The Design-Chain Operations Reference-Model

By John Nyere

At Supply Chain World 2006 in Dallas the Supply-Chain Council (SCC) introduced the first release of the Design-Chain Operations Reference-model (DCOR™). The new model fills voids associated with the Supply-Chain Operations Reference-model (SCOR®) and creates a value chain that unites the design chain and the supply chain. These process reference models integrate the well-known concepts of business process reengineering, benchmarking and process measurement into a cross-functional framework. Before describing the details of the Design-Chain Operations Reference-model, let us review the original SCOR-model and explain the need for DCOR.

SCOR

The Supply-Chain Operations Reference-model was developed and endorsed by the SCC as the cross-industry diagnostic tool for supply chain management. SCOR enables users to address, improve and communicate supply chain management practices between interested parties. The model has been used and continuously improved over the past ten years.

SCOR is a process reference model for supply chain management, spanning from the supplier's supplier to the customer's customer. Virtually every supply chain practitioner knows SCOR's five major processes: **Plan, Source, Make, Deliver** and **Return** (Figure 1).

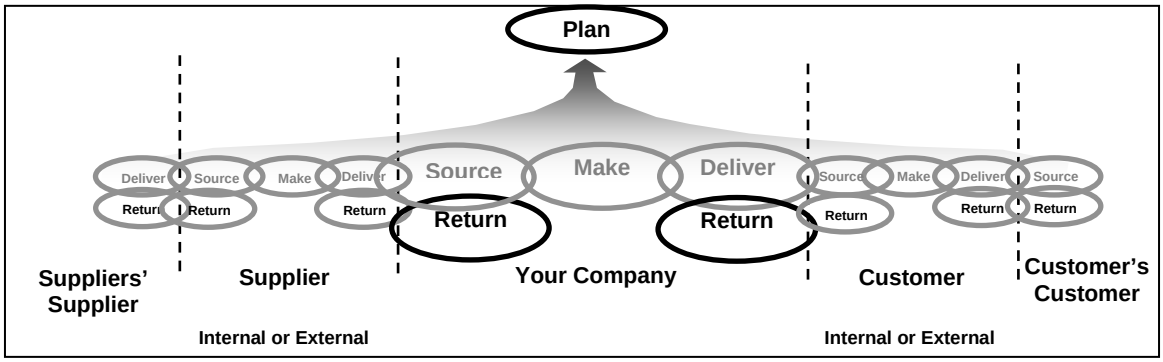

Figure 1. SCOR's five major management processes.

The SCOR-model describes the business activities associated with all phases of satisfying customer demand. By using process building blocks, the model can describe supply chains that are very simple or very complex using a common set of definitions. SCOR has been extremely successful in describing and providing a basis for supply chain improvement for global and site-specific projects. In the U.S. Department of Defense, the reference model brings together multiple armed services, commands and agencies to define what they do. SCOR also brings a complete set of inputs, outputs, metrics and best practices that can be configured to achieve desired outcomes. Make no mistake, in addition to being a process reference model, SCOR is a continuous-improvement process methodology.

Yet SCOR is silent on a number of key business functions. Specifically, the model does not address: sales and marketing (demand generation), product development, research and development**,** and some elements of post-delivery customer support. In response to an overwhelming consensus of members, the Supply Chain Council developed DCOR to address the product development and research and development business processes.

Early Design-Chain Operations Reference-model development

The SCC did not develop the DCOR model from scratch; it inherited an initial draft from the Business Process Management organization within Hewlett-Packard (HP). Under the lead of Joe Francis and Caspar Hunsche, HP developed the first Design-Chain Operations Reference-model. Not only did HP managers see a need for a Design-Chain model to be appended to the Supply-Chain model, they saw the need to develop a Customer-Chain Operations Reference-model (CCOR). DCOR's structure, and that of the forthcoming CCOR, were inspired by SCOR. Both HP models were conveyed to the Supply-Chain Council in June 2004.

In March 2005 the Technical Development Steering Committee chartered a group of practitioners to develop the first DCOR model to be released by the Supply-Chain Council. In March 2006 they released Version 1.0 at Supply Chain World, the organization's annual global conference.

What is DCOR?

The Design-Chain Operations Reference-model (DCOR) is a cross-industry diagnostic tool for design-chain management. DCOR enables users to address, improve and communicate design-chain management practices within and between interested parties. It spans product development and research and development, but does not describe sales and marketing (demand generation) and post-delivery customer support.

Like SCOR, the DCOR model is organized around five primary management processes: **Plan (Design Chain), Research, Design, Integrate and Amend** (Figure 2).

The intersections between SCOR and DCOR will be further clarified by the Supply-Chain Council in 2008; most of the actual exchanges will take place in the *enable* processes and in the *planning* processes of the model.

