ARGO

CONSULTING

Product Innovation & Value Management White Paper

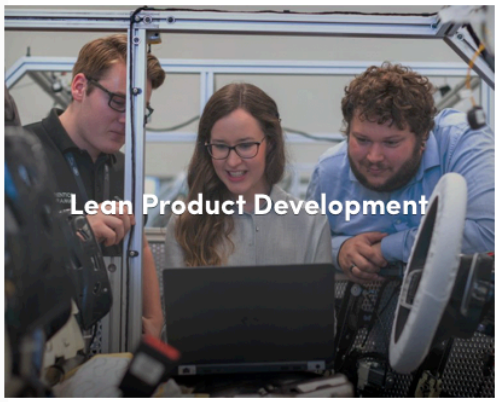
Learnings from a Five-Year Partnership With One of the World's Largest Providers of Products and Services to the Energy Industry

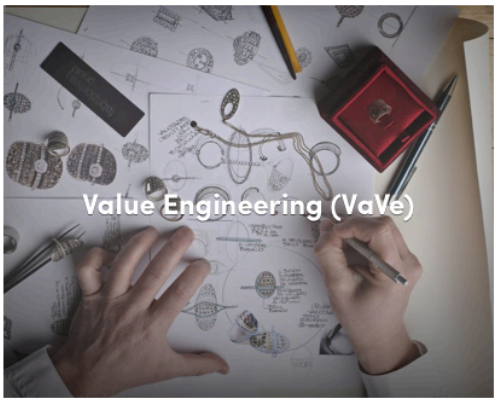
By Greg Esper, Dantar Oosterwal, and Andreas Dörken

June 2020

ARGO
CONSULTING

Table of Contents





The Situation

Relentless and unprecedented market forces have forced companies in the Oil & Gas sector to rapidly reduce costs while increasing speed and efficiency or face extinction. Being the market leader today is no guarantee for survival in the future. Our client saw the coming winds of change and acted by engaging Argo's Product Innovation and Value Management (PIVM) team to help them strengthen their market position and become more effective.

Argo's Relationship and the results achieved with the client evolved over 4 distinct phases as we ushered them into a never-ending improvement journey towards Lean New Product Development:

RESULTS AT A GLANCE

$195 Million
Improved Annual EBITDA through increased New Product Revenue and reduced costs

25 - 29%
Average cost reduction in product design

93%
Reduction in SKUs

Sustainment
Institutionalized organization and culture change for an on-going journey to Lean New Product Development

ARGO CONSULTING

Product Innovation & Value Management White Paper

Chapter 1
Value Engineering

Value Engineering yields Tremendous Cost Savings for a Traditional Engineer-to-Order Company

RESULTS AT A GLANCE

$11 Million
Reduction in costs

25%
Average cost reduction across 17 product families

Sustainment
Developed a stand-alone organization of facilitators and support

The Situation

A $2B division of a global provider of oil field services with 7 product and service lines was experiencing a sharp market downturn. The downturn was squeezing margins driving the need for cost management. Any given year, the company sold over 40k part numbers. Half of the part numbers were ordered only once while every part number required extensive product development efforts.

Argo's Actions

In the first phase of our partnership, Argo deployed its proprietary approach to Value Engineering within a pilot set of products to test the merits of the methodology. In this pilot program, Argo led 20 product re-design initiatives with client teams. Argo facilitated these workshops while training and developing client personnel. Due to the success of the pilot, the client created an entirely new organizational structure to carry on this effort and support the next phases of the Value Management strategy.

Why VE?

- Direct Material accounts for 70% of COGS (Cost of Goods Sold) for manufactured products
- VE focuses on the system to deliver the maximum amount and performance of functions at the lowest overall cost, setting it apart from other cost reduction methodologies such as component oriented cost reduction techniques
- VE is the most effective tool to minimize overall cost of ownership from a customer perspective

