**Design for "Constructability"…**

By Dominic Gallello,
CEO, Graphisoft.
dgallello@graphisoft.com

**Expect the construction industry to adopt some of the techniques pioneered in the manufacturing industry in the '80s and '90s.**

I constantly hear that the construction industry is a highly fragmented industry and waste is just a fact of life. You have heard the numbers before. 30% of construction is rework, 60% of labor effort is wasted, 10 loss due to wasted material. A large project generates 150,000 documents, and contractors need to pay 3-4% of a project for cost overrun insurance.

On my recent trip to Japan, I was reminded of the book, *Comeback, the Fall and Rise of the American Automobile Industry*. In the book, the authors describe the near meltdown in the US automobile industry in 1982 and what they learned about Japanese manufacturing efficiency. It was **not** technology that made the real difference in the meteoric rise of the Japanese; it was about process and human communication at the "right time".

There is no question that the art of architecture is different from mechanical design. Mass production of buildings is limited and most buildings are individual creations, not something that falls off the assembly line into a box. Still, the worldwide construction industry can learn some lessons from the manufacturing industry. I see a lot of similarities between an architect and a mechanical product designer, and a construction company and a manufacturing supplier.

It is the case that many in the building industry say that they can never achieve the efficiency of manufacturing, because manufacturing is much more vertically integrated under one roof. Nonsense! Manufacturers are almost as fragmented as the building industry. Just as the construction company complains that the architect is "crazy" because key elements of the building could never be built as drawn, the same is true in manufacturing. Mechanical designers and engineers, like architects, know a lot about design, but even today, they know very little about manufacturing a part. In mechanical product development, a part designed one way could cost $50K to

manufacture; with a manufacturer's suggested slight change to the design, the same part could cost $30K.

So, what has the manufacturing industry done to overcome this lack of understanding of manufacturability by design engineers? There are two areas, which I shall look at in some detail in the rest of this article. Please click here to read it.

1. **Timing of communications** – In the manufacturing world, getting the manufacturing department involved as early as possible in the process is key. I always marveled when I was living in Japan 15 years ago how the Canon Corporation would have the discipline to have a manufacturing engineer sit through all the meetings held in phase one (the industrial design phase) of designing a new copier. The reason is, of course, that as the designers were thinking about new organic forms, manufacturing could guide them through what was possible to build and what was not. It was also the case that design department had the chance to prepare manufacturing well in advance for a manufacturing technique that they were not able to execute at that time.

   Another example is a very large manufacturer of semiconductor machinery based in Silicon Valley. In the late 90's, they undertook a program to involve their manufacturing partners in the early "concept" design phase of parts for new machines. What they found was that if they involved the supplier's early, they could save up to 2% out of the cost of goods. When you are spending a few billion dollars per year on parts, this is a huge amount of money!

   So could this really apply to filling the gap between architecture and construction? Yes. One example is Kajima Corporation. They have instituted a process where the construction engineer is involved in the early design phases of any building project. They immediately started seeing positive results.

   In the UK, Taylor Woodrow, a rapidly growing $3-4B per year construction company, has built a "supply chain" with their outside design firms. They are collaborating "early on" in the process. In the US, negotiated bid holds incredible promise. If the building owner selects the construction company in the early phases of design, the opportunity for real collaboration in

designing a building that can be easily constructed is much greater. Of course, design/build firms around the world are proving their competitiveness, because they can collaborate better between the design and construction process.

2. **Model-based communication** – Most of the manufacturing world went from drawings to models in the 80's and 90's. It will never go back. The reason is that with a model, you can do more things more efficiently and you can communicate with manufacturers more effectively. With a model, in addition to design, a designer can more easily check interferences, verify structural integrity, simulate the plastic injection molding process and more easily cut the part. Is it any different in the building industry? Of course not!

   Starting with a 3D model allows for different aspects of building simulation, including design visualization, energy efficiency checking, structural integrity, collision detection, construction sequencing and cost estimation. Even without performing all these additional operations, the model helps to inspire confidence that the architect has chosen the right design for the customer, and that any drawings will be just a by-product of the design effort. In both the manufacturing and building industries, the model, as opposed to the drawing, is the true unambiguous representation of what needs to be built.

   Model based communication has always been popular with architects. For architects like Fender Katsalidis in Australia doing the 90-story Eureka Tower, or Rushton Chartock Architects in California doing a new structure at my house, model based design allows them to focus on getting the design to be the best it could possibly be, and more easily communicate their intent with their customers. And yes, they don't have to worry about plans matching sections and elevations, because the drawing is just a by-product of the model. The model is now becoming even more popular in the construction industry, where the value of the elimination of errors that manifest themselves in interferences is extremely high, and the ability to estimate off the model is becoming mission critical to their business.

In the case of the British Airport Authority's (BAA) massive Heathrow Airport Terminal 5 project, the construction company estimated that reduced ambiguity saves a minimum 20% in construction costs.

As reported in the Wall Street Journal, Toyota recently led a public/private partnership to manage the construction of an airport in Nagoya. As a result, the project was brought in at $6B, as opposed to the budget of $6.9B – a 13% underspend. They also delivered the airport one month early, despite a delay of six months in starting. This is in remarkable contrast to the Osaka Airport project, which was budgeted for $9.6B and was delivered at a cost of $13.1B – a 36% overspend!!

So what does this mean for the architectural firm going forward? It means being really proactive in reaching out to construction partners. Get them involved as early as possible. Invite them to your meetings. Provide them with model data that will allow them to really understand what can be built and what the potential problems could be. Go from delivering document sets to constructible information models.

This renewed focus on constructability is, after all, not new to the profession of architecture. Rather, it is a return to the grand tradition set by master builders such as Brunelleschi, Michelangelo, DaVinci and Wren.