

# Improving Time to Market and Smoothing Development to Manufacturing

James Scholler  
 MEC Companies  
 Milwaukee Wisconsin

**Abstract**

The product development and electronic manufacturing communities often face conflicting goals. There is need to stay on top of technological advancements, which seem to come at an ever accelerated pace. Those same technology advances bring changing processes that need to be understood, applied and verified for continuous quality performance. On top of that business performance pressures require that we shrink the time to market to take competitive advantage of those technologies.

The ability to shrink the time to market has the potential to pay major dividends. However, the traditional product development and NPI (New Product Introduction) processes setup significant roadblocks that prevent substantial improvements to time to market. This paper uses a real-world example to demonstrate how those processes can be evolved into a new process called Freeze Gate. This process provides optimum time to market providing the right amount of risk management.

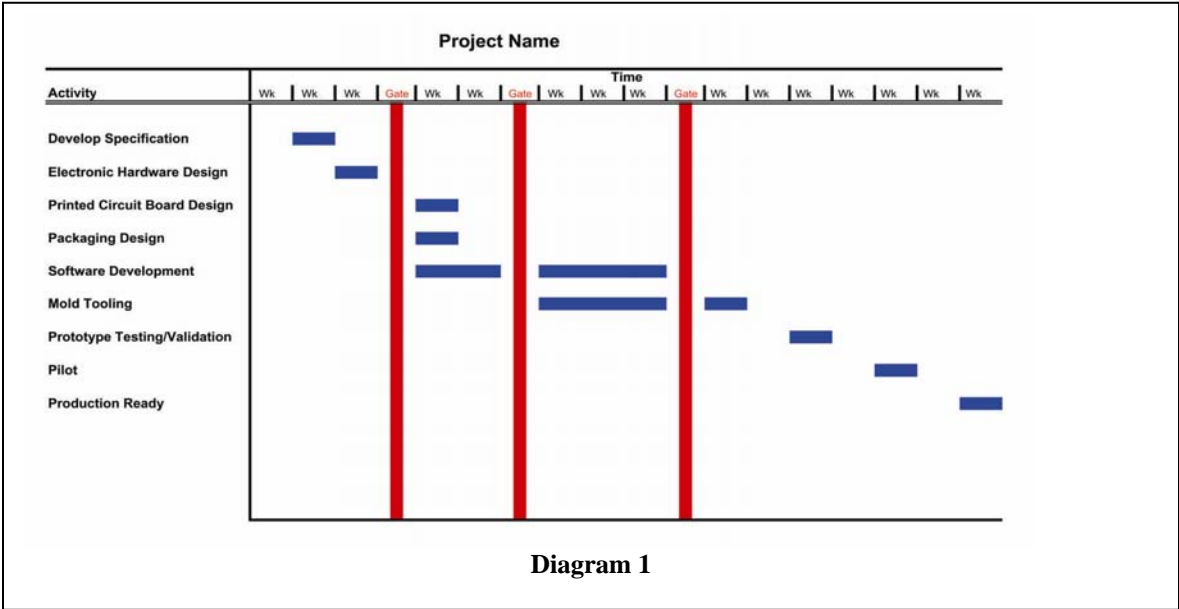
**Introduction**

As with many process innovations, the Freeze Gate process evolved as a response to a series of challenges in a complex project with a tight timeline. The project selected as an example is the basis for the process changes that were made and that evolved into the Freeze Gate Process. The end result is a process that delivers products faster with a smoother transition and incorporates Lean Concepts.

The product scope was to develop an Interface Module that would incorporate remote network communications to provide control signals to a motor controller. To a knowledgeable development engineer, this would seem to be a fairly straightforward development. However, the mechanical requirements were much more problematic. The project challenges included:

- packaging must meet IP67 (product must be able to experience a pressure wash down without any performance irregularities);
- product required multiple viewable indicators;
- there were numerous M22 and M12 connectors;
- the cost target was aggressive; and
- the delivery date for production was very aggressive.

The electrical and mechanical challenges posed were not overly challenging, however the delivery date requirement was viewed as not achievable. The major schedule constraint was a well thought out ISO process with clearly defined stage gates. The process implemented stage gates as shown in **Diagram 1**.

