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Using TRIZ in a Six Sigma Environment

Ellen Domb, Ph.D.
The PQR Group, 190 N. Mountain Ave., Upland CA 91786 USA
+1(909)949-0857 FAX +1(909)949-2968
ellendomb@compuserve.com or editor@triz-journal.com

Introduction: The Six Sigma system for quality improvement in products, services, and processes is a business-based system of using statistical analysis and customer-focused methods. It has been demonstrated repeatedly that a company that moves from three σ processes to six σ processes increases its profitability by 2-3 orders of magnitude, and that companies that use the Design for Six Sigma process create products and services with much higher levels of customer satisfaction and technical quality than those that don't (Reference 1-6). Coupling TRIZ with Six Sigma produces these powerful results faster, since the breakthrough problem solving aspects of TRIZ can be focused on the profit opportunities identified by Six Sigma and the technology forecasting aspects of TRIZ can be focused on planning new products at the right time in the product life cycle.

TRIZ and the Six Sigma System: TRIZ is beneficial in both the improvement of existing products, services, and processes, and the creation of new products, services, and processes.

The "Breakthrough Strategy" of Six Sigma is different only in vocabulary, but not in concept, from the "Plan-Do-Check-Act" method used in quality improvement for the last 70 years, and in human learning throughout our evolution (Reference 8). The tools of TRIZ that are used in the improvement arena of Six Sigma are as shown in Table 1 (Reference 1) as well as the relationship to the PDCA model. The difference in emphasis between Six Sigma and conventional quality improvement methods is the focus at all levels of application of Six Sigma on the business results of the proposed improvement.

TABLE 1: Opportunities to apply TRIZ occur in seven of the eight phases of Six Sigma's improvement process (sometimes called "MAIC" after phases C, D, E, and F.)

Plan-Do-Check-Act Phase	Six Sigma Phases	TRIZ opportunities
Plan	A. Recognize	Functional analysis (or Su-Field analysis), Ideal Final Result
Plan	B. Define	Functional analysis (or Su-Field analysis), System Operator
Plan	C. Measure	Develop measurement methods, improve instruments (76 Standard Solutions, Scientific Effects, Conflict Resolution)
Plan	D. Analyze	

Plan-Do-Check	E. Improve	Create new product, process and service concepts (Elimination of physical or technical contradictions, 76 Standard Solutions, Scientific Effects)
Check-Act	F. Control	Same as C
Act	G. Standardize	Anticipatory Failure Determination
Act, Plan	H. Integrate	Apply to design phase for new products or services

Typically, Six Sigma Champions identify improvement projects, and Black Belts lead project teams to conduct the analysis and improvement, using the 8 steps identified as A-H in Table1. Green Belts are members of the project teams. Master Black Belts train the Black Belts and serve as advisors to the Black Belts as they conduct their projects. In many companies, the Black Belts and Master Black Belts are now getting TRIZ training as well as classical Six Sigma training so that they can accelerate the improvement process.

Design for Six Sigma (DFSS) is used for either of two reasons:

1. To design new products, services, or processes that can function at a 6σ quality level, or at whatever quality level is selected for business reasons, using the Six Sigma criteria.
2. To improve existing products, services or processes, if the improvement requires a discontinuous redesign from the earlier system. Improvement beyond 4.5σ (the so-called “wall”) often requires complete redesign. (Reference 5.)

Table 2 lists the phases of DFSS and the TRIZ tools that are useful in each phase.

TABLE 2: The relationship between the TRIZ tools and the phases of Design for Six Sigma

DFSS Phase	**TRIZ Tool**
Multi-Generational Plan	Technology Forecasting, Guided Evolution, Functional Analysis, System Operator
Voice of Customer and other elements of Quality Function Deployment	Conflict Resolution, Ideal Final Result, development of measurement methods.
Concept Development	All
Detailed Design	All
Optimize	Conflict Resolution, Trimming, Problem Solving
Validate/Implement	Same

Typically, DFSS is merged with the company's previous methods of product development initially, and a Six Sigma methodology is developed after the company has extensive experience with pilot projects.

Methods of introducing TRIZ into Six Sigma: Six Sigma is a very highly structured system, with a hierarchy of champions or project sponsors, master black belts, black belts, and green belts with defined levels of knowledge of business, identification of opportunities, statistical processes for analysis and control, and improvement at each level. Companies have inserted TRIZ into this process at a number of different points, and in a number of different ways (training, workshop, consulting, etc.)

Motorola, the company that developed the Six Sigma process from its earlier quality improvement initiatives in the late 1980's, is at the least structured end of the spectrum of methods of incorporating TRIZ into Six Sigma. TRIZ is taught and facilitated through the Intellectual Property Organization. Six Sigma methods are taught and facilitated through a separate Six Sigma Organization. Black Belts frequently study TRIZ and used TRIZ methods to solve their problems, but no joint curriculum exists.