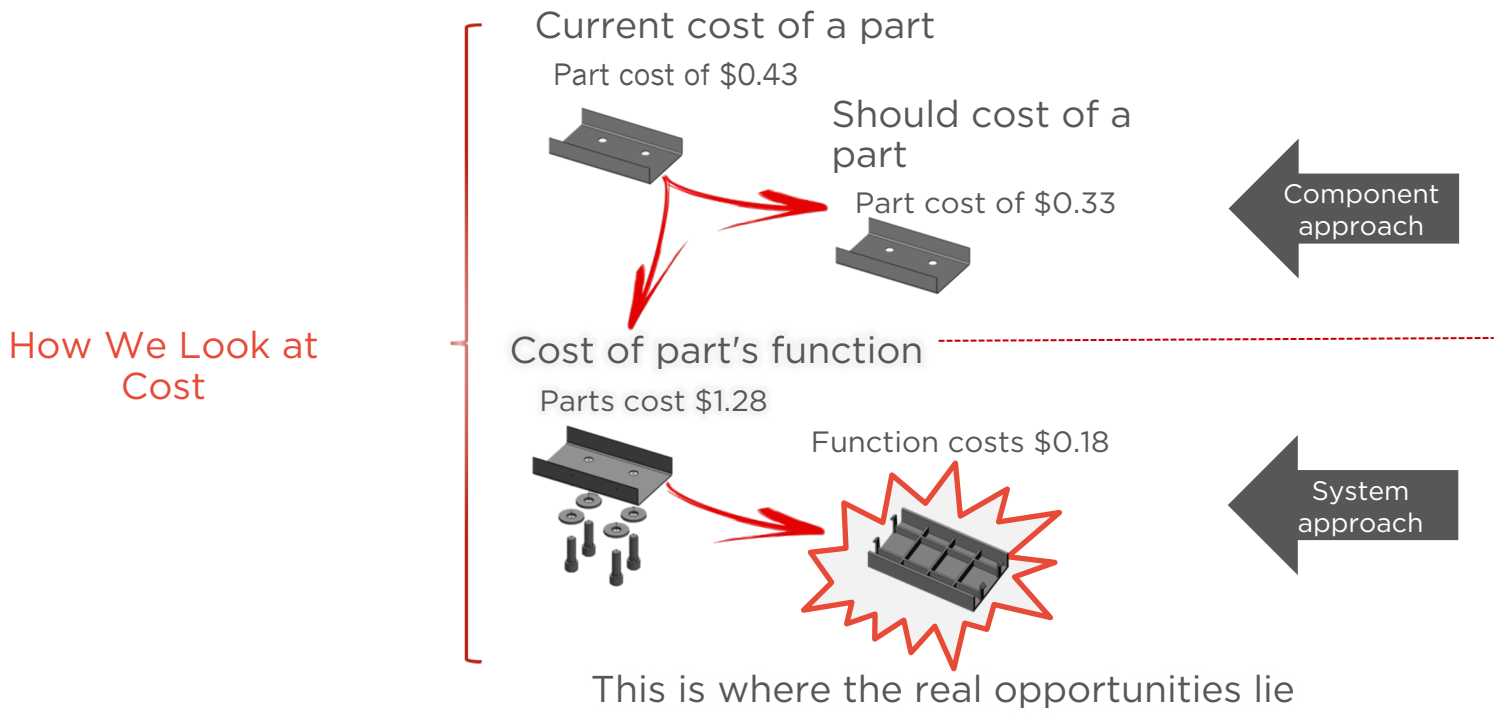
Value Engineering as a value creation lever

Value Engineering (VE) is an intensive, interdisciplinary problem-solving methodology that analyzes product designs and focuses on improving the value of the functions that are required. *Value* is defined as the ratio of function to cost. Typical approaches focus on cost reduction while preserving minimum function. ARGO uses a unique systematic set of proven techniques to work with clients in redesign of products and processes to maximize the overall function to cost relationship. The Argo approach concentrates on three areas:

1. Product design
2. Manufacturing process including Design for Manufacturing/Assembly (DFM/A)
3. Procurement & sourcing

Value Engineering vs. Design to Cost (DTC) or other cost reduction programs

Traditional DTC programs focus on components, whereas the VE methodology focuses on the functions performed verses the cost relationship at a system level



