Enhanced New Product Introduction through Design to Cost & Value

Stephen Holmes CEng FIMechE

Design to Cost Leader

GE Distributed Power, Achenseestrasse 1-3, Jenbach, Austria

Abstract

Today's market place is highly competitive, with significant downward pressure on margins and increasingly high customer expectations of performance. New product introduction timescales are constricted in order to deliver first to market and increase competitive advantage, in parallel increased cost pressures at point of launch and positive contribution margin expectations during ramp up reduce the scope to pass cost challenges down the chain to serial product cost out programs. Enhancement of traditional New Product Introduction through Design to Cost and Value therefore becomes critical to drive customer value whilst also delivering product to launch phase with acceptable margin. The result of this is to ever more closely tie together supply chain strategy, technology development and concept design such that the cross functional team is engaged during all phases within NPI to deliver cost efficient and value enhanced solutions. Therefore developing cost models and affordability targets by function during concept, a common strategy between supply chain and engineering and supplier input to concept design iteration becomes critical to NPI success. Furthermore this approach is required to enhance development velocity through rapid decision making and reduced rework in order to support the time to market challenge and avoid additional burden to the overall NPI cycle. This study will present the application of Design to Cost & Value within NPI, with experience from implementation within GE Distributed Power for a new product and for an existing product upgrade program.

Introduction

New Product Introduction programs are increasingly stressed; continual pressure exists to reduce development cycle times, customer expectations of performance and quality increase year on year and the increasingly global competitive market combined with widespread economic challenges drive reduced margins. Traditional NPI focusses to technology and quality requirements during concept design and development phases; here achievement of technical deliverables is king with product cost roll up typically occurring later in process, during pilot build or launch. This approach is driven by a desire to launch first to market, provide technical competitive advantage against competitive solutions and minimize or constrain development budgets, but typically can result in large deltas to commercially viable product cost and therefore drive cost focused redesign shortly post launch or even cancellation of development programs late in the cycle. Design solutions during development are not optimized for low cost producer sourcing and even are often tied to specific sub-supplier technology or process capability, driving years of post-launch re-engineering. Additionally development teams feel disconnected from achievement of product profitability targets, focusing on customer technical and business timeline challenges, in doing so driving friction between product managers, supply chain and engineering as cost challenges are pushed down the chain and product profitability targets are missed.

The NPI Product Cost Challenge

The challenge therefore is to integrate cost methodology into NPI concept down select and design, without significant compromise to velocity, and drive cost ownership up the chain into engineering. To do this overall product cost target needs to be broken down by function and system and a more subtle understanding of customer value should be determined. Even still the engineering team is not best placed to determine the cost of complex systems which can, dependent on sourcing strategy and supplier capability, vary significantly in their purchased cost. Neither is the engineering team well placed to understand market stratification or the marginal value of performance, that is to say the degradation of value to customers of partial achievement and the point below which value is lost. Therefore a mechanism is required build a cross functional capability to model cost, understand volume sensitivity, engage with supply base, stratify customer value and so enable rapid decision making.

Design to Cost and Business Strategy

For Design to Cost to be successful product managers, sourcing, manufacturing engineering and the development team need to understand a stratified view of customer requirements, affordability and the zero customer value cut off for partial achievement of features. A product development program that aims to deliver all requirements to all customer segments at all times will result in excessive base product cost and, for many customers, performance that is in excess of requirements or non-valued. Therefore an understanding of ‘base offering’ and optional or market based features allows a cost optimal product development whilst maintaining control over variety.

Figure 1. Market Segments within GE

System & Function Cost Flow Down

Product cost targets are then required to be established per major market area, based on a serial volume assumption or ramp up volume points. These however are often intangible to the development team and particularly during concept there are few tools to enable total product cost analysis to form part of decision making. Critically this period in an NPI cycle is where significant cost decisions are taken even if without a clear understanding of the downstream implications. For the development team to buy in to and engage with product cost during development the cost target must be broken down; from customer affordability, through business required contribution margin and then to product systems or functions. The process of splitting the product target into system or functional targets is a key point where responsibility for cost management is accepted by the development team and engagement of supply chain to concept development is created. This cross functional team work produces first stage of a cost model, which ultimately is the core tool within Design to Cost methodology and will drive cost management through the NPI program.

