

# COLMINA: Manufacturing Digital Place to Create New Value in Manufacturing Industry

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Following Germany's Industrie 4.0 initiative, the United States, Japan, and China also launched national projects aimed at enhancing their manufacturing industries. As a result, a transformation in manufacturing sites is taking place. In the field of IoT, the ultimate goal is to use networks to connect facilities and equipment that incorporate sensors, and to maximize added value and cost reductions over the whole manufacturing process by enabling equipment to operate autonomously and cooperatively. It is also important to connect with partner factories via the Internet to optimize the entire supply chain. In the future, by linking manufacturing sites together, it will be possible to implement advanced "digital manufacturing" by making use of digital data. However, in many Japanese manufacturing industries, information is fragmented even within the same company's flow of design, production, and maintenance, making it impossible to link this information smoothly. To solve this problem, Fujitsu has devised an open platform, FUJITSU Manufacturing Industry Solution COLMINA, for the interconnection of all information related to manufacturing. COLMINA facilitates linkages on various levels, including the linkage of systems and know-how related to manufacturing in general, and the linkage of supply chains between corporations. This paper presents an outline of the COLMINA service.

## 1. Introduction

Following Germany's Industrie 4.0 initiative, countries around the world have been competing to transform their manufacturing systems. In the field of IoT, it is essential to use the Internet to connect facilities and equipment that incorporate sensors, and to maximize added value and cost savings over the whole manufacturing process by enabling this equipment to operate autonomously and cooperatively. We also aim to optimize the entire supply chain by connecting with partner factories via the Internet. For example, by establishing links between objects and between companies, it is possible to create new services and more advanced supply chains. In the future, by linking manufacturing sites together, it will be possible to implement advanced "digital manufacturing" by making use of digital data.

Fujitsu will provide a "connected service" that creates new value for the manufacturing industry by connecting practical manufacturing know-how,

factory systems and the like with know-how acquired through system integration (SI) and solutions. Also, as a platform for connecting manufacturing knowledge, we created a new manufacturing digital place called FUJITSU Manufacturing Industry Solution COLMINA.

In this paper, we discuss the product lifecycle management (PLM) in the manufacturing industry, and we present an overview of the COLMINA service including the supply chain.

## 2. Fujitsu's approach to digital manufacturing

Conventionally, the design sector has been a so-called virtual world business that has led to the production of real products on production lines in real-world factories based on information such as CAD data and drawings.

### 2.1 Interaction between virtual and real worlds

The Cyber-Physical Systems (CPS) of Industrie 4.0

is broadly divided into a cyber (virtual) domain that analyzes and verifies data in the digital world, and a physical (real) domain that collects all kinds of information occurring in the real world. To analyze and verify information gathered from the physical domain in the cyber domain, and to reflect the result in the physical domain, it is necessary to solve problems while these domains interact with each other.

## 2.2 Efforts in cyber (virtual) domain

Many businesses have not made progress in the introduction of ICT in upstream processes such as product R&D and design work, and in preparatory processes such as the collection of information needed for the production and design of facilities at production sites. However, with advances including the diversification of development centers, the utilization of digital data at manufacturing and maintenance sites, and global collaborative development initiatives, the use of information from upstream processes at an earlier stage is becoming increasingly important. Consequently, there is a growing need for support using ICT at each stage of the process and at each location.

For this reason, Fujitsu has established an in-house comprehensive design and development environment called the Flexible Technical Computing Platform (FTCP). Using FTCP, it is possible to use 3D data spanning the entire PLM from device design to production line design. In other words, FTCP provides, an efficient means of verifying the validity of product design information before starting production. Furthermore, in addition to using this information in the conventional design department, the same data can also be used when needed and in the forms required in the manufacturing engineering division, the manufacturing division, and the maintenance division.

In the manufacturing engineering division, design data is used to develop production preparation support tools such as FUJITSU Manufacturing Industry Simulation VPS and GP4. As a result, the manufacturing engineering division can reproduce the production line in a virtual environment on a PC, enabling production preparation tasks such as verification of productivity, workability, and layout to be performed efficiently and quickly.