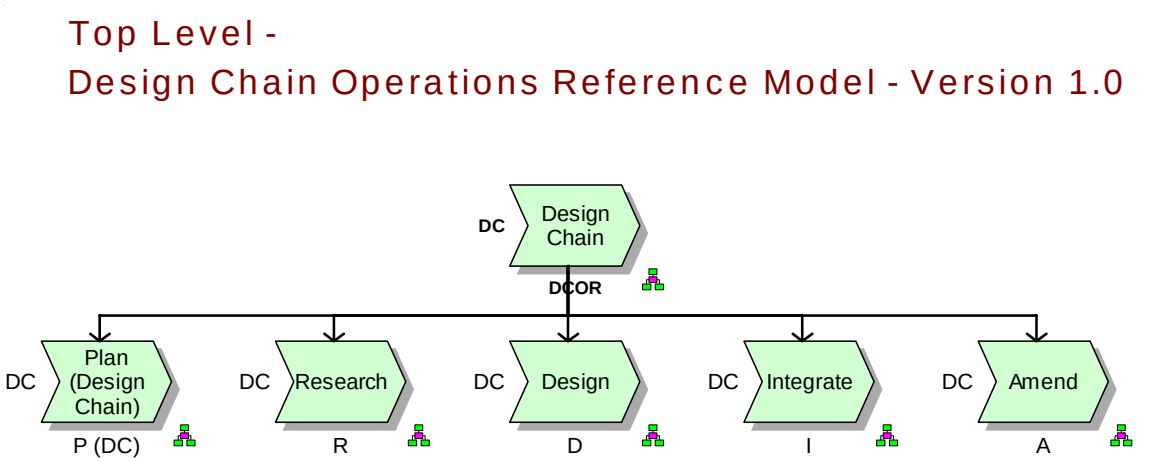

Figure 2. DCOR is organized around five major management processes.

Plan (Design Chain), Research, Design, Integrate and Amend

DCOR's five basic management processes are defined as follows:

Plan (Design Chain). The development and establishment of courses of action over specified time periods that represent a projected appropriation of design chain resources to meet design chain requirements.

Research. The Research management process encompasses the identification and decomposition of research topics, obtaining and synthesizing of information and evaluation and publishing or archiving of research findings. This includes the identification of sources of supply, sourcing and validation of materials/products against requirements.

Design. The Design management process encompasses the refresh of definition, creation, analysis, testing and release of form, fit and function of an existing product. This includes reviewing and adjusting sourcing, manufacturing, testing, servicing and disposal processes.

Integrate. The Integrate management process encompasses releasing refreshed product and new product definitions to Supply Chain for execution and releasing refreshed and new product design documentation to Marketing and Support organizations.

Amend. The Amend management process encompasses the gathering and analysis of product design issues and manufacturability feedback for current products.

To differentiate the "Plan" or "P" process in the Design-Chain model from the "Plan" process in the Supply-Chain model, and the Design ("D") process in the Design-Chain from Deliver ("D") in the Supply-Chain model, the DCOR project development team clearly identified all processes, process categories and process elements as being components of the Design-Chain. In Figures 2, 3, 4 and 5, every object that belongs to the Design-Chain model and not to the Supply-Chain model is clearly identified with a "DC" to differentiate it from a supply chain process, process category, process element, input and output, metric or best practice. This was essential because the two models will be joined and rationalized over the coming months.

DCOR-model Structure

Beside the five basic management processes that provide the organizational structure of the DCOR-model, it is useful to distinguish between the three process types in the model: planning, execution and enable.

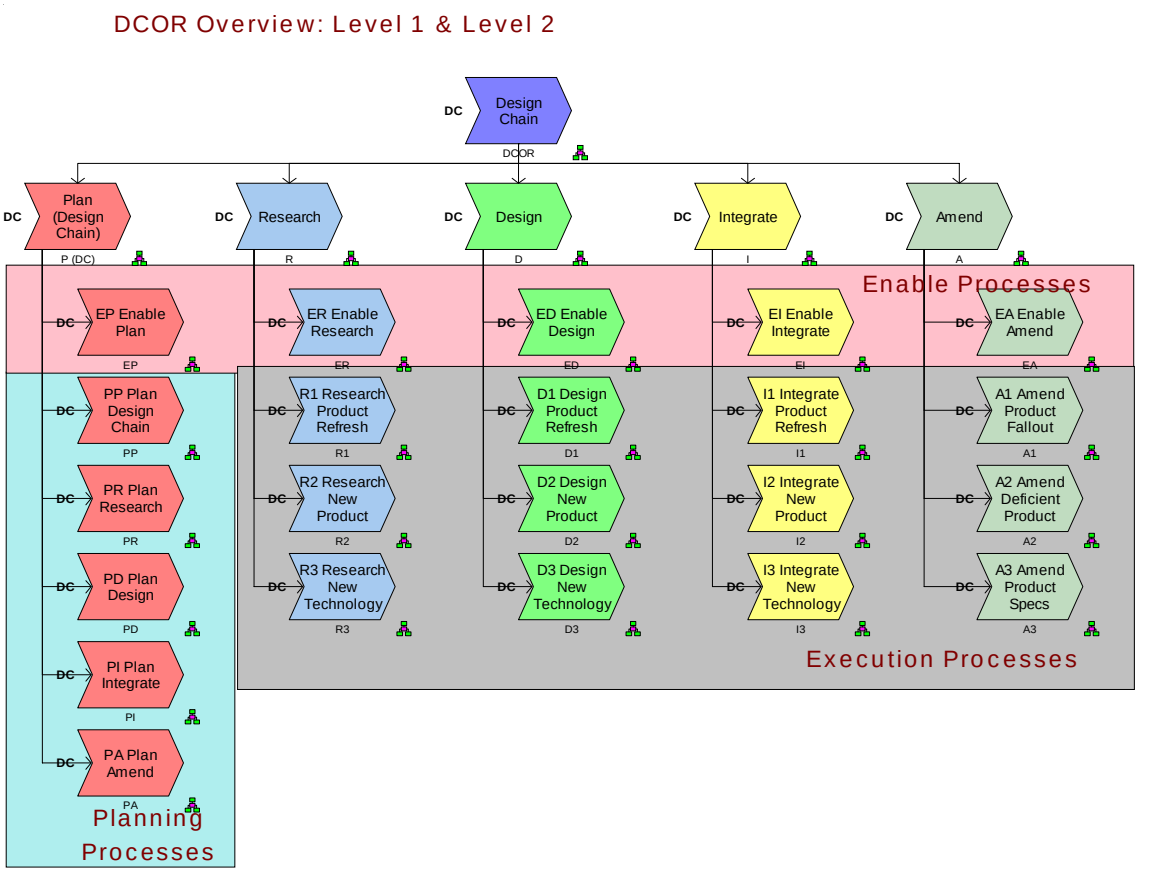

Figure 3. Level 1 and Level 2 DCOR Planning, Enable, and Execution process types

Planning processes align expected resources to meet expected design requirements. Planning processes balance aggregated demand across a consistent planning horizon. They generally occur at regular intervals and can contribute to design chain response time.