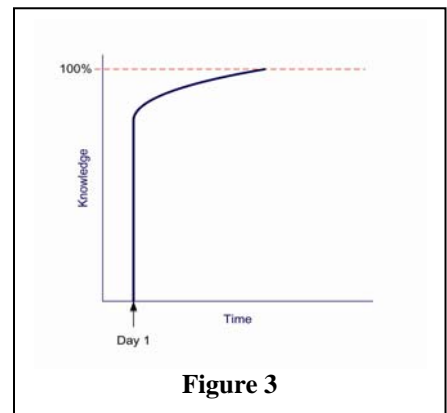
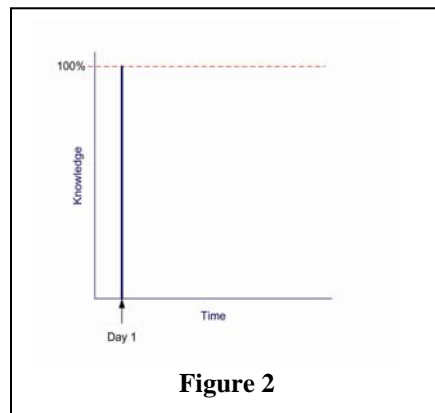
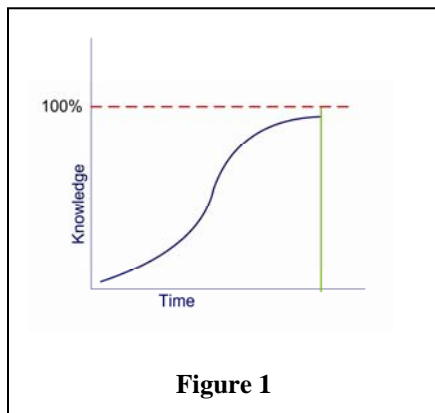


Stage gates were developed to mitigate the risk of conflicting activity when operating in a cross functional development team environment. However, working sequentially also has the net effect of shutting down the project while the activities required to clear the gate are completed and approved. This can not only stop the project, but can inject additional requirements making the team go back and redo activities to meet these new requirements, causing further delays. The stage gate requirements can often drive activities of a nature that serves interests outside the customer's core requirements. In an outsourcing environment, these activities are considered non-value added and the customer typically does not pay for those activities because they do not represent a deliverable. In an internal product development effort, they are simply a source of hidden cost. The major problem with stage gates is they stop development progress until all the activities are completed and management approval provided.

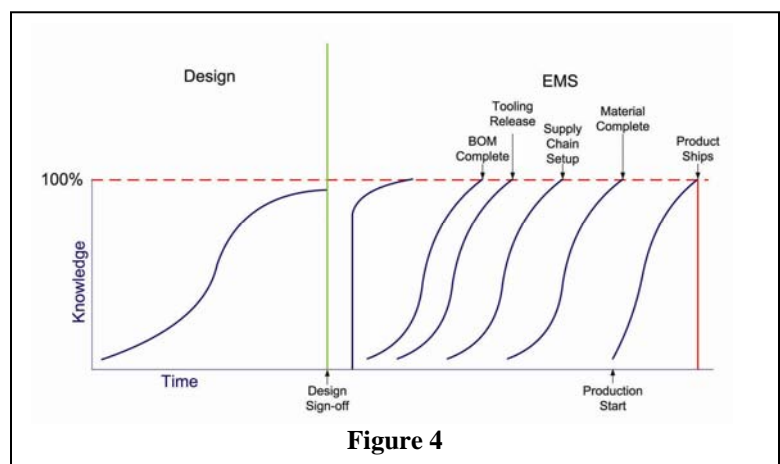
**Addressing the Problem**

In order to address this problem, the development project at hand was evaluated by considering the overall flow of the activities from the start of development to production delivery. The flow was looked at from a knowledge transfer approach. This is shown in **Figure 1** for a typical development knowledge transfer. The knowledge about the product is initially very limited and over time that knowledge grows. Achieving 100% knowledge in the design phase of the product cannot be attained until the customer signs off that the product is complete.