General Electric and Allied Signal/Honeywell, the companies most famous for the economic benefits of their Six Sigma systems, have been similarly loosely structured. There are many pockets of TRIZ knowledge within companies, using a variety of TRIZ-derived methods and software systems, and applying TRIZ to Six Sigma projects.

The Ford Motor Company is in the pilot project stage of introducing TRIZ into their Six Sigma process this year, using the USIT (Unified Structured Innovative Thinking) version of TRIZ.

Dow Chemical Company is also piloting the use of TRIZ in both Design for Six Sigma and the MAIC (process improvement) system. For MAIC, a brief overview of TRIZ is presented to the Black Belts in their training, and the Black Belts then decide whether to enroll in the TRIZ classes that are offered frequently. For DFSS, a group of Master Black Belts are being trained in TRIZ for problem solving and TRIZ for technology forecasting, as well as in the use of TechOptimizer™ software. They will then use TRIZ as needed, and teach TRIZ to the members of the DFSS teams during the development of a set of "showcase" pilot projects this year.

Delphi Automotive Systems is at the highly structured end of the spectrum of relationships between TRIZ and Six Sigma. The Delphi "Innovation Roadmap" was presented at the ASI Six Sigma Symposium, and is reproduced here to show their standardized process for product development.

FIGURE 1. "The Innovation Roadmap" used at Delphi Automotive Systems.