Execution processes are triggered by planned or actual demand that changes the state of products. They include scheduling and sequencing, researching and design, materials and integrating product, and amend.

Enable processes prepare, maintain and manage information or relationships upon which planning and execution processes rely.

The SCOR process categories are constructed around 1) Stocked Product, 2) Make to Order Product and 3) Engineer to Order Product. In DCOR, within the Research, Design and Integrate processes, the common internal structure (Figure 3), focuses on three environments: Product Refresh, New Product and New Technology. R1 is Research Product Refresh, R2 is Research New Product and R3 is Research New Technology. This same convention is used for Design (e.g., D1 – Design Product Refresh) and Integrate (I1 – Integrate Product Refresh).

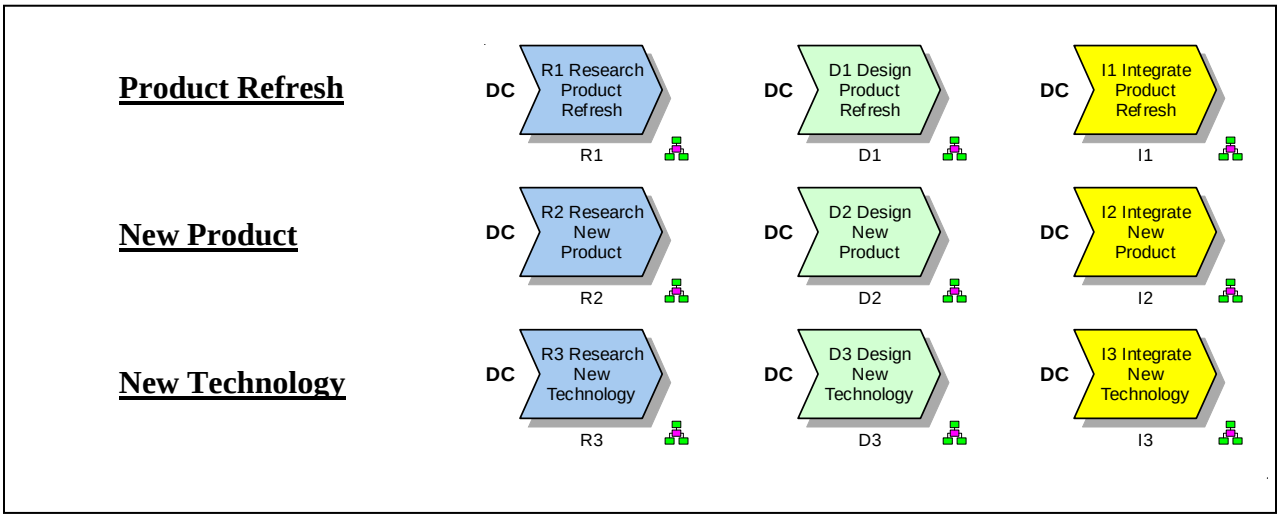

Figure 4. DCOR Focus: Product Refresh, New Product and New Technology

Product Refresh, New Product and New Technology

The three constructs—Product Refresh, New Product and New Technology—vary from industry to industry. Product Refresh relates to an existing product. In the automotive industry, this would equate to introducing "next year's" model when a company spends 15 months to incrementally improve upon an existing model. In the technology area, product refresh may span three to four months.

A new product equates to an automotive manufacturer introducing a totally new product, e.g., a truck, when the company had only produced passenger vehicles to date. This may take as long as seven years. In the U.S. Department of Defense it takes even longer to introduce a new weapon system.

With new technology, a company may be operating in a space where they have never operated before, such as fuel cell technology to continue the automotive example. Obviously, the cycle time (time to market) will be progressively longer as companies refresh, introduce new products and employ new technologies. Correspondingly, it costs less to refresh than to introduce new products (higher) and new technologies (highest).

Amend Process, Process Categories and Elements

While SCOR's ***Return Process*** decomposes into sourcing and delivering defective, repairable and excess product, DCOR's ***Amend Process*** deals with product fallout, deficient product and product specifications. Each of DCOR's three Amend Process categories warrant further examination.