In the manufacturing division, work and assembly instruction manuals can be displayed in real time

on-site PCs as digital manuals. Thus, even if a design changes suddenly, these changes can be rapidly confirmed at the production site. The contents of a design can be efficiently studied and examined while referring to CAD data displayed on-site PC.

In this way, FTCP is useful for the creation and co-creation of knowledge for various improvements in on-site work and work efficiency.

## 2.3 Efforts in physical (real) domain

In 2003, we introduced the Toyota Production System (TPS) at production sites. In 2006, we started work on transforming the development process, and while incorporating ICT into TPS through a process of trial and error, we have been applying the Fujitsu Production System (FJPS) at each factory in the Fujitsu Group. At approximately 20 Fujitsu Group production sites in Japan, we have implemented various innovative activities by practicing FJPS. From these in-house practices, we have created IoT-based solutions such as store picking carts and product location management. In particular, at Shimane Fujitsu, solutions are being created to optimize the replacement of parts in surface mount technology (SMT) lines such as SMT-Assist adapted to the mass customization of notebook PCs.

**Figure 1** shows how the usage records with reel parts (i.e., tape materials wound on to reels) is being connected in real time with the state of production on SMT lines to assist in efficient production through the use of work instructions in each process. In addition, as products produced through co-creation with clients, we are also using tools such as production status monitoring (FUJITSU Manufacturing Industry Solution VisuaLine), which is described later.

Fujitsu will develop these technologies related to the CPS of Industrie 4.0.

## 3. Overview of COLMINA

Manufacturing industries have so far been mainly concerned with making and selling goods, making it difficult to differentiate between the "exchange values" of individual objects or services such as their quality or function. In recent years, there has been growing interest in mass customization, where products are tailored to individual customers to suit their preferences and/or requirements. In the changes of the business environment represented by globalization of production and

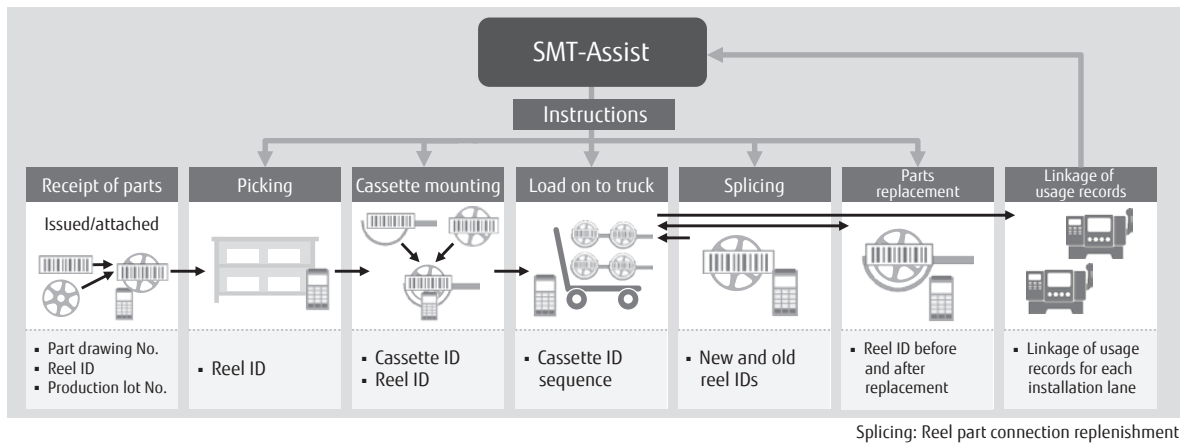


Figure 1 Improving the productivity of small lot SMT line (SMT-Assist).

