

Manufacturing Process Flow System at IGT

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Introduction

IGT is recognized as the world leader in slot machine and video gaming machine design and production. Its products include the S2000 and Vision Series spinning reel slots, the Game King multi denomination, multi game video product, a full line of interactive video iGames, the EZ Pay Ticket System, the Players Edge-Plus video poker line, and the Japanese Pachisuro slot. The company's 17" Game King Upright game and Slant Top game are pictured on the cover page.

IGT's video poker machines ushered in the video gaming revolution in the 1970s, and its spinning reel slots completed the slot machine's transformation from an electromechanical device to a microprocessor-driven game.

On the production floor in Reno, Nevada, IGT's computerized factory control system routes machine cabinets and individual kits of materials through eight assembly and test lines and allows multiple machine models to be moved electronically into position for each customer order. With all eight assembly lines running at full capacity, a single shift of IGT employees can produce more than 300 machines a day, or up to 80,000 machines a year. IGT is further supported by more than 130 outside vendors for a variety of machine parts.

About 2,000 IGT employees work at the corporate headquarters in Reno, Nevada. The million-square-foot campus is comprised of Manufacturing, Sales, Engineering, Product Development, Graphics and Silkscreen, MegaJackpot Systems, a Cabinet Shop, and numerous support departments.

This paper will first give you an understanding of how parts are received from vendors and are systematically stored in the company's warehouse. There is no name given to the system used at IGT, but for the most part the department that handle the stocking and inventorying of the materials sent to IGT is called the Warehouse.

Following the material receiving procedures will be an explanation of the company's manufacturing (production) process flow. IGT currently uses FCS (Factory Control System) as a means of the machine building process.

Receiving and Warehouse area:

IGT receives hundreds of boxes a week from the over 130 vendors mentioned in the introduction. These vendors range from hardware (nuts, screws, etc.) to electronics (PC boards, computer chips, wiring harnesses, etc.).

When boxes arrive in the receiving area, they are stacked in no particular order in sections that are marked and given a location name. The boxes from a shipment are recorded as being in that particular location. When the receiving clerks can get to that shipment, the parts are then pulled from the box, are sent to Quality Control (QC) to be checked (not always), and then stocked.



Receiving area conveyor belts



Receiving staging area

The check that QC performs is basically comparing the physical part received from the vendor to the drawing of the part, which is on file in the company's database. The part received is marked to be at a current revision (i.e. Rev A or Rev B) and this revision must match the revision of the drawing in the database. The part is checked for measurement accuracy as well as for its revision. It is important that parts received match drawings because even the slightest error in the part can result in one part or many parts not fitting into the machine correctly.

A big problem that IGT has encountered is that not all parts received in shipping are checked by QC. Usually, for example, when a shipment of 100 of the same parts come in, only five are taken from that shipment and sent to QC. This is probably a result of the thousands of parts that come in a week and the time and resources it would take to actually check each part. Shipments are generally done this way unless it is a new part (Rev A) and it is the first shipment received of this new part. In that case, it is typical that all the parts received are checked in QC. The system can be tedious in that it causes IGT to have to purge (remove) parts from stock or even the production line (work in progress) when a problem is discovered and then do whatever fixes are required, sometimes resulting in line-down situations.