Our Value Engineering Approach

Definition:	Product Selection and understanding of portfolio, business, and market needs
Preparation:	All necessary data are defined, team is selected and invited, competitors' products are selected, Voice Of the Customer is requested and suppliers are identified.
Workshop:	The team works together full time. From function identification through design proposal calculations
Deployment:	The implementation plan is defined with project manager assigned and Visual Management developed
Consolidate:	Sketches and necessary designs are made and RFQ sent out. New Costed BOM is built up. Project Team comes together to freeze concept and create Program Of Demand
Sustainment:	Deployment plan updated with consolidation information and plan execution and results tracked and monitored for proper execution

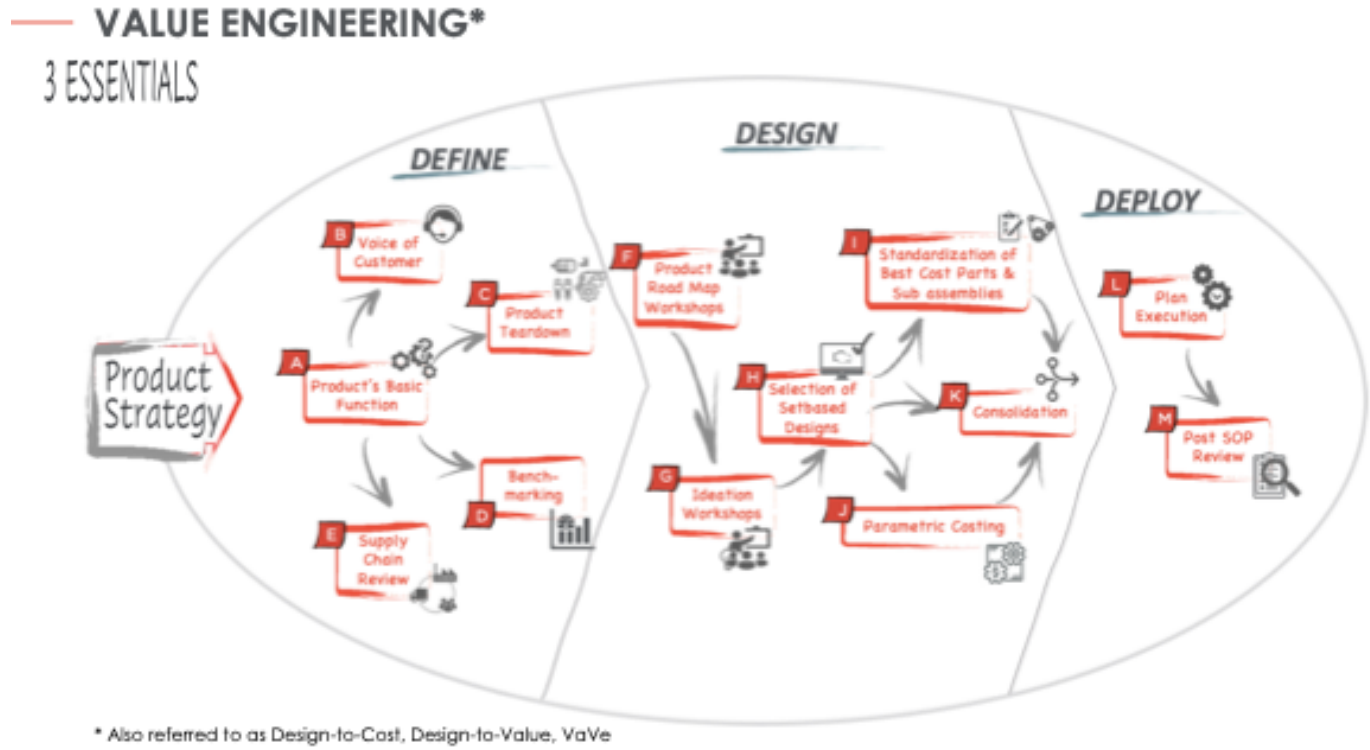
Sources of ideas from which the teams generate product design alternatives:

- Voice of the customer
- Engineering effort & processes
- Supplier ideas, supply chain, sourcing
- Benchmark
- Function analysis, design challenges
- Performance teardown

ARGO
CONSULTING

The Steps in VE Initiatives

Together with the client, we decided to embark on a "VE-light" approach: a rigorously structured but shortened approach to help the client redesign their products and processes through intense concurrent engineering and multifunctional teamwork. Our holistic methodology drives success from a 3-step approach: Define, Design, Deploy.



