

Fast and Flexible Design and Manufacturing Systems for Automotive and Sheet Metal Parts

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1.0 Summary

The period from January 1995 to June 1995 has concentrated on expanding the project to more deeply research several issues. Our previous findings encouraged us to apply effort in four areas:

- explore the transactions occurring during the sourcing decision making and subsequent product delivery;
- research an auto electronics firms whose products have a much faster product cycle than car development programs;
- replicate the transactions analysis and test for effectiveness;
- Our work in developing a methodology for identifying Key Characteristics (KCs) continues to mature. We are developing a method tradeoff between customer requirements, manufacturing process capability and manufacturing cost and identify KCs from the Tradeoffs.

Coincident with expanding the number of project sites we have also added two new students. One student is a Leaders for Manufacturing fellow who will perform 6 months of fieldwork at Cadillac. The other student is a Lehigh Industrial Engineering Masters student who will perform a three month fieldwork period at Ford Lansdale Electronics.

2.0 Site Expansion

2.1 Rationale for Adding Sites

Our research in the automotive industry has suggested to us that the body engineering is the longest lead time item in the schedule. The dominant element in the body engineering schedule is design and development of tooling which is frequently procured over the supplier web. Therefore it a natural extension of the research to explicitly focus in this area. In addition to time, tooling represents a very large percentage of the costs to launch a new vehicle or model year change.

We plan to focus on both sides of the assembler-supplier transaction, again focusing on the transaction quality during design and production.

We also plan to confirm our successful application of Transactions Analysis by repeating the effort at a Ford Lansdale Electronics.

2.2 New Partners

In an effort to test the migration of our tools Prof. Fine working through Leaders For Manufacturing contacts was able to negotiate participation of three new company partners. Prof. Groover working through a similar program secured the participation of an electronic firm.

- General Motors Cadillac Division (CLCD). Our research is focusing on the sourcing of two body panel stamping dies for the 1997 Park Avenue. The first set of dies for the doors is produced by Ogihara Corp. in Japan. The second set of dies for the rear quarter panel is produced by Cadillac's internal Die Management Group. Die designs are lead products in the development of new products.

The project will contribute to efforts to reduce future product development times through improvements of the die design and manufacture. Rapid new product development is an important aspect of business strategy for CLCD. Under the current system the production of dies for body part stamping presses is on the critical path for the introduction of new models. This project will focus on the development and the production of dies from clay model to production tooling with an emphasis on understanding the time required to complete the process. In particular the current complexity of the supplier web and its transactions will be examined and improvements suggested.

- General Motors Mid-Lux Car Group and the NAO Manufacturing. Our research is focusing on product (Anti-Lock Braking Systems) and process (Underbody Assembly Tooling) supply chains. The supply chains cover both

internal and external suppliers. The objective is to develop methods to enable and facilitate concurrent product, process and supply chain design. The volatile nature of ABS technology with other design elements makes this a transaction intensive design process.

- Ford Lansdale is a automotive electronics build-to-print manufacturer working in a state-of-the-art facility. Among the products they manufacture are engine controllers, anti-lock braking controllers and sensors. Ninety percent of Lansdale's products are directly or indirectly supplied to Ford. They are beginning an effort to garner a larger percentage of non-Ford business. Fundamental to this strategy will be creating an engineering design capability in-house.

We have two goals at this site. The first goal is to replicate Transactions Analysis to confirm its effectiveness in process mapping and diagnosis. The second goal is examine an organization which is working on products with fast product cycle times and where multiple generations of products are available for research.

We have added two new students to staff our new sites. One student joins us from the Sloan Leaders for Manufacturing Program. This is a unique program in which participating students obtain a dual Masters degree in Business Administration and Engineering. Our student is conducting an six month internship conducting research. Brian Kelley has been assigned to the General Motors Cadillac site. Albert Poe is an Industrial Engineering student from Lehigh University. He will be joining Steve Roth, Lehigh and Renata Pomponi, MIT to staff the Lansdale site.

Paul Gutwald who is continuing with us has been assigned to staff the General Motors Mid-Lux site.