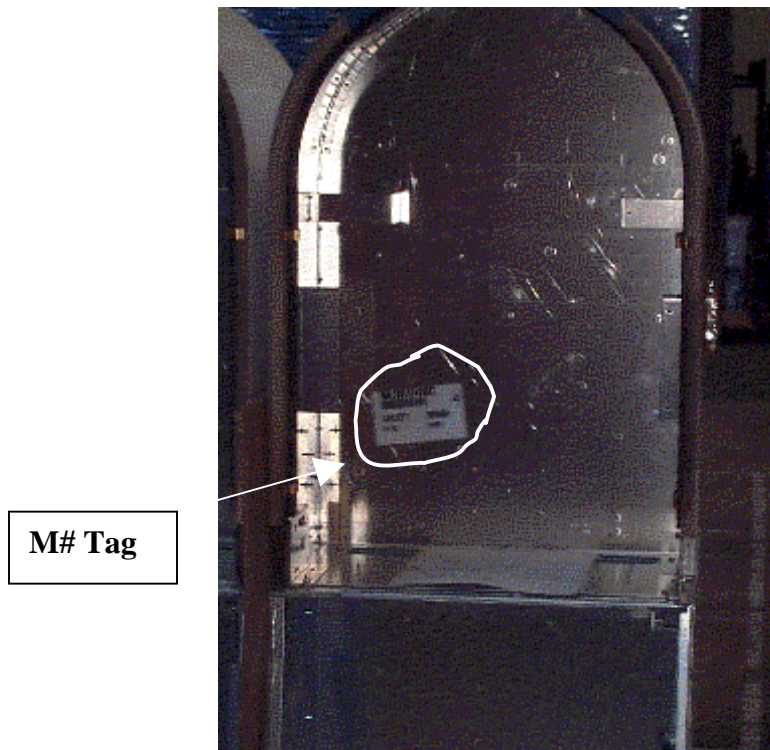
The shipping department also handles items that are shipped to the company for non-production uses. Items such as computers, paper items, writing supplies, etc. As a side note, IGT has been recently forced to install cages in the shipping area for computers that arrive because they have had problems with items being ripped-off...security is not the greatest there.

Pre-Production

When a customer (a particular casino or any property that orders a machine) places an order, the machine options requested are put together in what is known as a machine configuration. A configuration consists of the options that make the machine up such as a 17" Game King (see picture on cover). Options such as a bill acceptor (same as bill validator, an optional assembly that accepts valid paper bills and causes the host machine to either dispense change or issue credits), a particular game theme (Multi-denomination), a particular color, with gold or polished stainless steel plating, and a game program. These are just a few of the many different choices that one must decide upon when ordering a machine.

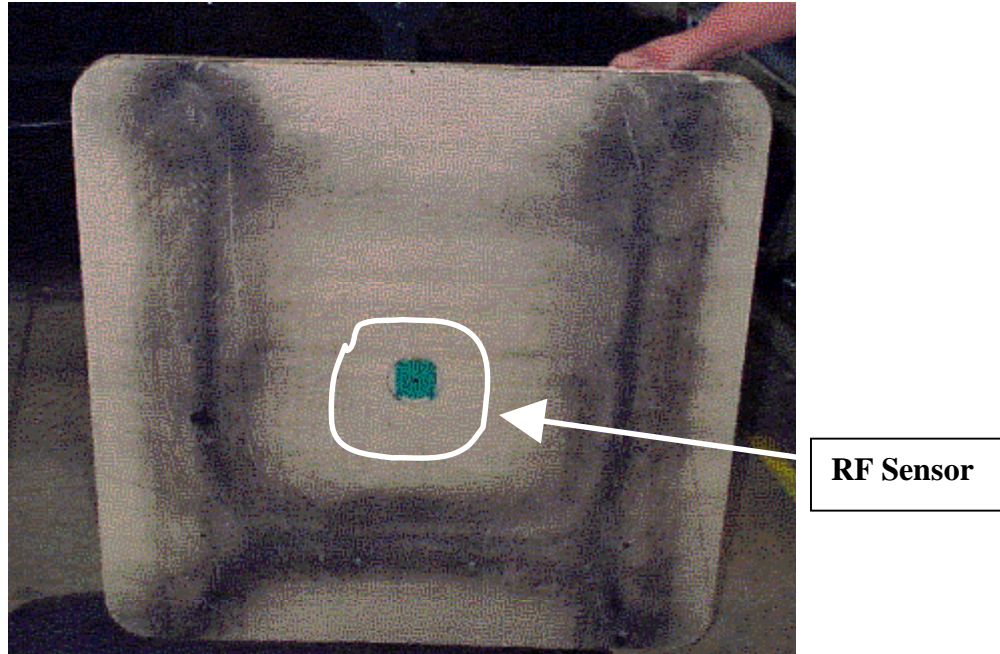
Once a machine is configured, a traveler (see fig #), which travels with the machine until it is shipped, is created which basically tells anyone who may be involved with building up the machine all the parts, options, and programs that the machine must have installed. The production-scheduling department generates this traveler, which is in charge of allocating all parts required for a machine to be built as well as scheduling the build of machines.

