The NEC Platforms plant in Kofu, Yamanashi Prefecture produces 120,000 Express Servers each year, all made BTO (Build-to-Order). We went to the Kofu plant in hopes of discovering its secret for continually producing such a wide range of products at such high quality.

Ingenuity that Achieves a 100% Delivery Compliance Rate Even in High Mix/Low Volume Production

Where the People and the Process Nurture High Quality!
A Visit to the Birthplace of the Express Server
NEC has been operating in the domestic production of servers for a long time. At the time of our visit to the Kofu plant, it was serving as NEC Platforms’ production base for its Express5800 Series. At a factory site of about 120,000 m² (with the actual building area being approximately 41,400 m²), production is carried out for a variety of products, from high-end servers and IA servers to storage devices, business terminals, display controllers, and more. Since February of 2013, the plant has also been producing small electronic storage systems for home and office use.

NEC Platforms Ltd, was founded in July 2014 as a company that would manufacture business solutions for other companies. NEC’s four production facilities - including their tape storage operations, their server infrastructure operations, and each BU (Business Unit) supply chain’s control functions - have all been integrated with one another. This has had a big hand in the development and production of globally competitive, quality products that pursue an “appeal and QCD (Quality-Cost-Delivery) far beyond the rest.”

According to Yuko Watanabe, Senior Vice President, NEC Platforms, “Each factory has its own strengths, but they were not quite able to exert those strengths before the integration. However, now as one company, everyone can use the best we have.”

NEC Platforms has adopted a company policy of “manufacturing through a quality process,” which guarantees the highest quality of products that support company infrastructure. As Ms. Watanabe puts it, “If even one out of 10,000 of our units is defective, for the customer who gets that one unit, it is a defective product. That is why we are always thinking about building a manufacturing process that from the start will not produce a defective product and that will continue to make only satisfactory products.”

In order to achieve this, the company has enforced (a front loading products development system that is conscious of production), multiple inspections throughout the production processes (from parts receiving to product shipping), quality risk measures and recurrence prevention, line organiza-
tion and labor wastage elimination, and much more. The goal is to strive to "never use inferior components," "never make inferior products," and "never release that which is inferior." In order to make this ideal into a reality, the company uses a traceability system, which can follow its operations history, and invests in the skills training and certification of its workers.

Regarding product delivery dates, the company meets 100% of its deadlines. This is largely due to the help of its supply chain management system, which includes everything from suppliers to logistics. Meeting the factory’s promised delivery date means determining the distribution route and creating a product that will fit the shipping service. Moreover, because the entire NEC Group is using the distribution network at set times along set routes, if even one product does not meet its deadline, it would need an entirely separate shipping service to do so. Thus, the plant has removed this type of logistics issue by laying out the production system so that it will always comply with promised delivery dates, effectively making it no longer necessary to have to adjust deadlines.

Of course, it did not reach this status overnight. "In the past, even the sales side of operations did not trust that we would meet the suggested delivery dates. Because of this, sales would often set a really early delivery date. For that reason, there would sometimes be large gaps between production requirements and the eventual shipments," recalls Ms. Watanabe. In order to end this, a sales manager was invited to the factory to actually look at the production system and assess its ability to meet delivery dates. Ms. Watanabe says, "Now, sales no longer questions whether the manufacturing side of operations will ship the product by our indicated delivery date. As a result, we no longer have to deal with confirming that the delivery date matches the one set on the customer’s original order form."

To capture these distinctions found in the Kofu plant’s production in a single idea, one could say that it is "the ability to deal with change" after all is said and done. Factors like product type, quantity, and configuration can differ greatly between high-end servers that require high-tech high mix/low volume manufacturing and IA servers that have adopted flexible manufacturing technology. To produce these products with different needs, to produce whatever the required amount is, and to do so while being able to adhere to the desired quality, cost, and delivery date (QCD) is...
the place for us to show our skill," asserts Ms. Watanabe. For that purpose, being able to visualize the production progress and the 4 Ms of Production (Manpower, Machine, Method and Materials), it is now possible to recover quickly even in the event that there is an abnormality.

A determination to continue producing quality products starts at parts receiving...

Now, let’s take a look at the factory, following along its flow of production. The factory at the Kofu plant is a four-story building. Components that come through receiving on the first floor get mounted onto circuit boards, which are assembled into servers on the third floor.

· Parts Receiving Operations
First, components brought in on trucks are checked and then sent around to the board manufacturing area. Here, an efficient inspection mechanism has been put into effect, which utilizes the "Kanban" inventory system with built-in RFID wireless tags. With this system, the entire inventory of an incoming shipment can be inspected all at once by simply having it pass through the receiving gate.
Nonetheless, it is possible that an RFID could be misread when multiple types of components are loaded together. The RFID system has difficulties with metal parts, and it is inevitable that some tags will overlap one another in mixed loads. For that reason, there is a separately prepared system that can inspect the contents of mixed loading containers all at once.