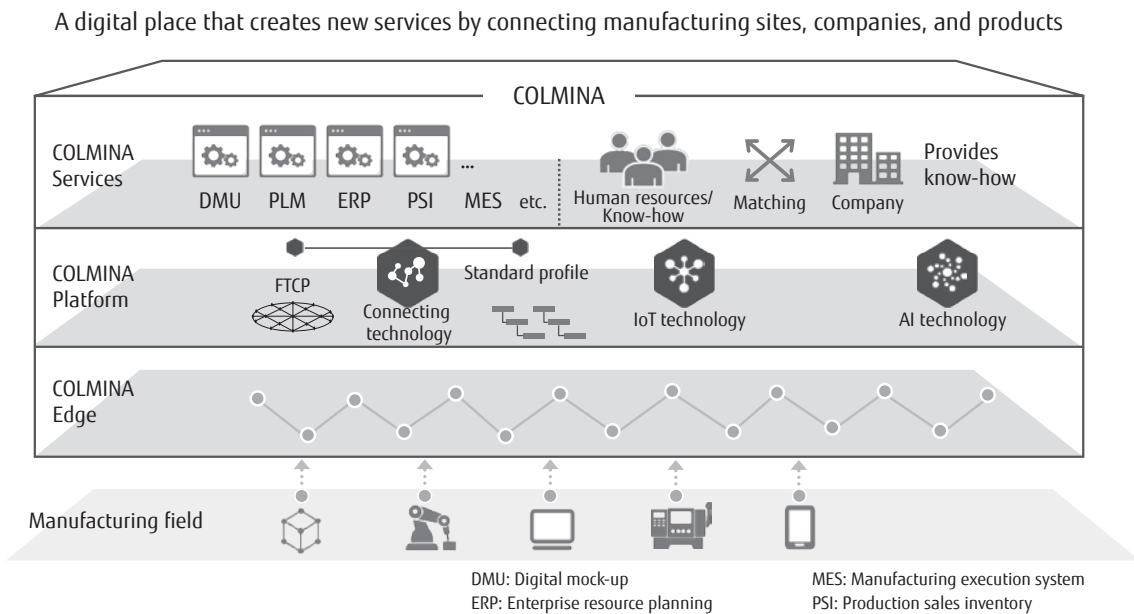


Figure 2 COLMINA system diagram.

commoditization of products, Japanese companies are facing the shift of customer’s pursuit of value in products and services from “exchange value” toward “utility value.”

At Fujitsu, we believe not only that production efficiency is increased by connections between manufacturing sites, those between companies, and those between products, but also that new business models and ecosystems will be created for the manufacturing industry. COLMINA realizes this vision by combining

Fujitsu’s manufacturing know-how with the systems engineers’ (SEs’) knowledge and know-how we have accumulated through our system integration (SI) and packaged hardware/software businesses.

In COLMINA, services are provided in accordance with the requirements necessary for customers by combining the following three levels (Figure 2):

- 1) COLMINA Services  
Provide groups of applications that use a COLMINA platform database or applications that have cooperative

interfaces with a COLMINA platform database.

At the same time, we are planning to provide a website where manufacturing industry customers can share information. We will develop a web forum that matches businesses with human resources and know-how.

#### 2) COLMINA Platform

Consists of a big data infrastructure and standard profile infrastructure, application programming interfaces (APIs) to COLMINA Services and COLMINA Edge access, and a system infrastructure (operation management, service infrastructure). In addition to a shared cloud type platform that is easy to use and a private cloud type platform that can respond flexibly to customer needs, we also offer an on-premises platform.

#### 3) COLMINA Edge

In addition to connecting with information from various items of equipment and sensors at production sites, this provides functions for cooperation with the edges and platforms of other companies.

### 4. COLMINA Services

In COLMINA Services, we provide added value on a service infrastructure that satisfies the "connecting" platform requirements of digital manufacturing.