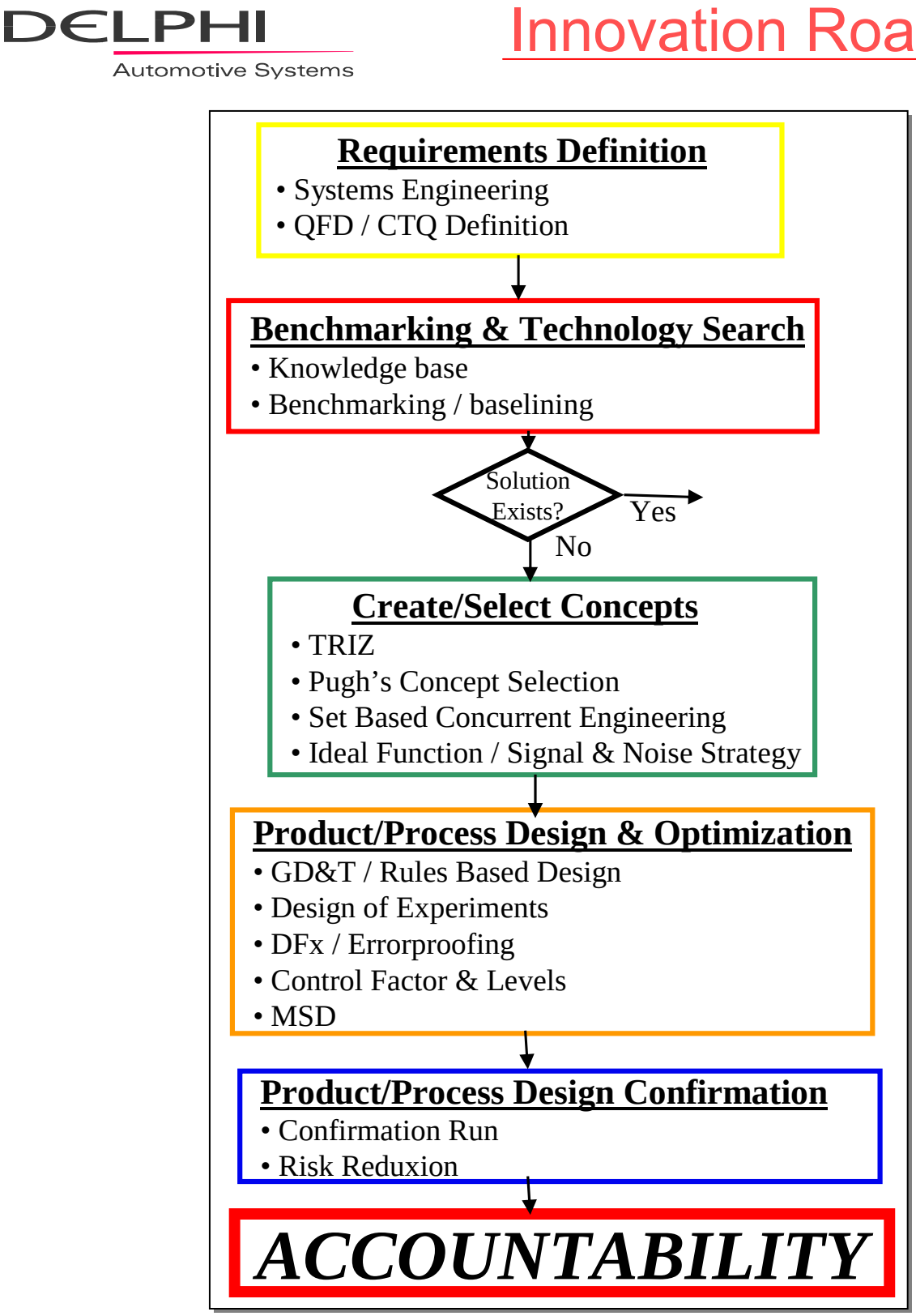
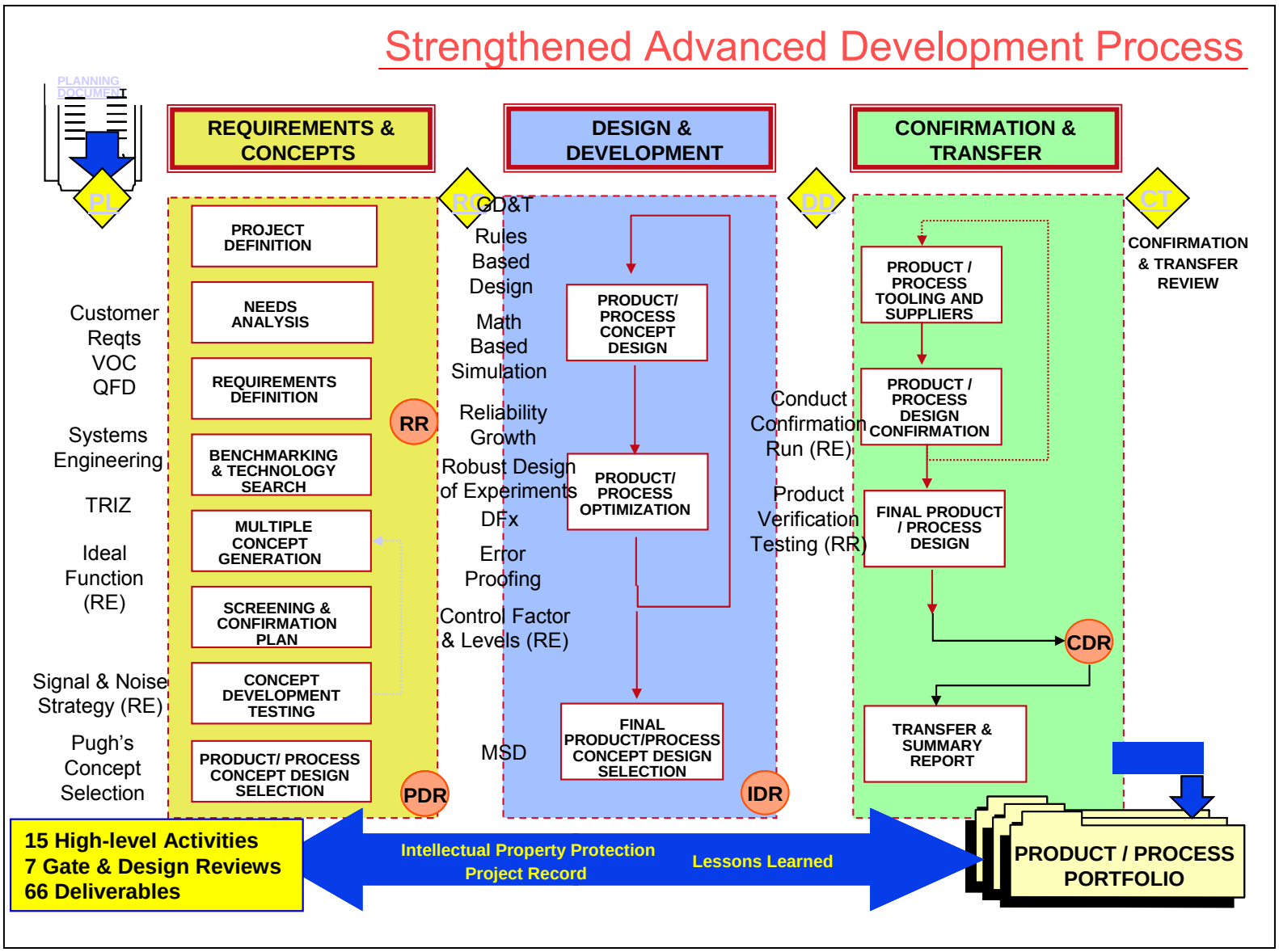


FIGURE 2. The Strengthened Advanced Development Process used at Delphi Automotive Systems.



Although TRIZ is shown as a specific technique only in the design phase designated "Create and Select Concepts" it is also used extensively in the process optimization phase. The overlap of tools and techniques between TRIZ, design of experiments, Quality Function Deployment, and other methods in the identification of the ideal system, function analysis, and iterative improvement (the feature transfer method in TRIZ and the Pugh concept selection method in systems engineering) is emphasized throughout the Delphi training program and the use of the Design for Six Sigma process.

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