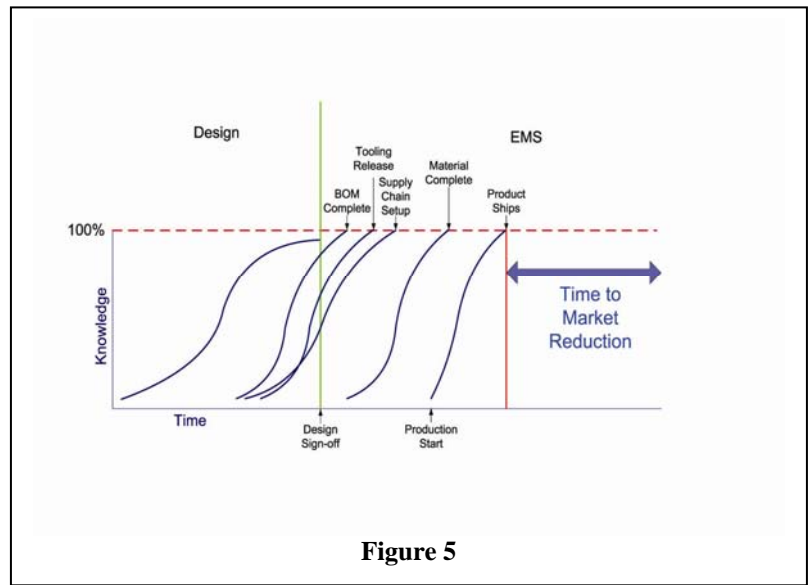
When an electronics manufacturing services (EMS) provider is considered in this approach, the expectation is that 100% of the knowledge required to build the product is delivered on day 1 as shown in **Figure 2**. In reality that scenario is not achieved and although a substantial amount is conveyed, there are numerous issues that require further information. Often, the biggest communication gap is lack is original equipment manufacturer's (OEM's) understanding of what information is necessary for the EMS provider to support a quality deliverable. The real knowledge transfer to the EMS provider is depicted in **Figure 3**.



When the curves are grouped together for all activities needed from design through shipment of the product, the knowledge transfer functions are shown in **Figure 4**. This now shows curves for the necessary functions of creating the bill of material, developing the various tooling releases, setting up the supply chains and material procurement. All of these functions are required before production and product shipment can begin. However, this traditional approach provides knowledge in batches. Batches are a bad word in this lean world.

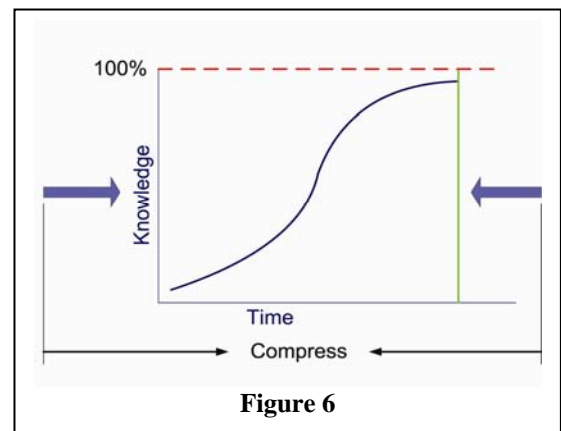


The next step was to show the OEM the shift required to meet the customer delivery date. This is shown in **Figure 5**. This led to an easy conclusion that if the traditional development approach was followed there was no way the product could achieve the desired delivery date. Several of the activities would need to be started before the design phase was actually completed. There was consideration given to shrinking the knowledge transfer functions of each of the activities. Certainly, for one of the longest functions the design phase, one would ask could that not be compressed to allow the sign-off to occur earlier? This would be as shown in **Figure 6**. The reality of that consideration meant that features would need to be eliminated or more people added to the team to shorten the development. Unfortunately, the OEM could not accept the loss of any features associated with this product and there was no substantial time available from other design resources. As in most companies, the engineers had multiple tasks and were not sitting around waiting for the opportunity to jump in and lend a hand.