Within GE Distributed Power the Design to Cost Leader is responsible to drive this process and ensure the cross functional teams are engaged in target cost definition during concept phase. For a new power generation product development program the system hierarchy for the product is defined and therefore benchmark data is leveraged to determine typical ratios of system cost. Once complete specific adjustments for the new product are included; for example increased weighting of electronic systems to account for additional relative functionality to historical products or reduced weighting of major castings systems due to a design and sourcing focus to lower cost suppliers. Technical system owners and their respective sourcing commodity leaders take the lead to define top level risks and opportunities and also work together to determine strategies to achieve each system target. The system target is additionally broken further to specific key components, but the top level system target is maintained as team success criteria to allow innovation in system cost optimization and avoid over constraint.

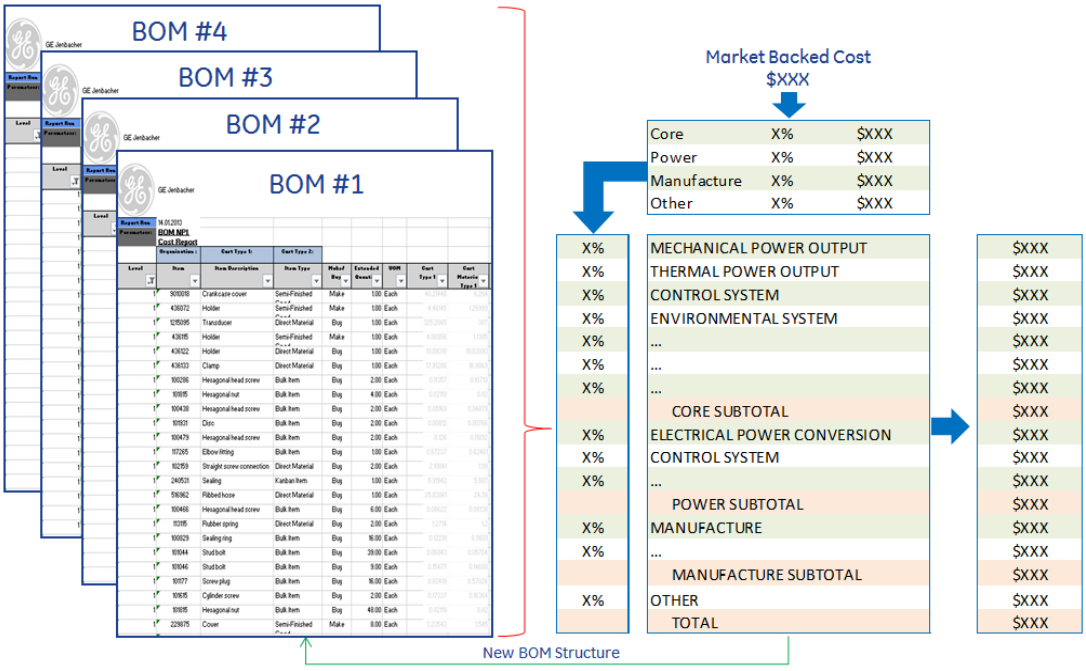

Figure 2. Target Cost Definition

For NPI programs based on existing products the process remains as described previously, except here the benchmark is the existing generation product. Within GE Distributed Power an NPI program based on an existing reciprocating gas engine product is to increase power output and efficiency whilst reducing package size. Under historical development approaches this would likely result in high product cost impact, with Design to Cost philosophy however an aggressive product cost requirement is included. As for new programs the product cost target is split into system targets, with each system owner responsible to deliver. This drives integration of cost out thinking into the NPI program and for system owners to work closely with sourcing commodity leaders during concept. For example; the NPI goal to increase power necessitates increased capability air boosting systems but in order to achieve the air system cost target innovation in design and sourcing is applied to the high pressure air handling and cooling that offsets the impact. Additionally cost targets are defined for systems not core to NPI performance or packaging requirements in order to achieve the overall product cost target and leverage NPI validation for new suppliers or lower cost design. This integration of what historically would be separate NPI and PCO (Product Cost Out) thinking allows acceleration of new supplier qualification for critical components such as pistons or bearings and a significant reduction in overall program spend.