First is the process category A1, Amend Product Fallout, which is the process of gathering, analyzing and addressing issues related to a product's manufacturability.[1] The process is triggered by feedback (an issue) that manufacturing quality or other process standards/metrics cannot be met. The Amend Product Fallout process category ends with the publication of an Advisory (the Engineering Change Notice). Amend Product Fallout decomposes into four process elements, as shown below in Figure 5:

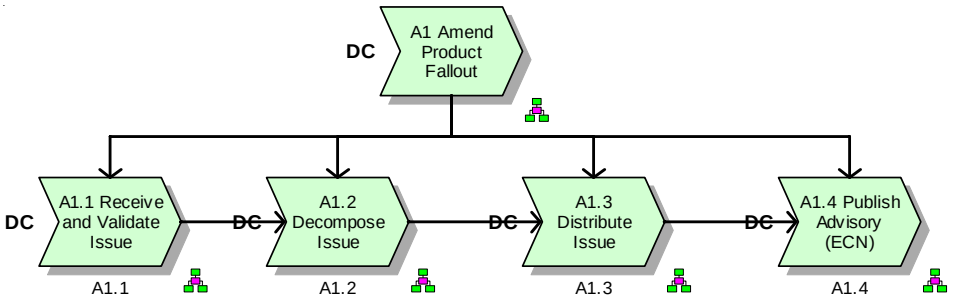

Figure 5. The Amend Product Fallout process elements

The second Amend Process category is Amend Deficient Product (A2), which is the process of gathering, analyzing and addressing a product's technical design deficiency. The process is triggered by feedback that product performance, behavior and/or appearance do not meet product specifications. This includes tolerances for safety. The process ends with the publication of an advisory.

[1] The complete definition of A1 is "The process of gathering, analyzing and addressing products manufacturability. The process is triggered by feedback that manufacturing quality and process standards/metrics cannot be met. This includes regulatory compliance issues."

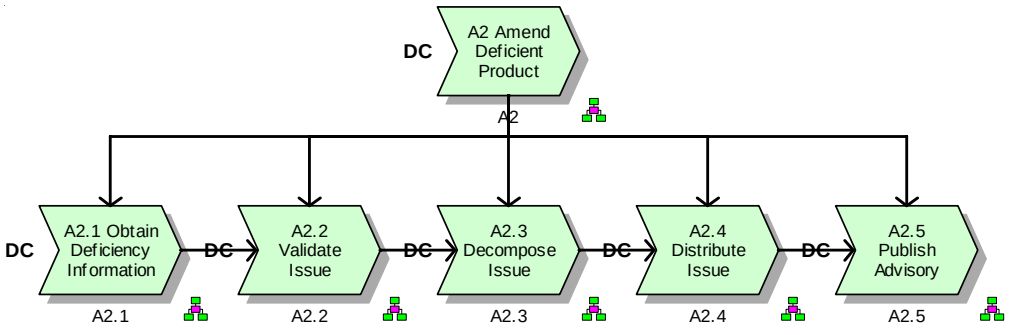

Figure 6. The Amend Deficient Product process elements

The third Amend Process category is Amend Product Specifications (A3), which is the process of gathering, analyzing and addressing a product's specifications. The process is triggered by feedback that the product's specifications as published must be revised. The A2 process culminates with the publication of a Specification Change Order.

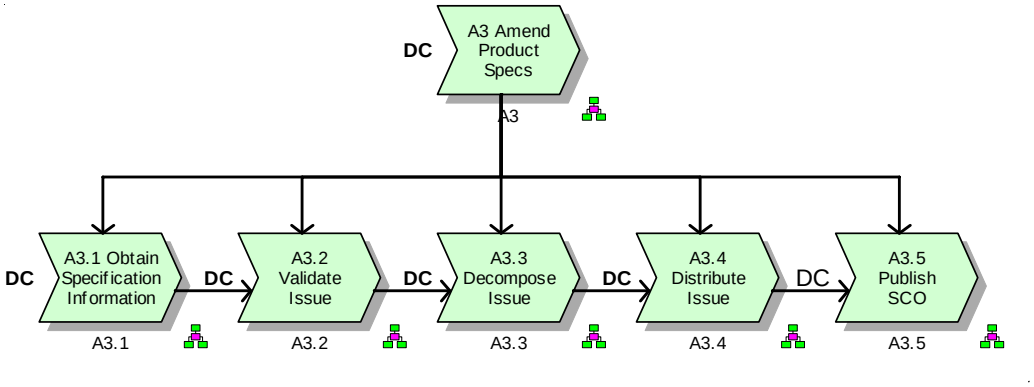

Figure 7. The Amend Deficient Product process elements

DCOR, like SCOR, Contains Three Levels of Process Detail

For those familiar with SCOR, it should be apparent that DCOR has maintained the same three process levels that SCOR has employed for a decade (Figure 8). Level 1 is made up of the process types, including Plan, Research, Design, Integrate and Amend. From the practitioner's perspective it is here that performance targets are established. At Level 2, the Configuration level, the process categories are configured to meet a company's strategy.