**Figure 5**

At this point all the key suppliers and engineers were pulled together and began to evaluate what approach could be taken to meet the delivery date. It became evident during those discussions that if certain decisions were made incrementally as the project developed it would allow the transfer of knowledge to the other activities. This would provide them the means to start earlier and would provide the knowledge in smaller packets, which allowed better time management to complete.

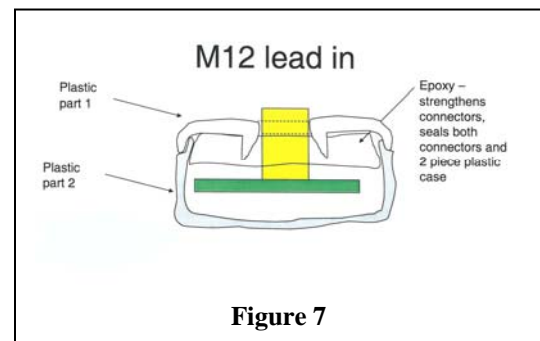


**Figure 6**

The next step was meeting with the OEM. This included all the same key suppliers and engineers who were involved in the strategy discussion, and the OEM's project engineers and managers. The concept was presented. The key team members were identified and their roles defined. The major risk factors in the program were also identified and the individuals responsible for their solution were defined. These risk areas included sealing around the connectors, how could the indicators be viewed and what approach would be used to seal around the various cables coming from the module. The customer understood the approach was deviating from published ISO procedures. A key area of discussion was around managing risks. It was agreed that a list of the decisions that were made about the various features would be kept with the appropriate approvals. It was mutually agreed that should a decision need to be reversed there would be significant consequences in time and cost.

### Implementing the New Process

As in most good development processes the high risk development challenges were taken on first. Sketches on how to handle the sealing around the connectors as shown in **Figure 7** were exchanged. One of the ideas was to use liquid compound filler to provide that sealing.



**Figure 7**

Another major concept that needed to be worked out was how to optimize the assembly of the components for manufacturability, while still providing for indicator viewing. An easy approach from a design viewpoint was simply using leaded LEDs mounted to the top of the enclosure with the leads soldered to the printed circuit board. The top of the enclosure would be the part identified as "Plastic part 1" in **Figure 8**. This approach would have substantial complications in the assembly of the LEDs to the case and mounting of the printed circuit board assembly. The idea to use light pipes from surface mounted LEDs up to the top of the enclosure gained the most support. The challenge was now to

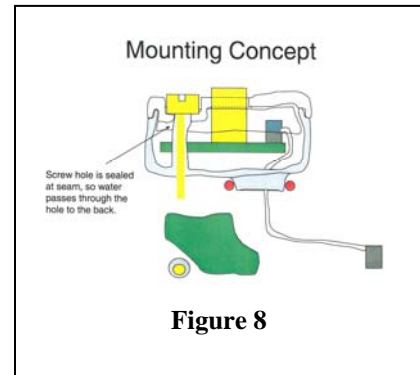
provide a means to seal around the LEDs on the printed circuit board and around the light pipes at the enclosure interface when the assembly was filled with the appropriate liquid sealing compound.

The other major challenge was related to the various control cables and wiring, which connected to the main motor control board providing the necessary control signals for operation. Sketches were again exchanged that demonstrated ideas on how to best accomplish that task.

An early approach for mounting and sealing of the cables is shown in **Figure 8**. The opening in the bottom of the case where the cables pass through would have a rubber sealing means around the perimeter of the opening.

These early sketches were used to fix concepts to allow the mechanical design to begin. Use of a liquid compound for sealing around the connectors, the use of light pipe approach for viewing the LEDs and the use of a rubber sealing means around the protrusion on the bottom of the enclosure were all fixed and signed off by the OEM.