In such a mixed loading inspection system, the placement of the antenna is optimized and it is possible to rotate the actual containers. Through optimal antenna positioning and this rotating mechanism, a large number of RFID kanban tags can be read without error and inspected all together.

- **Board Manufacturing (SMT Placement Stage)**
  After inspection, the next step is board manufacturing, in which electrical / electronic components are assembled on a printed circuit board. Solder paste is applied to the pad portion of the printed circuit board, and the mounting machine then rapidly installs the components. After that, heat will be used to melt the solder, connecting the components to the board. At the Kofu factory, there are multiple lines of this "SMT (surface mount technology)."

Although this board manufacturing stage is mainly carried out via machine, a great number of devices are used throughout the process to optimize the process significantly.

Take the “One-Touch Exchange of Die system,” for example, which can perform high mix/low volume production in a single line. In a line that produces large quantities of products with the same mounted components, the number and length of time needed to stop the equipment in order to change the mounted components can be minimal. “However, in the case of high mix production where you are installing different components, you must stop the equipment for each product,” explains Kazuhisa Kamijo.
Department Manager, Kofu Production Division, NEC Platforms.

In response to this issue, the Kofu plant groups together products that share common mounted components, reducing the time of machine stoppage as much as possible. Even during the product development stage, the premise of "ease of manufacturing" promotes the use of commonly shared components. This allows the factory to manufacture a wide variety of products in the same way as it would mass-produced products.

Furthermore, a unique individual ID is assigned to each component tape reel attached to the mounting machine. In reading a tape reel’s barcode, the machine can check that the printed circuit board is the correct one and that it is not installing a component by mistake.

Additionally, during the soldering process, the "VPS (Vapor Phase Soldering) reflow method" heats the entire printed circuit board, which melts a lot of solder paste at one time. In this method, vapors from inert fluids wrap around the entire product, so both small and large components can be uniformly heated. "Because it doesn’t overheat, it is also maintains the quality of the electronic components." (Kamijo) The reflow soldering apparatus also uses its own device to control component input, so it has become possible to switch products by simply changing their speed of passage through the equipment.

Once the printed circuit boards are completed, an X-ray inspection device checks the soldering accuracy. Just like a CT scan, the transmission X-ray images are obtained through a cross-sectional analysis of the soldered portions, calculating the solder volume and shape and automatically determining its quality. After going through this kind of machine check, an additional automated optical inspection and a further human visual inspection, the circuit board proceeds to the next stage of assembly.

- **Board Manufacturing (T/H Placement Stage)**
  In addition, SMT placement that solders the components onto the surface of the circuit board, there is also T/H
Machine-operated SMT placement, and manually operated T/H placement.

**SMT Placement**

- **SMT (Surface Mount Technology) Placement**
  - Components are mounted using the relay production system, which maintains overall manufacturing efficiency through the coordination of multiple operators.
  - After the manufacturing stage is completed, the board’s peripheral equipment fittings are tested for connection and function.

**T/H Placement**

- **T/H (Thru-Hole) Placement**
  - Components are applied to the printed circuit board’s pad. In this process, once the components are mounted, they will be connected to the board by heating and melting the solder.
  - Solder paste is applied to the printed circuit board’s pad. In this process, once the components are mounted, they will be connected to the board by heating and melting the solder.

**Features**

- Allows for component downsizing and the use of narrow-pitch components through high density mounting.
- Commonly conducted via automatic placement by machines.
- Primarily used for the placement of condensers, resistors, LSI and IC.

**In this process, the bottom surface of the printed circuit board is put into contact with the fusion (melted) solder, and because of capillary motion, the solder fills the thru-holes to ensure the attachment.**

**Features**

- Results in low density mounting for mounting components with large surfaces.
- Commonly conducted via manpower.
- Primarily used for the placement of connectors, etc., that require additional mounting strength.

What the Kofu plant’s board manufacturing site has adopted is a “relay production system” where workers move along the line, supplementing nearby operations. In a relay production system, it is essential that the assembly line be able to efficiently eliminate any bottlenecks. The line is optimized, and in the event that the work could not be finished at a particular location, the next person can help. This eliminates waiting time and makes it possible for assembly to proceed smoothly.