2.3 Ongoing Site Research

A significant accomplishment during the period was the development of a sample Key Characteristic flow-down for an actual part using our developing methodology. Don Lee, one of our Doctoral candidate has been leading this effort to develop a methodology to identify Key Characteristics based on customer requirements, manufacturing capability and manufacturing costs

We have observed the implementation of KCs in a wide variety of industries across both Aero and Auto. KCs are used to highlight the critical characteristics of a product. Our observations indicate that the methodologies used in industry of how to select, monitor and use KCs is less than effective and does not use all the information available.

We are proposing a more coherent and through methodology for identification and use of KCs. This methodology is being developed by combining methodologies from industry with a more systematic view of the product realization process which includes complex assemblies, supplier/customer relations, and the interaction of product design and manufacturing process.

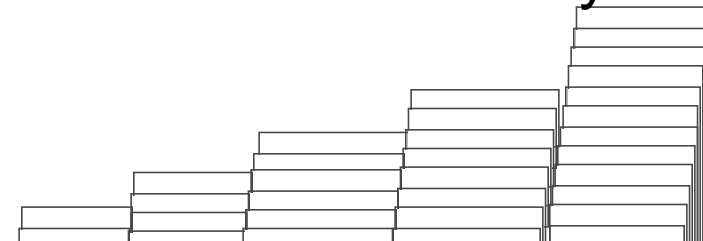
The methodology is three fold. First we are redefining the classifications of KCs to give the definitions more resolution. We have divided up KCs into non-KCs, KCs, and Stat-KCs. Non KCs are those engineering features that are not critical to the primary function and safety requirements of a product. KCs are those characteristics that are critical to product success. Stat KCs are a subset of KCs that highlight those KCs that are either not or are in danger of not being satisfied.

The second part of the KC methodology is the development of a set of tools and best practices for identifying system KCs and flowing them down to part KCs in a systematic method. This method is being developed by going through two real examples: horizontal stabilizer of the 757 and the Half Shaft Tripot Joint from Saginaw. Figure 1 shows a sample of the flow down. The data has been changed for proprietary reasons.

The third part of the KC methodology is the ability to combine disparate sources of design and manufacturing constraints to identify the Stat KCs. This methodology allows product customer requirements, manufacturing capability and product

characteristics to be evaluated simultaneously. By treating all three aspects at the same time, it is possible to identify which customer requirements (i.e., cost and quality) will be able to be satisfied given the current engineering design and manufacturing capability. This particular example will be completed this summer by collecting detailed manufacturing cost data as well the process capability information for the tooling involved producing the tripot lobe.

Snapshot of a KC Hierarchy



	SYSTEM	SUB-SYSTEM	PART	PART SUB-ASSEMBLY	COMPONENT	FEATURE
FAMILY	Car	Powertrain	23 size halfshafts	23 size tripots	Tripot Housing	Tripot Lobe
KEY CHARACTERISTIC			< 1 deg. lash			Lobe Diameter
CONSTRAINT			< 1 deg. lash	23 deg. angle		35.81 to 36.20
VOICE OF THE CUSTOMER	Smooth braking and acceleration	Low lash	Low weight			
MATERIAL REQUIREMENTS					SAE 8720-H	SAE 8720-H
DRAWING #	VIN#		21012173	26014726	26013189	
MFG. OPER. COST	\$8.500	\$3.500	\$23.647	\$14.482	\$9.268	\$0.312

Figure 1: Sample KC Flowdown.

Key characteristics are an important element of our research. We plan to continue to extend this emerging methodology by applying it to different cases and evaluating its effectiveness.

At Delphi, we have gathered the information regarding the myriad of data sources used prior to production. The next step is to gather the same information utilized on the manufacturing floor. Therefore we will have a view of the end-to-end transactions and the supporting databases (which serve as individual decision-aids) for the complete design-manufacture cycle. As well as a methodology to use that data.

4.0 Upcoming Activities

Three external briefings/conferences are currently planned. On Aug. 17 we plan to brief the Lean Aircraft Initiative Supplier Focus Group. We will provide an overview and progress report to this group. During this session we plan to propose a collaborative research effort between LAI and Agile. We have submitted two abstracts for the Defense Manufacturing Conference in Nov. 1995. We intend to submit a variety of abstracts for the Agility Conference scheduled for March 1996 to enable us to disseminate our findings as well as get feedback from the community at large..