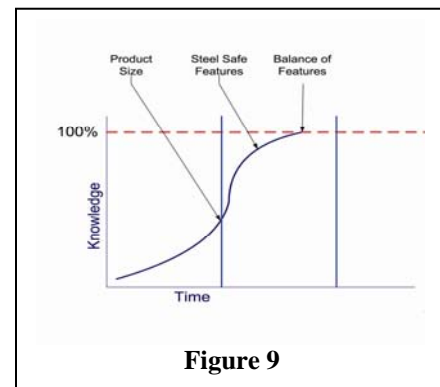
What was beginning to take shape in this development environment was a very strong idea generating machine between the OEM, the development engineers and the suppliers. There were many new concepts that required process knowledge the development engineers did not have. They absolutely needed the suppliers to step up and provide the same level of ideas and solutions to help carry these early concepts to a defined process that would optimize manufacturability.



**Figure 8**

One supplier provided ideas on how timing of decisions could compress the development process with respect to tooling. The enclosure was meant to be plastic and required injection molded tooling to produce the part. The interchange that took place with the tooling supplier identified opportunities to begin the tooling process before the final drawing of the part was completed. These concepts are shown in **Figure 9** as they relate to knowledge transfer.

The tooling supplier stated that once part size was fixed, they could place the order for the die. It was also identified that once the part was designed with all steel safe features they could begin to cut the tool. This would provide the early start necessary to meet the needed delivery date. When the final details of the enclosure were defined they would then complete the die. The team agreed to this approach and when the enclosure size was known the OEM signed off and the tooling supplier was released to procure the die required. In similar fashion, when the part was designed to the point of having defined all the steel safe features the OEM sign-off occurred and there was subsequent release of the tooling supplier to begin cutting steel.



**Figure 9**

Although the example used injection molded tooling to show how development timing improvements to the traditional approach of waiting until the part drawing is complete and signed off can be achieved, it must be understood that this approach was used in all aspects of this development. The electronic hardware engineer could proceed without knowing all the details on the type or style of connectors. Early prototypes could be developed and tested to ensure the core functionality was understood. These prototypes looked little like the final configuration, but provided a reassurance early in the project that nothing was misunderstood. While the enclosure and electronic design were progressing the software was also being developed with releases of core functionality occurring with the early prototypes. This provided the confidence that the critical functionality of the unit was operational and any bugs were small in scope and could be resolved quickly.

Another major benefit that emerged from making incremental decisions only when necessary, is that those decisions were optimized by making them at the latest possible time with the maximum accumulated product knowledge.

The EMS provider was integrated all along the way. The end customer was an early Lean adopter and the production requirements were to be setup in a pull system with a kanban arrangement. Besides the longer development activities, the supply chain needed to be brought in early due to numerous components being of a long lead time.

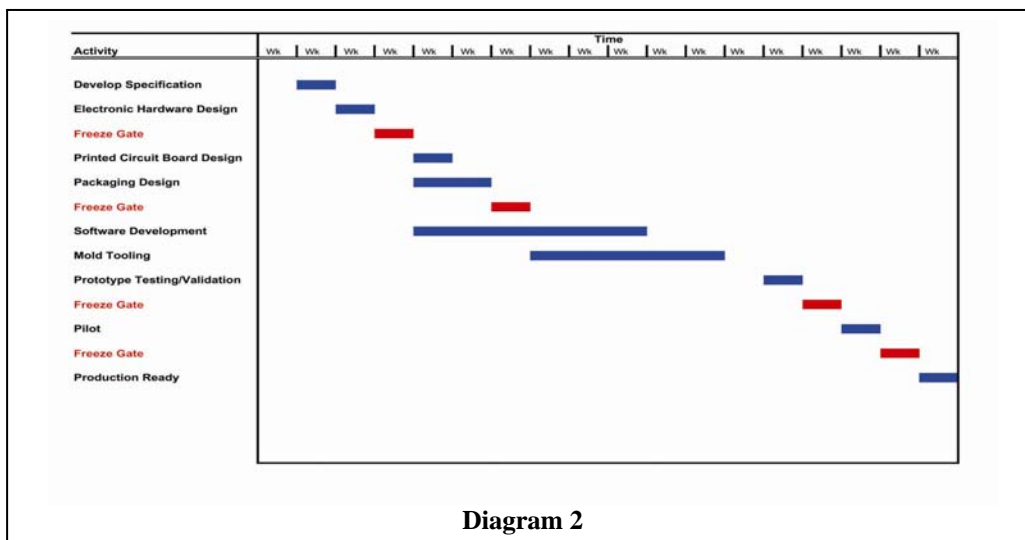
The same concepts that were being applied in the development stages were supported on the EMS side. In order to bring the component supply chain in early enough for manufacturing to meet production delivery needs, the need was to release the bill of material in segments. The start of this supplier discussion activity needed to occur at the time the prototypes were being