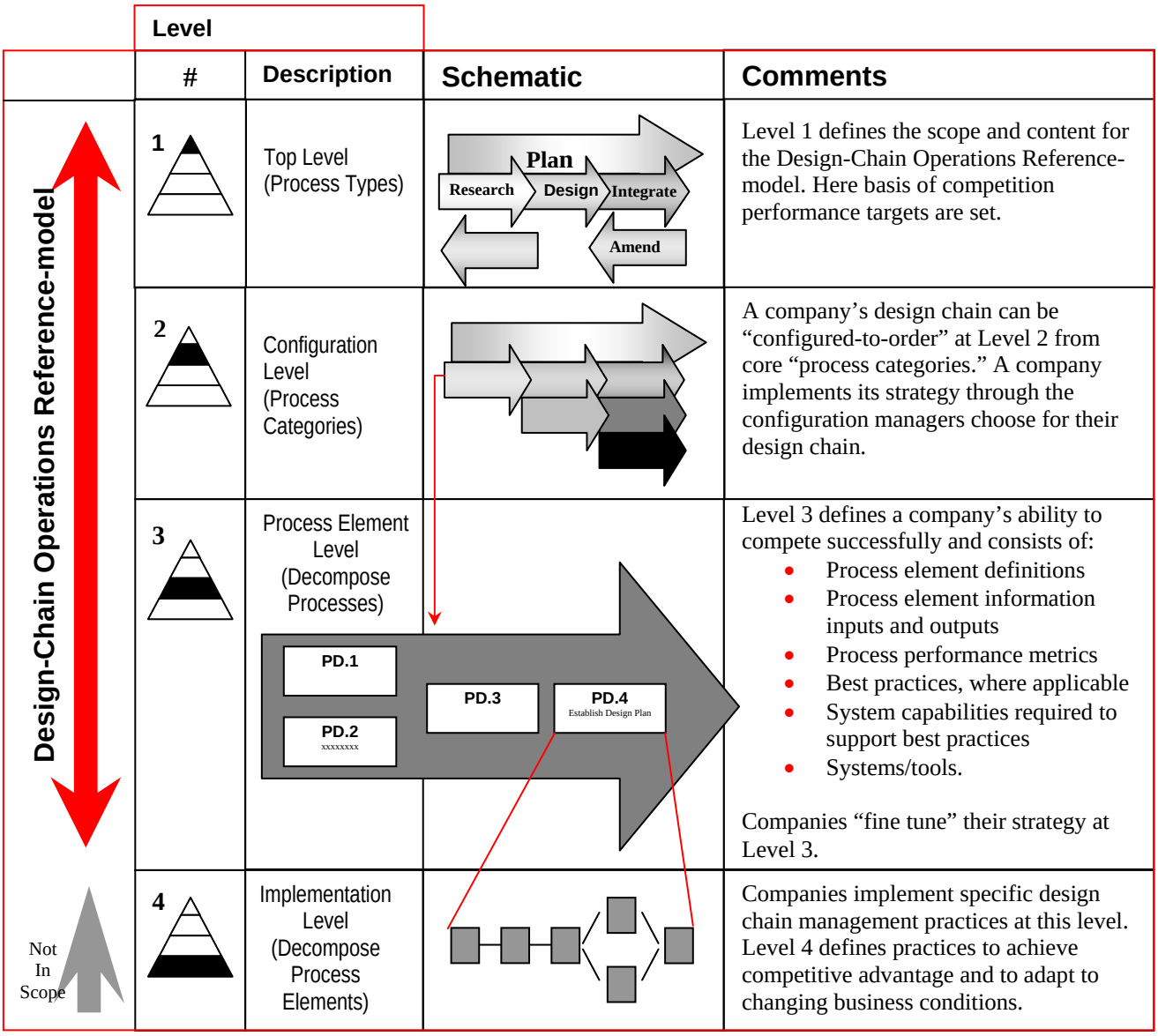

Figure 8. DCOR is hierarchical with three levels

At Level 3 we have the process elements, what some call "functional activity descriptions." Fine tuning the company's strategy takes place at this level. It is at Level 3 where a process element has inputs, outputs, metrics and best practices. Here companies can begin to configure their business to drive the intended results. Let's look at one process element: EP.2, Manage Design Chain Performance:

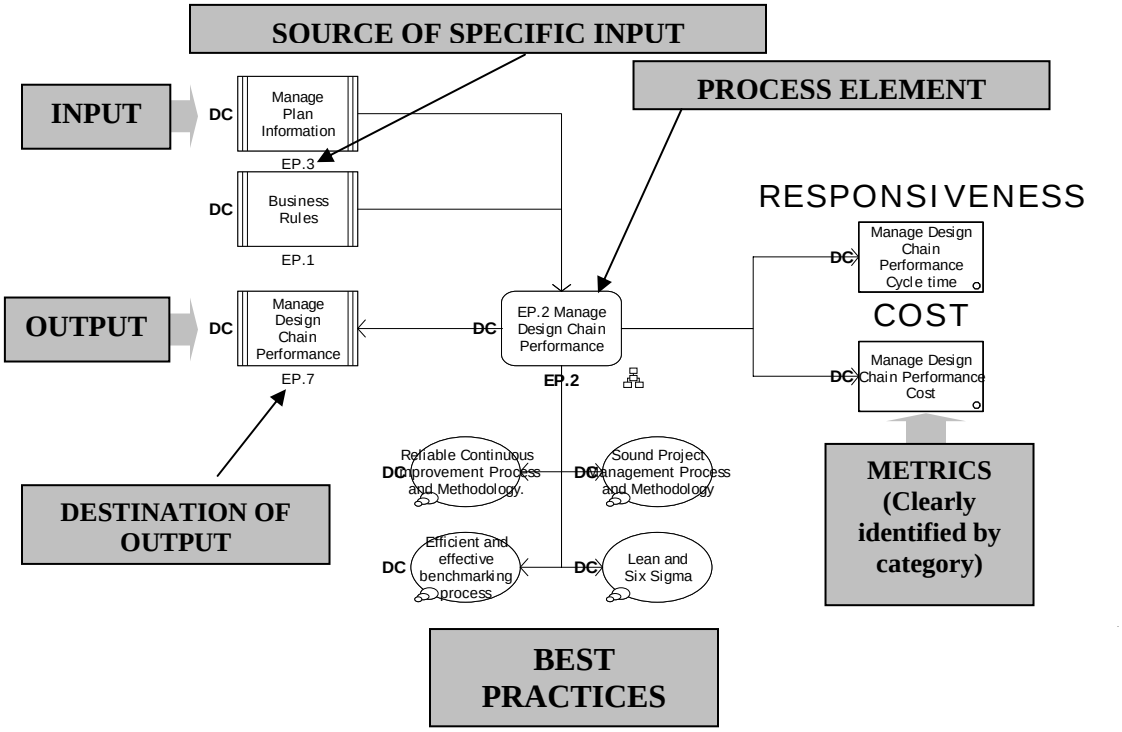

Figure 9. EP.2, Manage Design Chain Performance

In a process element the input's source and output's destination are conspicuously identified. For example, the Input, Business Rules, comes from Enable Plan (EP.1), Manage Business Rules. The Output, Manage Design Chain Performance goes to EP.7, Manage Design Chain Configuration. If the company is focused on responsiveness and not cost, managers would put the responsiveness metric "in scope" and the cost metric "out of scope." DCOR provides over two hundred best practices that a company can use (or not). In Figure 9, for example, Lean Six Sigma is one of four best practices that may be applied to this process element.

As a side note, the model conveyed to the Supply-Chain Council, came without a single best practice. The DCOR team applied applicable best practices from the SCOR model to DCOR, leveraged the U.S. Department of Defense's repository for best practices, and the Corporate Synergy Development Center in Hong Kong for design-related best practices.

As with best practices, the model conveyed by HP did not contain a complete metrics suite. It still does not but the DCOR development team went to great lengths to ensure that every process, every process category and *especially* every process element had a responsiveness metric and a cost metric associated with it. Both best practices and metrics will be improved in future releases of DCOR. Regardless, this brief discussion of metrics at the lowest level is a good segue into the overall Performance Attributes and Level 1 Metrics of the DCOR model.

Performance Attributes and Level 1 Metrics

Referring back to the Level 3 model (Figure 6), Level 1 Metrics are primary, high level measures that cross multiple DCOR processes. Level 1 Metrics *do not* necessarily relate to a DCOR Level 1 process (Plan, Research, Design, Integrate and Amend). Again, the model remains true to the SCOR framework by maintaining the same five performance attributes employed in SCOR: Reliability, Responsiveness, Flexibility, Costs and Assets (Figure 8). As stated above, Responsiveness and Costs were the focus for this first release of DCOR.

	Performance Attributes				
Level 1 Metrics	**Reliability**	**Responsiveness**	**Flexibility**	**Costs**	**Assets**
Perfect Product Design	x				
Design Chain Cycle Time		x			
Product Design Change Cycle Time			x		
Total Design Chain Cost				x	
Design Chain FTE per Product Design					x
Design Chain Fixed Assets Value					x

Figure 10. DCOR Level 1 metrics and performance attributes

The Design Chain **Reliability** Performance Attribute (Level 1) is Perfect Product Design. It measures the performance of the design chain in delivering: the correct design to the correct place at the correct time in the correct format with the correct documentation to the correct customer.

The Design Chain **Responsiveness** Performance Attribute (Level 1) is Design Chain Cycle Time. It measures the speed at which a design chain provides products to the customer.

The Design Chain **Flexibility** Performance Attribute (Level 1) is Product Design Change Cycle Time. It measures the time to change a product design after it has been released to operations.

The Design Chain **Costs** Performance Attribute (Level 1) is Total Design Chain Cost. It provides the costs associated with operating the design chain.

The Design Chain **Assets** Performance Attribute (Level 1) is the effectiveness of an organization in managing assets to support design chain operations. This includes the management of all assets: fixed and working capital.

Using DCOR by Itself or in Concert with SCOR

SCOR has been employed for nearly a decade without the benefit of DCOR. Like SCOR, DCOR can be used by itself to support analysis, measurement and improvements of design chains. In "fabless" industries where companies design but do not manufacture or distribute product, the DCOR model has tremendous potential. Keeping DCOR loosely integrated with the other reference models that make up the Council's Integrated Business Reference Framework (see next paragraph) allows the other models to be improved on or used independent of the others. The maturity levels of the reference models are also very different, with SCOR being a very mature model and DCOR waiting for refinement by practitioners.

Loose model coupling also unburdens the two different disciplinary areas. But some benefits can only be realized by coupling the two models in an expanded value chain. Tradeoffs and optimization between supply and design can now be made. Time to market and time to volume can only be measured when the two models are used together.

The Integrated Business Reference Framework

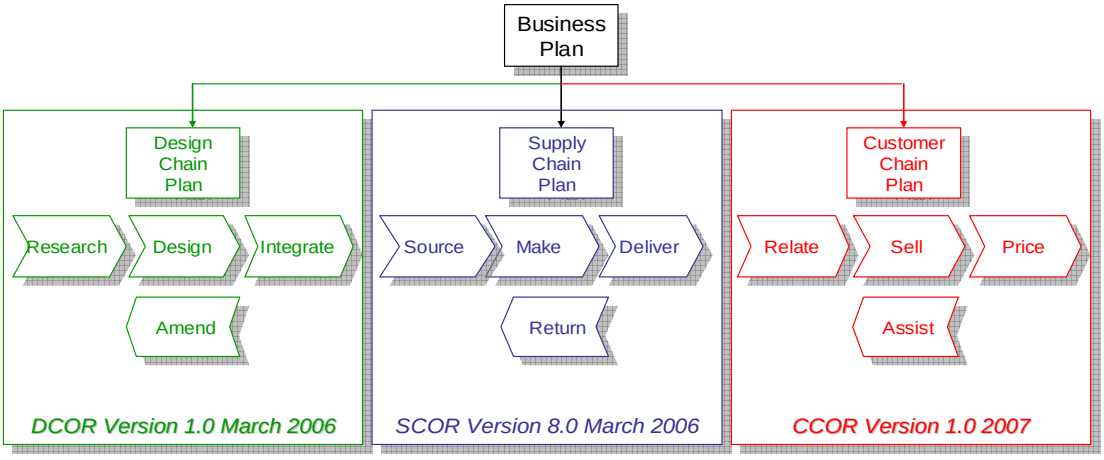

Figure 11. Supply-Chain Council's Integrated Business Reference Framework[2]