#### 4.1 COLMINA service group

COLMINA Services consists of the COLMINA certified service group and COLMINA standard service group. The benefits of each service are as follows:

##### 1) COLMINA certified service

In this service, we provide an environment that incorporates procedures for connecting information on existing business solutions with a standard profile and using them as knowledge, regardless of whether products are manufactured by Fujitsu or another company. The added value that is created and/or provided consists of the following five parts:

- Implement mass customization (connecting businesses)
- Improve the supply chain (connecting enterprises/centers)
- Pass on manufacturing know-how (connecting craftsmanship)
- Create new services (connecting customer needs)
- Open innovation (connecting development environments, people, and skills)

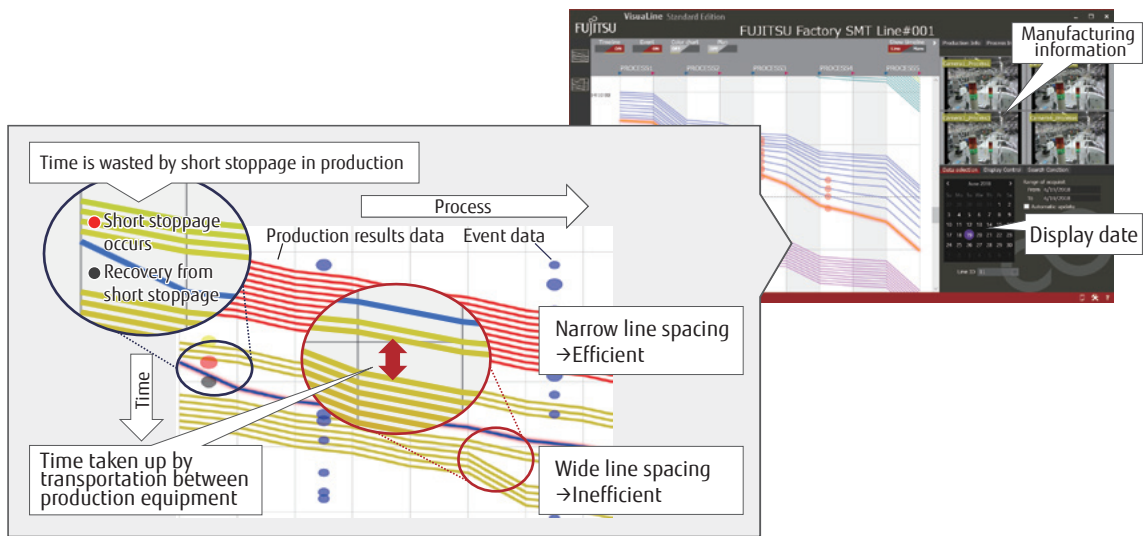
##### 2) COLMINA standard service

This service is installed as standard in COLMINA and provides added value through the visualization, analysis, and evaluation of information required on site. The original information is collected from the systems horizontally and vertically integrating PLM, enterprise resource planning (ERP), and manufacturing execution systems (MESs), which are the backbone systems of the manufacturing industry, and is stored in COLMINA. We also use reference models that are practiced at factories in the Fujitsu Group, support services such as improvement or optimization for factory production, and information from sources such as production facilities and MESs. Data corresponding to phenomena observed in the monitoring of production sites and processes is then extracted, visualized in graphical form, and provided to user.

In particular, we are making a special effort to visualize manufacturing sites that are indispensable for digital manufacturing. As optional services, we are providing functions tailored to particular applications, including a manufacturing status monitor (VisuaLine), an order delivery risk monitor, an inter-company production cooperation monitor, an equipment operation status monitor, and a process progress monitor (Intelligent DashBoard).

In VisuaLine, on the basis of diverse equipment data collected by COLMINA Edge, we visualize the flow of goods throughout the entire production line rather than just individual items of equipment. Visualizations from multiple points of view are implemented by incorporating user experience (UX) design concepts such as line graphs with time-series information on production output on the vertical axis, and different processes on the horizontal axis. We aim to achieve optimization by actually studying how the manufacturing department of a factory can grasp the status of a production line, and from what sort of viewpoint this information should be analyzed to make improvements. Consideration of these factors will result in a design that can be checked and grasped the status of a factory's production line at a glance.

**Figure 3** shows the deterioration of production efficiency due to issues such as short stoppage in the production line. In particular, by representing the status of a production line as a linear disturbance quantity or as event information responsible for this disturbance,



**Figure 3**  
Production status monitor.

it is possible to draw attention to changes occurring at the production site. High production efficiency is represented by parallel closely-spaced lines, while the locations of anomalies in production are represented by disturbances in the lines. We aim to make it easy for anyone to gain an understanding of the efficiency of a factory production line and where improvements can be made.