At the Kofu plant, the solder melting apparatus is placed outside of the assembly line, thereby making it possible for the operators to work in a straight line. Conventionally, a solder melting apparatus would be located in the middle of the assembly line, but this makes it inconvenient for the operators who have to move around it. However, with its own conveyor belt, now it is possible for the solder melting apparatus to be removed from the line. In addition, by con-
Converting to in-house production of the solder mask plates and using video to analyze the cause of failures, it maintains a high product quality not dependent on an operator’s skill level.

A board that has completed the manufacturing stage will have peripheral equipment fittings in all of the slots on its surface. A dedicated diagnostics program checks the function of each board. And of course, the final check is done by the human eye. In order to progress with detailed components and high-density installation, quality must be preserved through this confirmation that there is no indication of any defects, damage, or blemishes.

Next, we will move to the device assembly stage where everything from the circuit board to the power supply, memory, and housing are brought together. The main point of Express Server production is, of course, that it depends on the customer’s required specifications, with BTO (Build-to-Order) products made one by one as efficiently as possible.

In fact, most of the Kofu plant’s 120,000 Express5800 servers are BTO custom products. They carry out production on customer configurations that use various specifications from among approximately 100,000 individual options. In other words, all the servers produced here are different. It used to be that the unit base and the options would be delivered individually and assembled at the customer’s location, which required verification of this action. However, now products are only sent after verification that all options have been assembled and the OS has finished installing. For this reason, the product will start operating immediately after the customer plugs it into an outlet, and there is no trouble with installation or adjustment.

The tower configuration Express5800 Series and Takayuki Nakanishi, Senior Manager, Kofu Production Division, NEC Platforms
The delivery date from the time of ordering is a minimum of four days. According to Takayuki Nakanishi, Senior Manager, Kofu Production Division, NEC Platforms, "You say four days, but it takes one and a half days for sales to go through the product line-up (supply of other products and equipment), and inspections can take eight hours, so the actual time spent making the product is about one to one and half days." This means that manufacturing must be completed within a very short lead time. Nevertheless, the factory has achieved a 100% success rate of meeting its promised deadlines. Perhaps it can be said that this is the strength of domestic production.

In order to produce 100,000 different kinds of servers without any errors, and reliably meet their delivery dates, everything is tightly coordinated in-house - from the sales management, logistics management, and production management systems, to the site production line management system. Ms. Watanabe says, "From the start, we wanted continuous improvement, beginning with the disposal of unnecessary items and gradually building up to a single line that can make any number of products. Because of such accumulation, it has become possible to manufacture different products on the same line with two to three times the regular workload. Now we are at a place where we are creating a managed flow that allows us to continually make good products." So let’s go look at the actual assembly line.

**Taking full advantage of RFID, from picking to component checking!**

The Express Servers are manufactured on the third floor of the building. In contrast to the first floor, which has the automated SMT placement line and the manpower-based T/H placement line, the entire third floor is organized into a simple single line of materials storage, assembly line, and inspection.

The number of units to be manufactured each day is determined overnight based on the previous day’s order information. Manufacturing starts when the “production instruction kanban” issuing order information is set up on
each line’s bulletin board. Some operators supply the line with materials matching the customer’s specifications, and other operators carry out the assembly. Once the assembled product has been inspected, the last thing is for it to go through packaging and shipping preparations.

In order to make a product based on customer specifications configured from about 100,000 different combinations, picking the necessary items means picking them from a large number of materials. Here again, RFID plays a very active role. Order information including each customer’s configuration is stored in RFIDs called travelers, which are issued one per production instruction kanban. Based on the traveler, the operator conducts material selection, indicates operation details, collects information regarding the components used, and verifies the configuration.

For example, if “shopping” is the material meant for selection, the RFID will read that, and so the LED on the necessary material tray will light up. Once the quantity displayed on the indicator at the front of the tray has been gathered, a button is pressed and selection is completed. If anything extra is brought out onto the line, the green lamp will not light and nothing will move along to the next station. It is because of this that it is possible to have only the necessary components supplied to the line.

“So as not to make any errors regarding the specifications received from the customers, a five-stage check is conducted using RFID. Some say that we are going a little overboard, but it is thanks to this that not even once in the past have we had the complaint that we sent different specifications.” (Nakanishi)

The production line employs the same relay production system as the first floor, with multiple operators who remain unfixed to a set working range so that they can support nearby operations. “Something different is being made each time, and moreover, the production quantity and details change as well. At the same time, quality and lead time must be stabilized. In order to respond to these fluctuations, the work done here has to be carried out by every person.” (Nakanishi) Since the specifications are different
for each customer, operations instructions are all displayed on a monitor, and even the components are individually supplied to the line.

