IV. What the Tool and Die Customers Need to Consider

The domestic auto companies wish to reduce the tooling cost disadvantage they experience with their Asian competition (e.g., refer to Figure 3). A significant reduction in costs will require a joint effort between the T&D shops and the auto companies. Granted, the T&D shops can more broadly implement cost reduction initiatives that will contribute to reducing total costs as outlined previously, but many opportunities require joint cooperation. The requirements in terms of die standards and die components, quality certifications (ISO and QS standards) and performance requirements including dimensional objectives and the production validation process (such as the production part approval process or PPAP) all contribute to higher costs, leading some to argue their value.

Most industry experts do not refute the assertion that the product designs of the domestic automakers are inherently more difficult to produce than those for the Asian auto companies. Consequently, there is less carryover of design and manufacturing knowledge, and the sourcing relationships have not encouraged the development of standardized practices or recognized the "total system cost" in launching a new vehicle. Total system costs in this case include tooling related performance factors such as:

- Capital tooling cost (for all dies, fixtures, assembly tools, etc.)
- Tooling design and engineering
- Tooling tryout and production validation
- Implementation of engineering changes
- Product launch effectiveness (ramp up speed and quality)

Past practices have emphasized reducing tooling costs by focusing on individual tooling quotes (typically by bidding one supplier against another), which likely shifted costs to other areas in the total system. There are several areas of collaborative opportunity (between the auto companies and tool and die shops) where improvements can greatly reduce the total system costs associated with tooling.

A. Collaborative Product and Process Engineering

Closer communication between product design and the tooling suppliers can significantly reduce complex problems that do not affect the product design features important to the final customer. Tool and die engineers have in-depth knowledge about tooling design that can be brought to bear early in the development process. Closer communication and earlier involvement would allow tooling engineers to identify manufacturing concerns related to part interface features (e.g., flanges) and forming issues that affect die lineup (number and complexity of die operations, blank die design, and material utilization) without changing the exterior part appearance. This level of involvement will help offset later engineering changes from process design, and help prevent program delays.

B. Development of Analytical Design Methods

The auto companies and all major tool and die suppliers have a significant investment in software and technology to support die design. Forming software to analyze feasibility and draw die development is very effective. Many more advances are needed in the rapidly changing field of spring back prediction, particularly given the rapid introduction of new materials (e.g., numerous high strength steel varieties and aluminum), which often have a higher degree of spring back compared to standard mild steels. Most companies, both auto and supplier, consider their knowledge in these fields proprietary and often do little to support co-development. A closer collaboration in developing these analytical methods, and then supporting their use early in the product development process will reduce downstream engineering changes due to product complexities, and accelerate the tool build and tryout process, resulting in higher manufacturing productivity.

C. Lean Die Standards

There are a number of die construction standards used by the domestic automakers. Some standards are unique to the facility where the tools will be put into production. Many standards are also developed that "over engineer" the dies to compensate for manufacturing negligence, e.g., poor press maintenance or process control discipline such as loading two blanks in the draw die. There are also aspects of the die standards, which differ between auto companies that are not designed to provide anything unique, but help contribute to higher costs. Auto companies and tool and die suppliers have agreed that a coordinated effort could produce substantial savings by re-evaluating the multiple die standards and rationalizing an approach to reduce the number of standards. The number of variations of die components could be reduced, and building dies to the required standards could be simplified. Some of the Asian lean die standards have included:

- Reduced bearing surfaces
- Fewer wear plates
- Using smaller dies as appropriate for the part rather than for the press
- Using fewer die inserts and flame hardening surfaces
- Less finishing on non-show panel dies

Some of the lean die standards require significant internal advancements by the automakers first. For example, lighter dies will require well-maintained presses. "Right-sizing" dies (e.g., making the size of the die match the size of the part rather than a press) requires an internal press replacement / adjustment / maintenance strategy that can be expensive and long-term before implementation.

D. Functional Build

Numerous studies have been conducted at tooling tryout sources (die shops) and stamping facilities that have shown that very few parts throughout the industry meet all of their initial dimensional specifications set by design (see Auto/Steel Partnership for reference reports). Larger, more complex parts tend to experience this problem more, and the same observation is true for European and Asian auto companies as well. Researchers at the University of Michigan have estimated that 50% of stamped parts at domestic automakers have never passed the production part approval process (PPAP). Further, it has been shown that most of the parts that have not passed PPAP, and therefore are out of specification, still result in assembled bodies that are within specification. This is an indication that the assembly process is insensitive to the incoming part variation, and that many part tolerances are tighter than necessary.