NPI Schedule Consideration

The integrated approach can necessitate some flexibility in the overall NPI process, with new supplier / design qualifications not necessarily achieving equivalent per product milestone maturity as incumbent equivalents. Here GE Distributed Power's approach to Design to Cost maintains focus for time to market with new systems or components not required to launch the product, but required to achieve cost requirements, having individually defined maturity growth and cut in plans. This combination of integrated qualification with flexibility of maturity growth timeline enables rapid time to market along with clarity of the cost work out through production ramp up as volume build efficiencies and low cost systems mature.

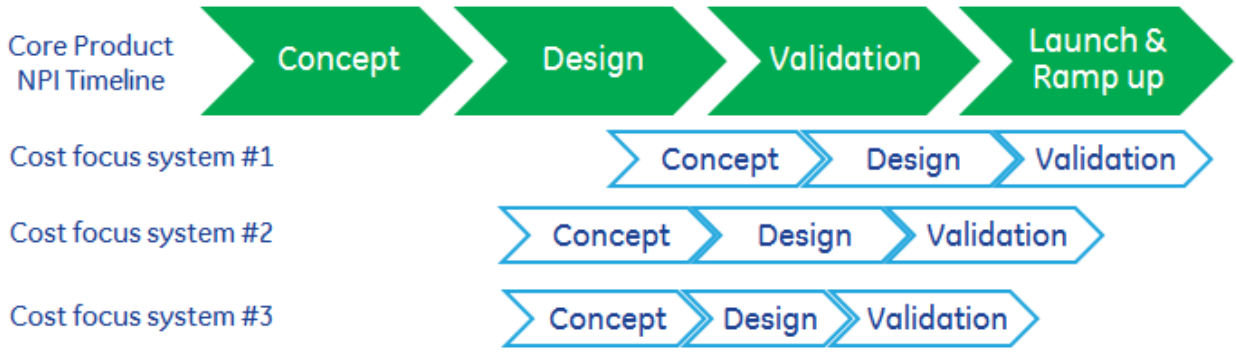

Figure 3. Flexible NPI scheduling to maintain launch timeline

Cost Estimation & Model Development

The creation of top down system cost targets define, directly in concept, a product structure that is then carried forward into the development program. Within this structure key subsystems and components are called out and defined with Design to Cost targets but this does not as yet constitute a Bill of Materials (BoM) based cost model for the product. This occurs during the next stage in Design to Cost where a bottom up estimation of product cost is developed by the cross functional team. Each system or function is now broken down by the technical team into its major building blocks, key components or sub-systems are defined through the flow down of requirements to understand their critical characteristics and low criticality

components are either listed or simply bundled for later definition. This defines the per system or function top level BoM for the team to work through with cost estimation. At this point minimal design work may be available; instead the technical flow down of requirements to each key component is used to determine cost drivers such as outline dimensions, material, weight, production methods, region of supply or manufacture, etc. It is therefore only collaboration of engineering and supply chain together that can effectively determine cost and, as is the case throughout the process, the cross function team is required to form a common view for input to the product cost model.

Cost Estimation Process

Cost estimation techniques vary dependent on maturity of understanding or component type but benchmarking of current, similar components is often the start point with offsets or scaling factors applied to account for deviation in requirements. Even still for the team to build an effective cost model single point estimations are of low value, as uncertainly at this point is high, so instead estimations are based on a range of lowest to highest likelihood with the most likely point also selected. Doing so reduces reliance on absolute estimation accuracy and allows the team to form and document critical assumptions or strategies related to development and sourcing of critical components. This approach also provides more than simply a cost roll up (that could easily be challenged on a component by component basis, derailing the whole process through disagreements on specific numerical estimates) as when combined with Monte Carlo simulation, analysis regarding product cost risk, broken down by systems or functions, is now possible. From here the program team is able to focus resources or develop targeted mitigation strategies to resolve product cost issues before even major components are designed.