In the case of multiple operators working along an advancing relay production system, the key to success is whether or not they can properly transfer control from one operator to the next. On that point, Mr. Nakanishi says that even in the middle of operations, “progress can be grasped at a glance, and transfer can be carried out smoothly, because a detailed work procedure has been decided all the way down to the tightening of the screws. Really, it is actually through the transfer that both sides can confirm whether the procedure is being followed.”

Products that complete this assembly process are then temporarily taken out of the line to enter the inspection stage. Here again, each customer’s configuration is read by the RFID, and then the OS and software are automatically installed. Based on accumulated quality know-how, each customer’s specifications automatically undergo necessary durability tests such as function testing and aging, and then it is finally time for the packaging stage.

A reality that builds up efficiency and eliminates even the smallest labor wastage...

What we admired most during the visit, was that thorough waste elimination and the pursuit of efficiency were part of every area.

For example, take the return of the component containers used during assembly. At the Kofu plant, empty component boxes can be returned at the touch of a button. “With three seconds needed per return, if ten containers were needed for one unit, it would take thirty seconds. Say for example, you have to make 100 units today. You would waste a combined total of fifty minutes just with returning the containers.” (Nakanishi) Additionally, even tasks like label peeling and supplying the required quantity of screws are machine automated. Moreover, it is surprising that all of these are the company’s own work. It was realized that eliminating even the smallest waste and building up efficiency would lead to a high QCD. “18 years ago, we had no such thing as a machine of our own. We were compelled out of necessity, so we made them and this is what it is now, * reflects Ms. Watanabe.

These improvement efforts, of course, influence cost, as well. As the manufacturing sector globalizes, Japanese manufacturing has to compete with the world. “Indicators of productivity improvement are always pointing to China and emerging countries, and we aim to catch up,” says Akira Miyanaga, General Manager, Kofu Production Division, NEC Platforms.

Considering labor costs and the cost of land, it may be difficult to see the merits of domestic production. However, with daily improvements and the free use of IT along its supply chains, the Kofu plant’s competitive advantage...
is visible even at the global level. Mr. Nakanishi says, “As labor costs gradually continue to rise in China, I don’t think we are losing if you look at the line operating costs for a single item.” And, above all, the Kofu plant is far superior in delivery time and quality. Things like delayed delivery and malfunctions eventually have repercussions on cost.

Will Kofu’s manufacturing go back to the slogan from 400 years ago?

With IT vendor manufacturing sites, much attention is placed on a system that encompasses everything from logistics to the supply chain, but in the end the security of the QCD comes down to “people.” Even as it is said that “in the near future, intellectual labor will be taken over by the computer and manual labor by the robot,” at the Kofu plant, where everything being made is different, the focus is instead returning to people.

“To tell the truth, there was a time around the end of the 1990s when NEC was aiming for a fully automated, unmanned factory. But then the variation of goods started increasing, and we’re moving away from this need to make large amounts of the same thing.” (Watanabe) For that reason, areas allowing for automation will be automated, but it was concluded that people are absolutely necessary for integrity and dealing with changes in order to maintain superior product conditions.

And so, in Ms. Watanabe’s opinion, companies should function as a vessel for that purpose. “Humans are thinking about us. About making us even better. Because they are bound to us eight hours each weekday, naturally I’d like to help them grow through their work, too.” (Watanabe)

It is only a matter of course that such a concept is at the heart of the Kofu plant’s on-site improvement activities. These efforts are carried out one-by-one, from things like executives touring the site, exchanging views with workers on initiatives for improvement, to other things like the sharing of know-how between positions and during outcome report meetings. As Mr. Miyanaga remarks, “Rather than matching our operations to the machinery, we are going to make use of machines that match our own operations. So, it’s not that the operators simply manufacture. They’re thinking about how to best reform the assembly line, and they’re putting together human resource development programs for equipment development.” Instead of being forced to work, workers are working on their own, transforming the environment into one that produces a “climate of innovation.”

Making things is making people, and this is a major theme of the Kofu plant. “A factory does not exist solely through its manager. If the management side of things does not incorporate the opinions of the people who actually make unit after unit of a product, it cannot personally build an environment of improvement,” says Ms. Watanabe. The Kofu plant’s policy states, “Without the growth of its people, there is no possibility for a company to expand.” This sentiment seems to echo famous samurai Shingen Takeda’s 400-year-old slogan, “People are the stone wall, people are the castle, people are the moat.” What Shingen Takeda meant all those years ago, and what Ms. Watanabe believes today, is that the power of people is what matters. A good company is just a group that is able to use each member’s talent to the fullest, that can embrace the distinctions and abilities of its individuals. Anything can be accomplished through the intelligence and ingenuity of its individuals. Today, the Kofu plant continues to live through this kind of “essence of manufacturing.”