In North America, the conventional process to buyoff dies has required the suppliers to continually rework dies to get the dies as close to design intent as possible (Cpk > 1.33). Then when the deadline to ship the dies approaches, engineering evaluates what else must be changed with the time that is left. In effect, the full development time is used in an attempt to create "perfect" parts. Then the process is repeated when the assembly process is validated (see left hand side of Figure 8). However, studies have shown that 50% of parts are accepted as less than perfect due to deadlines. This imprecise process is deadline driven (forcing many dies to be late) and results in the tooling supplier making many die changes during tryout to create a perfect part that will not necessarily improve the final quality of the assembly.

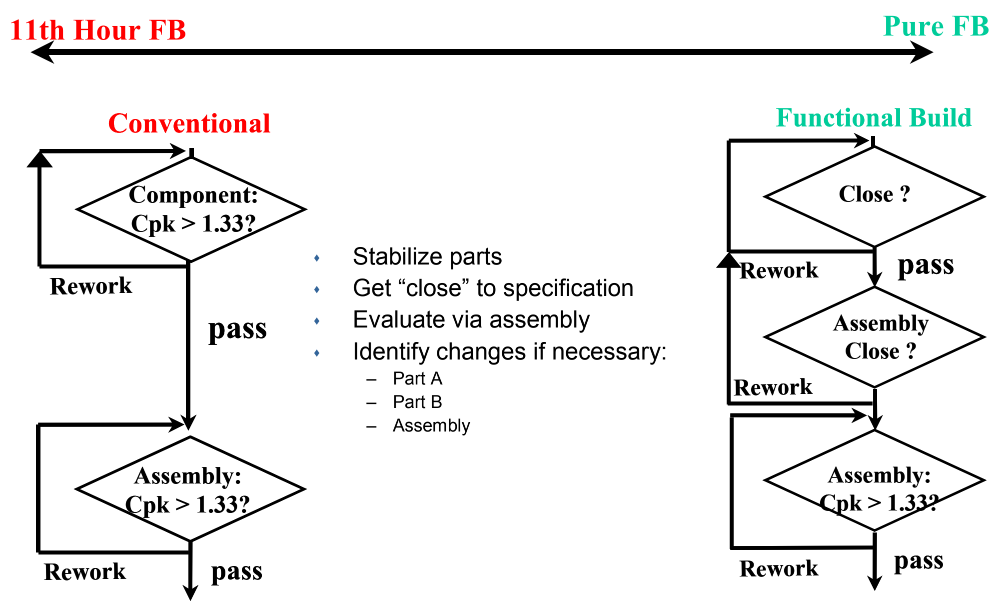

Figure 8 – The Functional Build Continuum.

The functional build process acknowledges that stamped parts do not have to be dimensionally "perfect," yet can still assemble into an acceptable assembly. A development process that recognizes this early during tryout does not wait until time runs out to make the final buyoff decisions. Instead it creates assemblies during the pre-launch phase to evaluate whether parts result in acceptable assemblies, even if they are not within specification. These pre-launch assemblies are usually built on special functional build fixtures, since the production assembly tooling is often not yet available. Hence, there is a two phase approval process. First, the parts are checked to determine whether they are close enough to specifications (often 2x or 3x the specified tolerance) that they will result in a good assembly. If not, then the dies are reworked. Then the functional build assembly is evaluated to determine whether the assembly is close enough that it will result in an acceptable assembly in production.

If the functional evaluation assemblies indicate a potential problem, then a decision must be made between the following options:

A. Rework the die of the part that is not within specification
B. Rework the die of the mating part (that may or may not be within specification)
C. Adjust the assembly tooling

Traditionally, option A would be the only choice possible, since the part is not within specification. Functional build argues to do that which is most expedient in terms of time and cost. Often this is option C. In this manner, only those features that affect the assembly quality are reworked, even if other features do not meet specification. Generally, there are rigorous and statistically based acceptance criteria to ensure a justifiable level of risk.

Since either strategy (conventional or functional build) ultimately relies on evaluating the build-up of the assembly instead of the individual parts, both are considered a form of functional build. However, the conventional strategy is called 11^{th}-hour functional build, and the former strategy just functional build or pure functional build (see Figure 8). The 11^{th} -hour functional build process suggests that when die makers meet their timing deadlines (which they almost always do because achieving Cpk is so difficult), then they revert to functional build in a desperate attempt to get things to work (i.e., do "whatever it takes") at the factory.

The strategy to implement functional build has been pursued to some extent by all of the domestic auto companies, but with limited success. The major barriers to its successful implementation tend to be more organizational than technical. The tooling suppliers, in general, strongly support implementation of functional build. Regardless of whether the execution is controlled by the auto companies or by the tooling suppliers, substantial lead time and quality savings could accrue if it were more widely practiced.