation of an upcoming process. Moreover, in an experiment, three enterprises could share information on the production progress by a platform.
“Inclusive predictive maintenance” that anyone can easily introduce will be realized by applying “IVI concepts” in the project driven by desires of shop floors to “see”. Setting challenging targets, the workgroup discussed services using collected big data and models that can be practically utilized. The objective of the activities is to develop standard models through creating use cases in as many shop floors as possible to

Of the 20 use cases created, 12 cases are shown in the upper right figure. As an example representing these verification experiments, an activity for predictive maintenance in the welding industry is introduced.

Original Concern
(Example: welding) The concerns at the beginning were: (1) Welding torches are managed by number of pieces and replaced. Workers would like to use welding torches until they will be unusable. (2) Since welding is a special process, the result can be examined only by means of destruction tests. It is desirable that all welded products be inspected easily without destroying them.

Final Goal, Verification Experiment
The aims of the experiment are: (1) to find out a way to extend the service life of welding torches, (2) to create a logic (standard model) capable of predicting failure of welding devices in real time as well as judging whether parts are successfully welded, and (3) as the final goal, to verify that edge computers mounted on welding devices can autonomously determine peculiarity of each device and anomalous thresholds, by having edge computer AI (artificial intelligence) learn the logic to evaluate welding quality. The system (as well as its economic benefits) will be considered in a manner it can be introduced in real production lines instantly.
Predictive Maintenance System to Detect Signs of Equipment Abnormality at Low Cost

Verification experiment — Abnormality and symptom detection: composition —

- A detection model is developed through analyses on collected data
- Conduct an experiment with the IoT Platform by Toshiba using simulated data

Original Concern
In plants, there is existing equipment that cannot be substituted, such as carrier devices. A part of daily checking done by workers are qualitative and sensuous, thus it is dependent on individual skills. Sometimes a sudden equipment failure occurs unexpectedly because a sign is overlooked. One way to solve the problem is constant observation. However, it requires high cost to install expensive sensors on existing facilities, and a negative impact on operation can be concerned.

Final Goal, Verification Experiment
This workgroup discussed on sensing methods at low cost without a harmful impact on equipment operation, and a way to detect and alert symptom of failure by analyzing collected data. Sensors and devices which are as inexpensive as possible were mounted on existing equipment as appendices or external apparatuses to build a system for failure prediction. By using idle lifting devices, sensor data (vibration, electrical current and sound) were collected and analyzed in normal condition and anomalous conditions which was generated artificially to create a failure prediction logic. It was confirmed that pseudo failures could be detected and alerted by use of a commercially available platform.
Original Concern
To prevent failure of production equipment and maintain performance, it is essential to perform periodical maintenance including replacement of consumables. Naturally, best possible maintenance efficiency (minimization and optimization) is desired. The balance of maintaining performance of equipment and optimizing cost for maintenance should be achieved based on visualization and utilization of data on equipment operation.

Final Goal, Verification Experiment
The point of the transformation is, by enabling realizing early detection of abnormalities, to ensure flexible adjustment of the maintenance and to inhibit expansion of the influence range so that time and man-hours to deal with it can be reduced. The workgroup conducted an experiment on (1) collection, accumulation and visualization of information on workers’ operations, sensing and equipment operation and (2) data modeling for predicting and capturing signs of failure and visualization of the results. A retrofitting system was introduced into old-style processing machines to visualize and utilize historical data. It was confirmed that both maintaining performance of equipment and optimizing maintenance cost could be achieved by smarter maintenance work.
Original Concern
In collaboration with the workgroup 2L01-1, this group addresses prevention of equipment failure and maintenance of performance through periodical maintenance, replacement of consumables, and improvement of maintenance efficiency (minimization and optimization). The balance of maintaining performance of equipment and improving efficiency of maintenance should be achieved by analyzing records to acquire knowledge and digitalizing maintenance information.

Final Goal, Verification Experiment
In the project, maintenance records of the past ten years were analyzed to extract correlations concerning failure, causes and methods to solve, and to systematize such knowledge. On the other hand, maintenance information combining visual information (photos and videos), sensing data and schedules were digitalized. It was verified that promotion of digitalization leads to a raise in quality and quantity of knowledge. In turn, it has effects on sophistication of all kinds of operations and tradition of knowledge.
Original Concern
In the last few years, equipment manufacturers make considerable efforts to develop technologies such as failure prediction by taking realtime data from equipment so that their products can be compatible with the trend of IoT/Industry 4.0 in an intense competition. This project is executing such a preventive maintenance scenario with real production data from a real company in realtime.

Final Goal, Verification Experiment
In the experiment, this workgroup aims to develop technology enabling provision of added value (such as prediction and prevention of equipment failure and direct contribution to improvement of customers’ product quality) to customers. The project targeted at equipment of a member of the workgroup, OHTAKE Noodle Machine MFG Co.,Ltd., that manufactures equipment processing instant noodles. The experiment was conducted in cooperation with an actual customer making noodles with equipment of OHTAKE Noodle Machine MFG.
The workgroup creates logic to collect data from equipment processing a major product, upload the data to a cloud, predict failure on the cloud, conduct analyses to stabilize quality, as well as control these processes. Based on that, the project aims to develop a system for the customer to visualize plants, predict equipment failure and optimize repairing parts so that the customer will be able to stabilize product quality and reduce manufacturing cost. Moreover, by monitoring status and operations of equipment, the information will be utilized to improve quality of equipment.

Members
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Mitsubishi Electric
NTT Communications
SATO
Nikon
ABeam Consulting
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