tested by the engineers. In development, the bill of materials is often largely complete at the time of the prototypes. There may be passive component changes required following testing of the prototypes, however these tend to be components with short lead times and readily available. Most often the major components are known early and tend to be the longer lead time items, such as microprocessors, specialized integrated circuits or displays. These components often require more detailed arrangements with the supplier to support kanban arrangements thus longer negotiation timeframe. Consequently, the long lead components on the bill of material were fixed and signed off by the customer at the time of the prototype. This signoff is most important for the EMS provider who is purchasing material to have the customer committed for inventory responsibility. The early involvement allowed review of components and the manufacturing processes that would be required. This allowed the manufacturing community the ability to provide feedback at a stage when cost and time implications are minimal.

The project moved along a timeline that would meet the OEM's requirement. However, in most projects there are changes that occur and some are significant. This program was no different. Late in the development process it was decided that an identification feature on the project was critical and needed to be incorporated into the end product. The feature affected the enclosure. The size did not change however the identification feature required an undercut in the part. The mold tool, which was underway, was designed as a simple two cavity die without any need for lifters. Unfortunately, the new identification feature, if known earlier, would have modified the die to one with lifters and would have required a different die base. Although the feature was solved by the creativity of the mold designer, which allowed the same die base to be used, it points to the power of having feature signoff occur. This was an OEM-driven change. There was a signoff by the OEM. The agreement with the OEM stated earlier, "It was mutually agreed that should a decision need to be reversed there would be significant consequences in time and cost". Although this was a very significant change, the consequences in time and cost could have been significant. However, the creative solution by the mold designer dramatically reduced the impact on both fronts. The process demonstrated appropriate risk management. The project was completed three weeks later than the revised schedule, which was all related to the identification feature change. However, given the fact that the revised schedule had compressed the original schedule by two and a half months, the feature change impact was minimal.

### Conclusion

This project demonstrates the power of an evolved process called the Freeze Gate Development Process. This process breaks the barriers to a free flowing development and new product introduction process to allow for the Lean concept of "keep it flowing" to win out. Equally important is it allows information to flow in significantly smaller amounts that align with Lean concepts of "one at a time". The development team along with the key suppliers need to have the capabilities to define what features need to be fixed and when. The evolution of the process incorporates freeze gates in the development timeline. The freeze gates need to be along the critical path and have a scope that flexes with the scope of the project. This is shown in **Diagram 2**. When compared to the stage gate process in **Diagram 1** this approach visually demonstrates the removal of the gates that stop development and shows the means of continuous flow.



The process of freezing focuses on the features of the product and not documents. This will break down the barriers that prevent information from flowing earlier in the process. This delivery of information earlier makes the work of those down stream significantly more manageable by incremental steps rather than one large dump of information and makes for a much smoother transition on the part of suppliers of all classes. A significant attribute of this approach allows decisions to be made

when product knowledge is greatest. When documents must be signed off, attributes must be fixed early in the development with the loss of knowledge that would have been gained by delaying the decision.

The stage gate approach as defined in **Diagram 1** was created to manage risk; however this approach stops further development until the gate requirements are cleared. This is a management approach that expects the project to fail. Freeze Gate approach changes the perspective to one that is expected to succeed.

The development process should be one that allows for continuous flow. The freeze gates that are created need to be flexible and aligned with the critical path. The process should focus on freezing design features and not documents. Those features should be made at the latest possible time to allow maximum knowledge to be gained. The key suppliers need to be active team members. The EMS provider will gain component knowledge that will allow them to make recommendations at a point in time when it is most economical. A development process incorporating these elements will achieve significant reduction in time to market and provide a smoother transition to manufacturing.