Figure 11 presents the Integrated Business Reference Framework first described at Supply Chain World in 2006. With the release of DCOR, two thirds of the overall framework are now in place. CCOR is the final third of the overall framework, which is scheduled to be released in 2008. The Integrated Business Reference Framework is the

[2] The Integrated Business Reference Model was developed by Scott Stephens, former Chief Technology Officer of the Supply-Chain Council, who presented it at Supply Chain World 2006.

business plan that drives all of the company's value chains. As illustrated below, customer requirements, product data management (PDM) and product lifecycle management (PLM), cycle times and costs, can now be gauged in a more complete manner:

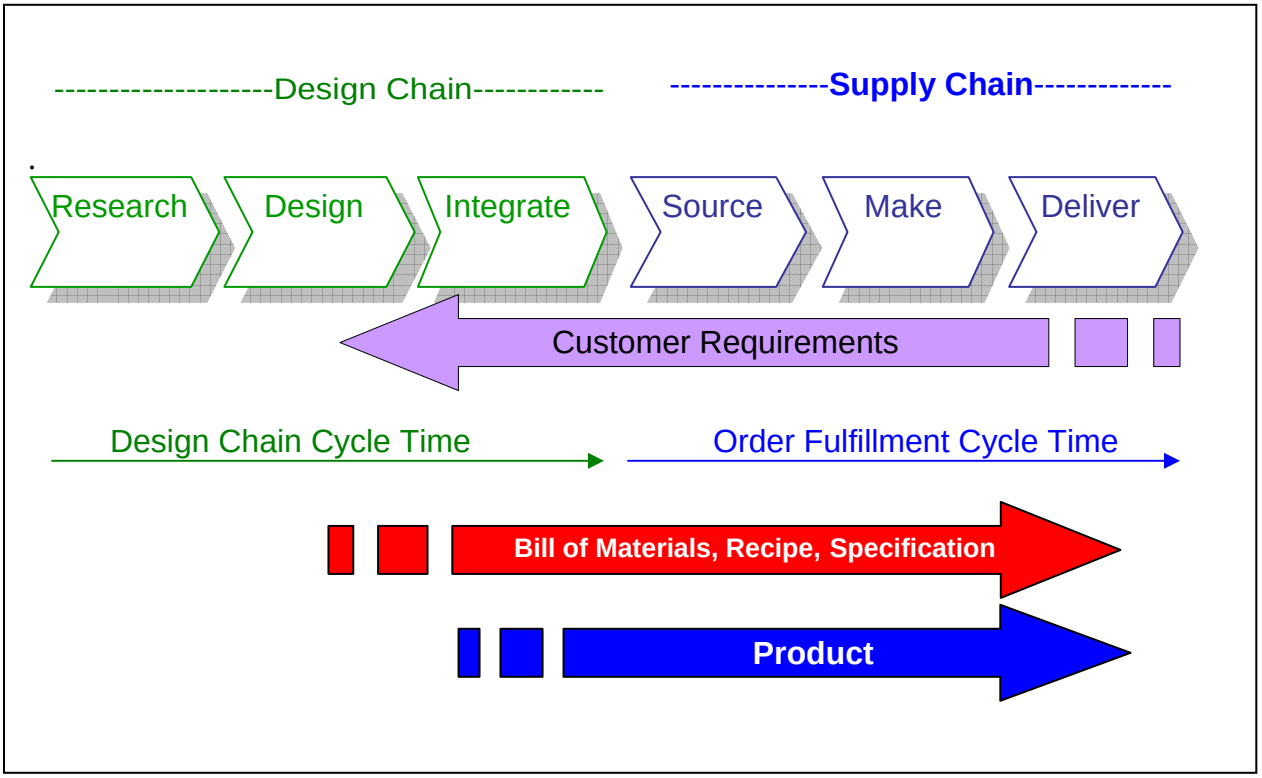

Figure 12. Customer Requirements, Cycle Times, Bills of Materials and Product across the Integrated Business Reference Framework

Let me conclude with a couple of comments about the integrated framework. First, there will need to be a leveling between the SCOR model and the DCOR model. Over time, the SCOR model added more detail to the processes associated with engineer to order (ETO) product and—to a lesser degree—the make to order and the stocked product "chains." SCOR S3, M3 and D3 respectively address Source, Make and Deliver ETO product as shown in Figure 13.

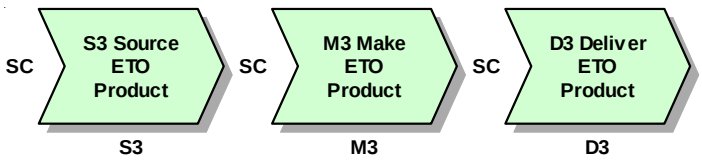

Figure 13. The SCOR Engineer to Order value chain

But with the addition of DCOR's New Product R2, D2 and I2, we have a value chain that looks like Figure 14.