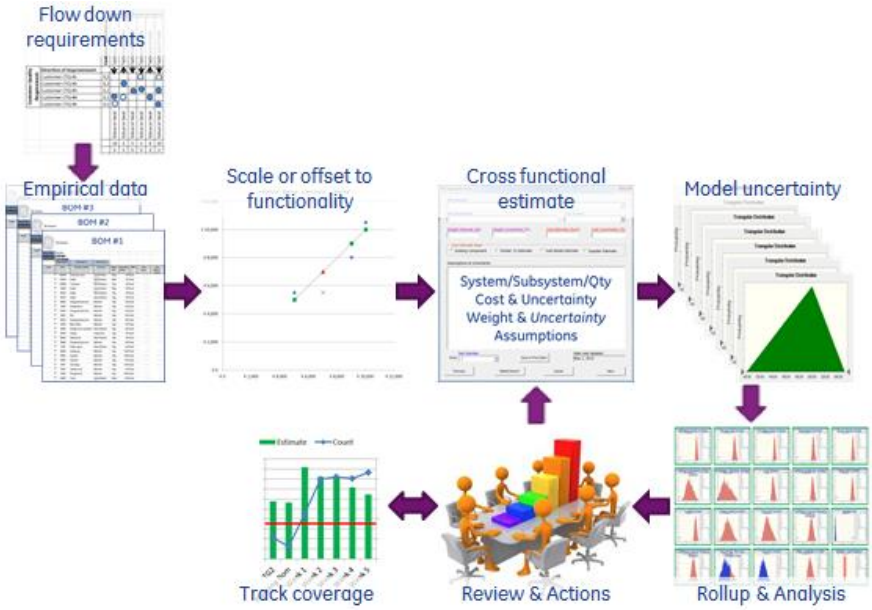

Figure 4. Cost estimation and model creation

Cost Model Use & Impact

At this point the model build up is based on the development team's translation of customer requirements into technical objectives, the supply chain view of sourcing and manufacturing strategy and benchmark data from similar product or systems with modifications for new product specifics. Utilized within GE Distributed Power, this process produced model output above target cost for the new product and

therefore three major mitigation strategies were implemented. The team was asked to relook at key component and system estimates based on refined assumptions; supply chain were actioned to develop a more comprehensive low cost sourcing strategy and to consider in more detain the impact of volume production, engineering improved the translation of customer requirements to technical parameters through refined understanding of customer value drivers and product management revised or removed product requirements through understanding of the product cost to customer value benefit equation. These functionally lead recovery actions are intrinsically interlinked and require cross functional engagement to ensure success. For example, to execute low cost country sourcing the systems and component design requirements must include supplier process capability understanding. Crankcase castings and other major components cannot easily be sourced from high technology western suppliers to low cost alternatives due to differences in materials process technology, minimum capability of wall thickness or draft angle, casting tolerance assumption for machining or complexity of core box design. Included through concept however customer critical product requirements can be delivered alongside low cost sourcing support, significantly reducing late NPI program rework and so accelerating the overall timeline to profitability. In addition through Monte Carlo modelling the cost model provides detailed information to help product management understand the cost / benefit of customer requirements. This value analysis is utilized to produce a more focused product requirements view and avoid a ‘wish list’ of requirements not compatible with product affordability targets.