* Also referred to as Design-to-Cost, Design-to-Value, VaVe

VALUE ENGINEERING. 3 ESSENTIALS

Product Strategy

Product Strategy Product / Solution total lifecycle strategy is defined, incl. components

Define

A Product's Basic Function

A. Product's Basic Functions
Product's / Solution's Basic Functions are used to generate Concept Designs for now and the future (incl. long term vision). Also analyzed are product variants, options and take rates in order to understand opportunities for modular designs or platforms.

B Voice of Customer

B. Voice of Customer, Market and Competitive Environment
Product / Solution Value Proposition will be defined based on a thorough market and competitive environment analysis. Purchase drivers will be defined correlated to actual and past sales (heat maps), market share evolution, competition offering, trends and regulations.

C Product Teardown

C. Products under study Teardown
Products under study / reference projects are physically or virtually torn down using parts or sub-assemblies, typically provided by the assembly plants, drawings or warehouses. Functions performed are identified and qualified (e.g. one time, safety, appearance, basic,...). Function costs are established.

D Bench-marking

D. Benchmarking
Products under study / reference projects are benchmarked against comparable competitors' products / solutions per market and/or region: Direct Competitor, High and Low End. Product's system basic functions design are benchmarked internally and against parallel industries. Additional competitors are also virtually benchmarked using data available online.

E Supply Chain Review

E. Supply Chain Review
Global Supply Chain footprint, internal and external, is mapped including sales network and density. Make versus Buy strategies are integrated, as well as LTA, MSA, etc. contracts with key or strategic suppliers.

Design

F Product Road Map Workshops

F. Product Roadmap Workshops
Design concepts are generated based on previously identified Product's / Solution's Basic Functions, on Megatrends, on upcoming regulations and after sales data (spare & wear parts, repairs,...). Offering and other variations are integrated in the financial roadmap.

G Ideation Workshops

G. Ideation Workshops for design concepts', sub-systems', modules', platforms' Functions
Multiple Design Concepts and Design Change Proposals are created to fulfill "wanted" functions ie. 'What the customer is willing to pay for'. Functions brainstormed are based on either existing comparable products or detailed concepts. Crowd Based Innovation may be used.

H Selection of Setbased Designs

H. Evaluation of Design Concept and Design Change Proposals (DCP). Selection of set based designs
The use of multiple sources generates hundreds of ideas that after a feasibility check can either be grouped in a set or need to be kept separate since they are mutually exclusive from others. All sets or DCPs are technically and financially evaluated according to a formal process.

I Standardization of Best Cost Parts & Sub assemblies

I. Standardization – Platforms – modules – interchangeable sets of parts
It is crucial to understand the product portfolio, the market segmentation and 'go-to-market' strategy to establish platforms, common interfaces, and common, backwards compatible parts.

J Parametric Costing

J. Parametric Costing
Software is used to identify optimal cost for functions from a design perspective, piece cost is studied to determine cost drivers, then "should-cost" is determined against cost libraries.

K Consolidation

K. Consolidation
Estimated cost for proposed Design Sets are replaced with solid offers based on supplier quotations Engineering or from Operations. Carry-over or carry-back are validated. Costed BOMs / reference costs are rebuilt with new information and expected benefits are formalized.

Deploy

L Plan Execution

L. Execution
Start with an implementation Master Plan based on validated assumptions. An execution rhythm and cadence is established, based on best-practice physical or virtual Visual Management Boards, incl. a risk mitigation structure

M Post SOP Review

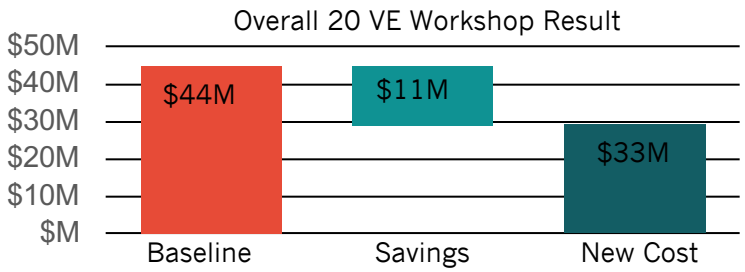
M. Post SOP
Hand over is made after ramp up to stable production, at defined O.E.E. and with minimum WIP. Skills matrices are up to date. Engineering references are updated, and project quotations re-evaluated

ARGO CONSULTING

Value Engineering Workshop as part of the VE Projects

Each 4-day workshop involved training each team on the methodology including the history and purpose for the process. The organization's top leadership was intimately involved by setting the business context for the effort and providing words of encouragement.