#### 4.2 Examples of COLMINA standard services

Since July 2017, we have been providing COLMINA standard services step by step. One of these services is failure prediction, which provides added value by using AI to analyze and predict the operation of manufacturing equipment. When a problem occurs in a production facility, it can report its cause and how to resolve it. This is aimed at minimizing the downtime of production facilities. It can also predict future operating states during normal operation, and can report the number of days for which the equipment will be able to operate in the future and the number of days until maintenance will be required.

Furthermore, we have also started offering services such as the abovementioned SMT planning support, 3D similar shape searching, layer number prediction (for printed circuit boards), a CAD converter, a virtual large room,<sup>note)</sup> and image recognition AI. These form a standard service group using the AI technology of Fujitsu

Laboratories and the reference model of design and manufacturing technology at Fujitsu Group factories.

### 5. COLMINA Platform

Since 2015, Fujitsu has been providing FUJITSU Digital Business Platform MetaArc as a group of products and services to realize digital formation.<sup>1)</sup> The first release of the COLMINA Platform will be deployed on MetaArc.

The COLMINA Platform comprises the following elements:

1) Service linkage API

An API group that cooperates with the above COLMINA Services to enable the referencing, extraction, updating, and deletion of data stored in various data assets.

2) Data storage/integration

A data lake that provides hybrid data storage functions in accordance with the characteristics of structured and unstructured data.

note) A system that digitally manages know-how related to product development, such as design information, analysis results, and the details of manufacturing department studies, and allows the necessary information to be extracted at any time by using a computer.

### 3) Edge linkage API

A group of APIs that input data into COLMINA from sources including facilities/equipment, edge servers, and sensors.

It also implements various operational system functions that are required by customers using the COLMINA Platform, such as user management, billing management, operation management, job management, authentication/authorization, and help desk. It can also use other platforms including FUJITSU Human Centric AI Zinrai<sup>2)</sup> provided by MetaArc, and IoT platforms.

In the future, we will provide an application service infrastructure that can also operate on other company platforms and plan to develop various services for the infrastructure.

## 6. COLMINA Edge

COLMINA Edge consists of a set of APIs for collecting and using data on factory facilities, sensors and the like, and a gateway for transmitting data to the platform. By extracting and organizing edge configuration patterns, it is possible to aggregate the IoT data with an optimal configuration pattern in accordance with the customer's requirements.

In the future, we plan to provide management functions in edge domains and implement functions including real-time visualization algorithms, interpreter server terminals which makes meaning of edge data, security group device management, and gateway management.

## 7. Conclusion

In this paper, we presented an outline of a manufacturing digital place for the manufacturing industry. This forum, which is called COLMINA, is organized as a platform that connects diverse information from design, manufacturing, and maintenance.

According to the Connected Industries<sup>3)</sup> initiative promoted by the Japanese government, Japanese manufacturing aims to create new added value and resolve social issues by making various connections, and is supported by using Japanese ICT. At Fujitsu, we aim to use ICT to realize a new digital society where people, machinery, and systems can work cooperatively.<sup>4)</sup> We will also continue to support the digital transformation of our customers.

## References

- 1) Fujitsu: FUJITSU MetaArc.  
<http://www.fujitsu.com/global/solutions/business-technology/metaarc/>
- 2) Fujitsu: Zinrai AI Business Solutions.  
<http://www.fujitsu.com/global/solutions/business-technology/ai/>
- 3) Ministry of Economy, Trade and Industry: FY 2017 Measures to Promote Manufacturing Technology (White Paper on Manufacturing Industries) Released.  
[http://www.meti.go.jp/english/press/2018/0529\\_001.html](http://www.meti.go.jp/english/press/2018/0529_001.html)
- 4) Fujitsu: MONOZUKURI Total Support (PLM).  
<http://www.fujitsu.com/global/solutions/industry/manufacturing/monozukuri-total-support/>



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