An M# is assigned to machines when an order is configured. Only games that are completely, identically the same are assigned the same M#, for those, the quantity of machines in that M# are listed on the sticker so that everyone knows how many machines are being built up the same way. The M#s are put into the empty cabinets (the exterior, laminated wood "shell" that surrounds the metal enclosure on some machines) in the cabinet shop, which is the first place that a traveler goes once a machine is configured.



The cabinet shop then ships the cabinets to the beginning of the production area where each cabinet is placed on a production pallet and put on the main assembly line. An RF reader sensor is imbedded on the bottom of each production pallet (see picture below). This sensor is part of the factory control system (FCS) that IGT uses to track and move machines along the

production lines as they are being built. The sensor tells the FCS which line to take a machine to and what group job it is a part of.



Group jobs are massed as a group by the production-scheduling department. The group job would be like all 17" Game King games or all sun gold or black gloss cabinet colors (for plated parts) with no difference in glass (graphics or game theme printed on glass), or no difference in programs. Not all groups are for one customer, for instance a group can contain all 17" Game King games, but they are going to Atlantis, Peppermill, and the Nugget. They'll have different M#,s, but are the same group job.

Glass warehouse

Glass is still considered unique parts because there are so many variations (currently about 1000). The term glass refers to the upper and lower glass on the machines that shows the denomination, pay table or game theme.

When the M# is first pulled, the glass is picked for that number and it is stored in the glass tower (rotating carousel). It stays in the carousel until the machine cabinet has been put on the production pallet and is sent to the induction area. The induction area is the place where the glass for each game is picked (see picture below) from the glass tower and placed in the bottom part of the production pallet. The induction area is also the place that the machine cabinet sits until it is ready to be sent to its appropriate production line. This glass travels with the cabinet as it is built up in production until it is actually mounted into the machine.



Warehouse worker programming M# into glass carousel computer



Glass carousel tower

Machine Movement in Production

The conveyor system is one continuous line with branches that carry the machines to the appropriate station or production line. The production pallets are moved throughout the production area on conveyor belts using a reader that interacts with the aforementioned sensor placed on the bottom of each production pallet. The sensor is read by optics mounted on the assembly line (conveyors) that tells the FCS when it is time to send a cabinet to a particular line. It sits in the induction area until a machine has passed from a production line, hence in need of another machine to build up. Sometimes, the FCS will trigger the line to send another cabinet to a production line, but there is no cabinet in the induction area to send. This might be because the Cabinet shop is running behind, or because something special needs to be done to the cabinets before they can go to the line.

Originally when the new IGT production facility was built in 1996, it was with the understanding that totes would be used to carry unique parts for every game. This tote would travel to the production line with the cabinet and all the parts would be installed into this cabinet. This proved to be unfeasible because of the varying sizes and shapes of the machines and parts within each machine. Things were getting destroyed and lost very easily...this was costly to the company. IGT has since gone to batch delivery, where parts are picked by group jobs (mentioned earlier). The parts are scheduled to be picked from the storage warehouse and delivered to the production line exactly when the machine is sent from the induction area to the appropriate production line.

Production lines

The production lines are set up such that the backside of the line (there's a front and back) are mirror images of each other with lines 1 and 2, 4 and 5 (see picture). Etc. There are two final test lines located close to each other for sharing of Quality Assurance people and test technicians. When the final testers have problems that they can't solve on their own, they can pool from other line technicians (technicians assigned to each particular machine style) to troubleshoot the problem.