Overall 20 VE Workshop Result

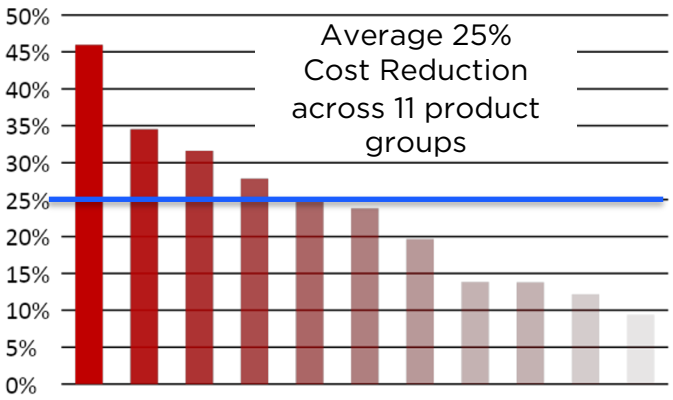


Workshop Makeup

- 20 VE workshops focused on a variety of products
- Cross functional team participation
- Identified savings opportunities from engineering design, manufacturing process, assembly process and procurement

Design Analysis

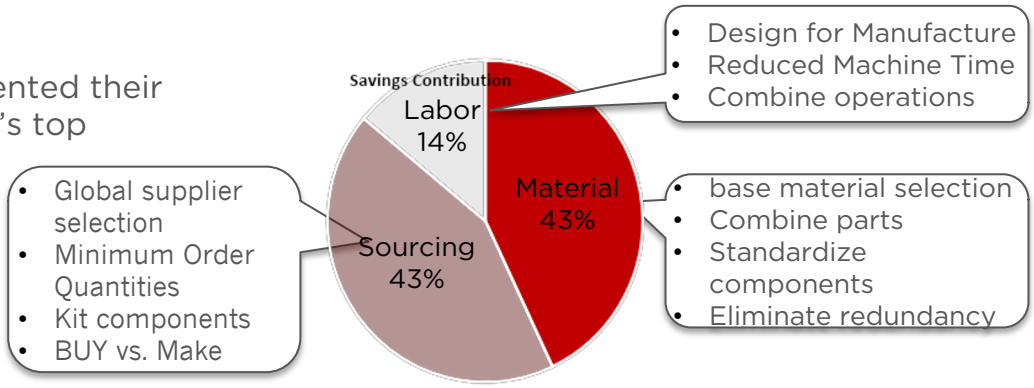
- Functions of every single component were identified, and costs estimated.
- Material choices, shapes, finish, tolerances, production routings, interfaces, etc. were challenged.
- High cost functions were brainstormed for alternate design ideas, classified and ranked by opportunity to reduce cost.



Workshop Report Out

Each team prepared and presented their findings to to the organization's top management, including:

- Workshop Savings table
- Costed BOM
- Cost/Function Worksheet
- Cumulative Savings table



Sustainment - Training and Personnel development for client

Detailed training was provided for 3 Managers, 8 customer sales Engineers and several VE leads – to serve as ongoing facilitators of the process. The training was repeated as new members joined the team, until the client facilitators were able to provide all training and take ownership for the entire program.

A Manufacturing Process Review Example

The manufacturing process required an internal diameter of 4.5 inch on a lathe then be moved to a burnishing machine to hone a 32 finish. The team was able to find new tooling manufacturers that could achieve the 32 finish on the lathe, saving $114 per unit.