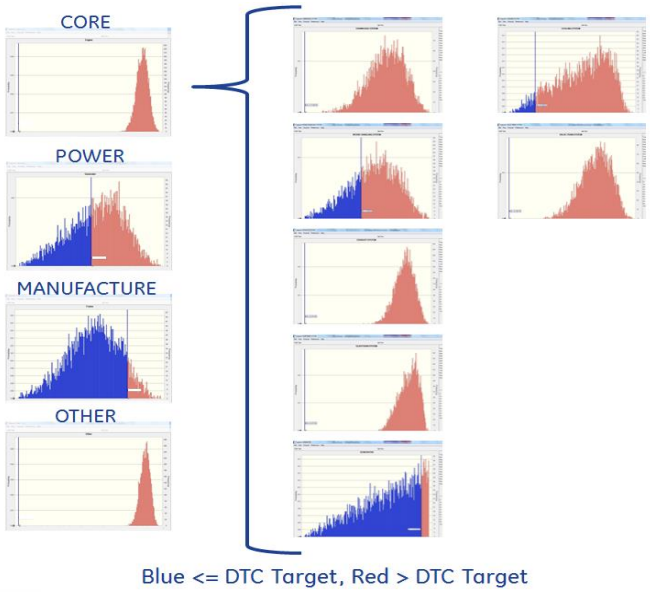

Figure 5. Monte Carlo output of cross functional system cost estimation

Cost Model Development

Whether a clean sheet design or development of an existing product, the cost model then forms the core of Design to Cost through the NPI program; driving continued cross functional engagement to refine estimates, improve the cost efficiency of designs, expand BoM cost estimation coverage and reduce uncertainty. Within this process the adoption of early supplier engagement and virtual cost work outs form critical steps to continued cost optimization of the product and ensure surprises are minimized downstream. As the program matures and designs refine should cost analysis can be leveraged to further drive cost efficient design iterations and ensure forward looking metrics are available to improve the team cost estimation. Should cost analysis then plays directly into sourcing vendor negotiation to help ensure product affordability is achieved in reality and that ramp up volume cost advantages are understood and

flow through to the product. This again can reduce late program churn as the delta from launch product to volume product is more clearly understood upfront and therefore the realization by senior management of a higher cost launch product has less likelihood to derail the team. The forward looking process is also an enabler of rapid decision making throughout the program, pragmatic and time to market decisions are now supported by cost impact data that can be accepted or ensure pre-planned and resourced downstream mitigation actions. Lowest cost producer or most cost optimal designs may not be possible on all components within the development window for the launch product but profitability impacts of such compromises are more clearly understood up front.

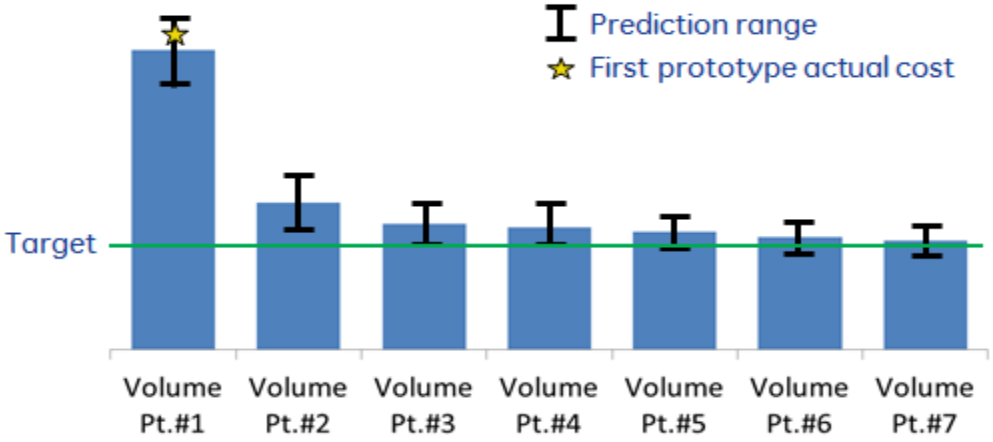

Figure 6. Product cost prediction by volume break point at 1st prototype build

From concept through design, test and validation to product launch Design to Cost and Value provides a framework for the cross functional team to collaborate and drive cost efficient product development whilst maintaining customer value. The product cost model develops from a top level system view of cross functionally agreed cost estimates to a fully itemized product BoM of vendor quotations and should cost analysis. Throughout the process cost data should be visible and the team held to account for both agreement of status and achievement of targets, thus allowing trade off with time to market objectives similarly to classical NPI management of performance or design features. Implemented and driven effectively Design to Cost and Value supports timely decision making and so overall program execution.

Conclusion

Effective implementation of Design to Cost and Value requires commitment from senior program leadership of all functions and close collaboration of the cross functional team from the earliest stage. Sourcing involvement in technology down select, engineering engagement with multiple vendors during concept design and product management optimization of requirements through understanding of cost to value relationships are enabled but not automatically leveraged via this process. Neither is the benefit effectively realized without an ongoing commitment to maintain cost focus throughout the cycle, continuing to hold the team to account at each review and ensuring the model data quality is maintained through redesign loops or pivots in supplier and manufacturing strategy. Implemented consistently however the process and ongoing iteration of the cost model provides the framework within which the cross functional development team is enabled to take rapid decisions and deliver complex development programs that achieve business product profitability goals. Within GE Distributed Power Design to Cost and Value is connected to early supplier engagement and ramp up of should cost analysis capability to provide an integrated process and toolkit for delivery of organizational product cost goals.