Partial view of production floor

The first 3 lines are set up for slant top machines, they have an additional amount of lifts and stations because there are more steps involved with putting together a slant top machine due to its deeper cabinet shape. The other 5 lines are for the Upright machines that are built such as the 17" video monitor games, or the 19" video monitor games, or the reel slot games.

It is necessary to provide assembly instructions for each line and for each type of machine and the assemblies within the machines to ensure that every machine is put together according to the rules stated in these instructions. These instructions are called MPIs (Manufacturing Process Instructions). The main purposes of these instructions are to ensure ease of assembly, to improve productivity, quality and consistency.

Sub Assemblies

There are times when it proves to be more efficient to pre-assemble parts before they are sent to a production line. IGT has sanctioned off areas in which this sub-assembly process is to take place. Hoppers (electromechanical device which collects and dispenses coins in the machine) are one of the types of items that are sub-assembled. Also included are the various types of Coin handling (a device that recognizes a coin size and allows the machine to accept only the particular coin size it is programmed to accept). And in addition, some of the special toppers (decorative tops) that a theme game may require is put together in the sub-assembly area.

Parts are sent to the sub-assembly area in much the same manner parts are sent to the main production lines. Once items are built up, they are identified with the kit number in which either an MPI or an assembly drawing specifies the parts and manner in which it was to be built. Once parts are done in the sub-assembly area, the kits are then sent to the production line and installed into the machines. Sometimes sub-assemblies are put together faster than the machines can be built and so they are stocked onto a cart and set in a designated area until they are needed.



Coin Hopper

Hopper sub-assembly area

Production Woes

Production lines often go down because of part shortages. There are many reasons why a line may not have parts at the right time. For one, IGT does not have a true MRP (Material Requisition Planning) system to drive anything with any surety that each order has the full amount of parts needed to complete an order. IGT is currently in the process of implementing an SAP system that will eliminate a lot of the problems incurred with parts shortages in production.

Another reason for part shortages is because production planning is continually rescheduling builds because a part is sometimes in development and the customer has found out

about it in pre-released stage, and requests the part or program irregardless. So, the build cannot be completed until these parts have been prototyped, sent out to be made, and have arrived from the vendor. Other jobs must then be scheduled around this one. Sometimes, orders are held for a part in development, but when the part arrives it is discovered that the part isn't exactly what everyone thought it would be, or there is a problem with the part not fitting correctly. At that point the part is quickly redesigned or reworked to fit properly so that the build can continue on.

Yet, another reason for part shortages is that lead times from vendors can change and it takes much longer than expected to get a part in. Production planning usually gets around this by leaving gaps in a machine configuration (place holders) because sometimes it is known that production will have to build 50 machines with coin handling, but not all the parts for the coin handling will be in on time. In this case, the machines are built up entirely without the coin handling and are set aside until the parts arrive at which then they are installed.

Machine builds are also rescheduled as a result of machine configurations being changed (addendum) while an order is waiting to be sent to the production line. When a sales order is "addendum", it is basically being changed to something different, say a different color, or different type of bill acceptor, etc. A customer may not know exactly if they want quarters, or nickels, or dollars. So the order continues to get addendum until, or sometimes even while it hits the production line.

These place holders in this case, or special orders are called SSLs. They are a way of allowing a customer to kind of stall on making a final decision on exactly what features they want in their machine. And why does IGT allow such a system...Because IGT never says NO. Probably the fact that there is currently a 4-month lead-time for customers to get machines from the time an order is placed, totally feeds into the factor. It's easier to change your mind about things when you have a lot of time to do it in.

Unbelievably, 85% of the games shipped by IGT in the 4th quarter of the fiscal year were short something. Most of the items that the machine lacked was found to be program approvals, in which case firmware in the processor were later shipped to the customer.

Also, there are times when machines get to a point where they are about to be shipped and it is discovered that something is wrong, such as firmware approval in a jurisdiction. Or, sometimes it is required to change out electrical components such as harnessing (take picture) or a PC board. These changes generally take place in our Customer Service department. When electrical components are changed, it is necessary to run them through test again and most importantly do a hi-pot test which is described in the next section.