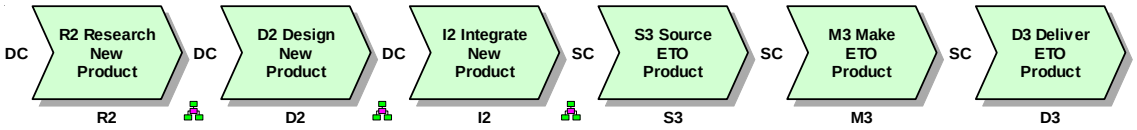

Figure 14. The DCOR and SCOR Engineer to Order value chain for New Product

The M3 process level looks like this:

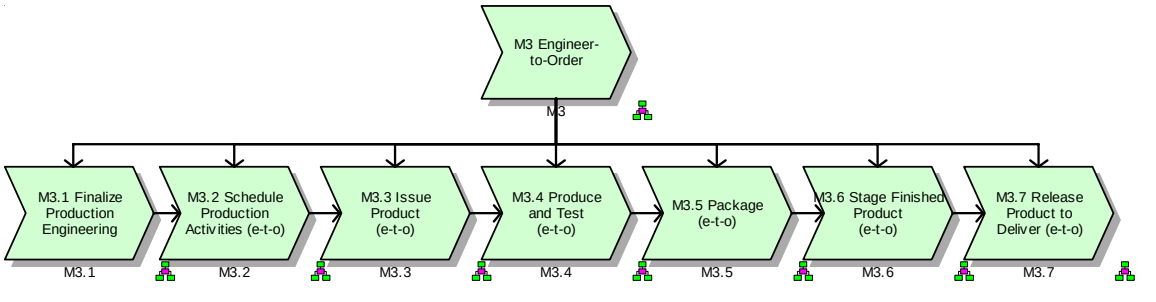

Figure 15. Engineer to Order value chain for New Product

M3.1 is the process element "Finalize Production Engineering," which is defined as "Engineering activities required after acceptance of order, but before product can be produced. [They] may include generation and delivery of final drawings, specifications, formulas, part programs, etc. In general, the last step in the completion of any preliminary engineering work done as part of the quotation process."

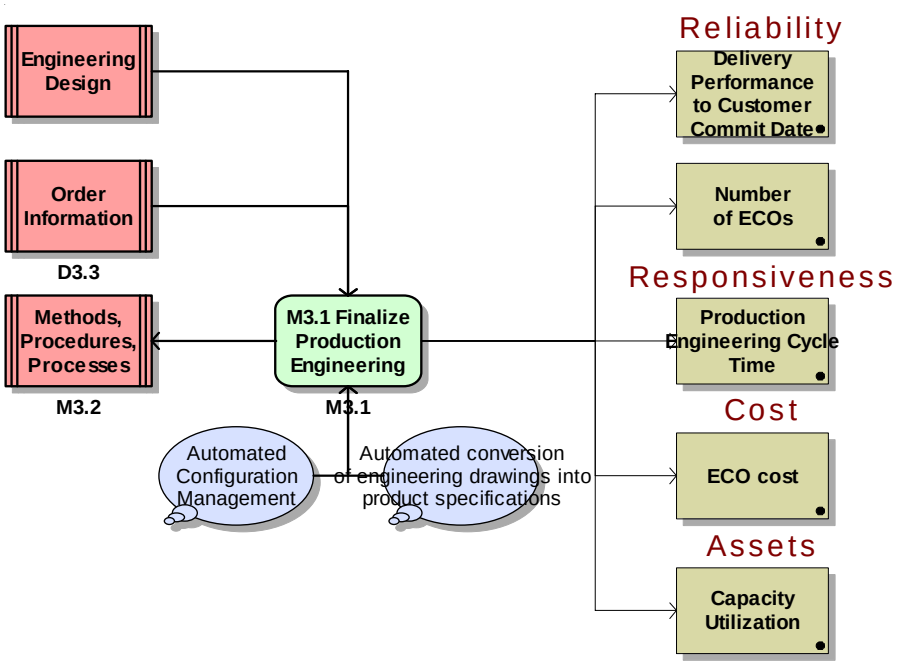

Figure 16. Finalize Production Engineering process element M3.1

Note that there are two inputs and a single output for M3.1. In addition to order information, Engineering Design is the second of the two inputs for this function. Engineering Design will clearly come from the Design Chain, from either the Product Refresh or New Product value chains. Methods, Procedures and Processes comes out of M3.1, which is defined as: "Methods, procedures and processes required to produce distinct items, such as parts that retain their identity through the transformation process and are intended to be completed after receipt of a customer order, including custom products that are designed, developed and produced in response to a specific customer request."

What this says is that in the case of Product Refresh, design specifications come out of D1.5 (Release Design to Integrate) and go to I1.3 (Obtain and Validate Design) where they continue through the remainder of the I1 process elements and finally result as I1.6 (Release Product) as product specifications.

Concluding Remarks

For the first time organizations have communications tools that bring together the design and supply chain to address problems that span more than just the supply chain. SCOR and DCOR enable them to address problems specific to the supply chain or the design chain, or both. Using the integrated framework companies can address process threads that span a product's lifecycle—not just the supply chain portion. The overall

framework can be used to develop a more balanced scorecard with a more complete set of measurements that can be benchmarked.

As a member of the Supply-Chain Council's Technical Development Steering Committee, John Nyere led the development of the first release of the Design-Chain Operations Reference-model (DCOR). He is the Special Assistant for Supply Chain Integration serving in the Office of the Deputy Under Secretary of Defense for Business Transformation in the U.S. Department of Defense. Nyere is a graduate of Washington State University and the U.S. Naval Postgraduate School.

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