Quality Assurance

After the machines have been completely built up, they are ran through the last part of the build line, quality assurance. Here they are ran through a quick system check as well as a hi-pot test. A hi-pot test is a current/voltage high potential leakage to ground test which verifies the wiring insulation of all alternating current (AC) circuit components of the primary winding side of the AC power transformer. This test is required to ensure the electrical safety of each machine as well as to ensure compliance with UL, CSA, and CE requirements. Theoretically, this testing is the final stage of the production process.

Post Production

After testing, the machines are removed from the production pallet and set on the floor on large shipping pallets in front of the QA lines, and are then sent to shipping. Unfortunately with



Area in front of racetrack

the shortage of space that IGT is experiencing with its large boom in production, not all the machines can be sent directly to shipping once they are built, so IGT has designated floor locations (which are tagged, and kept track of with bar codes on each locations). The machines are kept on the shipping pallets and are sent to these floor locations, once there, the machines is then scanned and the location is scanned with a bar-code reader. This seems to be the best way that operations can keep track of machines that are built up and ready for shipping.

These floor locations are often used to store unfinished machines that have to be removed from the line because of parts shortages. Sometimes, machines are incomplete so they send them to what is called the racetrack (picture). If they run out of room on the racetrack, they set them on the floor locations, still on the production pallets, and they stay there until they are completely built up and sent to shipping.

This picture below is a production pallet stacker. Once the machines are taken off the production pallet and sent to shipping, the pallets are stacked into this device and when it becomes full, a floor worker takes them back to the beginning of the production process.



Pallet Stacker

Production Personnel

A production Lead person is assigned to each line and is in charge of how the build goes. This person is in charge of getting the production workers trained properly. The lead also runs around for parts that may have not been sent with the order properly and is also involved with making sure that tools that may have broken down on the production line get fixed.

The supervisor tends to handle more of the traditional human resources activities, such as writing reviews. They are also responsible for knowing how the games are put together so that they can help develop a more efficient production line.

The Supplier quality group handles things that might get damaged during production, or handles situations when parts that have been taken to the lines are discovered to be wrong (parts weren't properly inspected in the QC area when they arrived from the vendor). They handle the rework required to fix these parts.

Manufacturing (or Operations) Engineering consists of a team of Manufacturing Engineers whose main function is to ensure an efficient flowing production line. A Manager who must stay involved with even the minutest issues in order to maintain control over any situation that may come up heads them. The Manufacturing Engineer's position is quite possibly one of the most tedious positions to have since, as you have read, there are very many problems that come up during the production process. These problems must be dealt with quickly or they could result in hundreds of machines not going out the door, and this could cost IGT hundreds of thousands of dollars.

The manufacturing engineers are the main writers of the MPIs. They must thoroughly understand all of the manufacturing problems, as well as design problems. Many times, they are responsible for modifying the design of released parts to aid in the ease of assembly. Other tasks include evaluation of manufacturing feasibility and cost, selection of optimum processes and processing steps, selection of production equipment, tooling, and fixtures required for manufacturing, and deciding material movement methods.

Conclusion

Touring the IGT production facility can be a bit overwhelming because there is so much going on at one time. It is easy to see how things can get mixed up. It's also amazing to see that the production line runs as smoothly as it does. Although as it was stated earlier that things do go wrong, IGT is still managing to put out 400 machines a day with the recent addition of a second shift (swing shift) of workers. The one million square foot building which houses the two hundred and fifty thousand square foot warehouse is one that anyone interested in manufacturing processes would get a great deal of knowledge from if they were ever to tour the building.

Problems

1) What do the acronyms FCS and MPI stand for?

Factory Control System and Manufacturing Process Instructions.

2) What is a hi-pot test?

A current/voltage high potential leakage to ground test which verifies the wiring insulation of all alternating current (AC) circuit components.