ARGO CONSULTING

Product Innovation & Value Management White Paper

Chapter 2
Portfolio Management

RESULTS AT A GLANCE

$24 Million
Reduction in costs

29%
Average cost reduction across all product lines

13,000+
part numbers replaced by less than 900

Sustainment
Developed a stand-alone organization of facilitators and support

The Situation

Argo's Product Innovation & Value Management (PIVM) practice looks to reduce costs across entire product families, not just product components as is typically done. The client's engineer-to-order strategy had generated over 13,000 SKUs. Through the portfolio optimization process, we were able to evaluate the entire portfolio on a holistic and systematic basis.

After the initial success with the 20 product re-designs value engineering workshops, the joint steering team decided to execute a new product architecture strategy:

- Develop a configure-to-order product strategy for the appropriate market segment
- Develop a process to create a Configured Product Portfolio, that would cover 80% of the target market segment needs, to maximize the benefit of the Value Engineering study
- Develop Value Engineering capabilities by establishing process, coaching engineers, and training client resources
- Conduct Value Engineering workshops with cross-functional teams from engineering, manufacturing, and supply chain

Argo's Actions

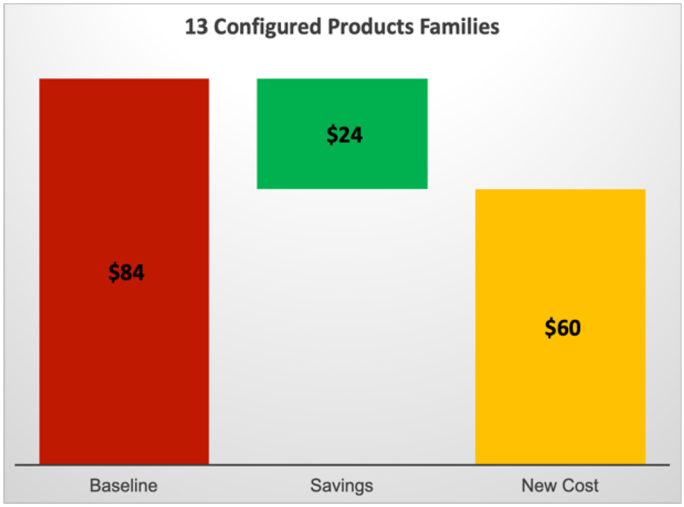
Argo worked with the client to create a hybrid standard/configure-to-order offering and catalog high volume production models. Then the boundaries for customized, configured, and commoditized product groups, and allowable ranges of variation for each were defined.

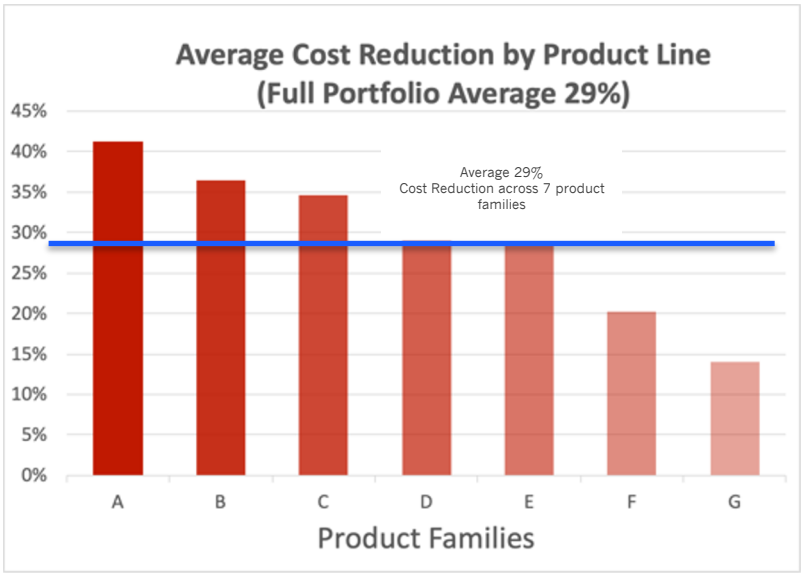
Next, a strategy to create a rational and standard, configured portfolio based on prioritized product families was developed considering both the long-term future state as well as immediate goals for the organization.

In order to sustain the strategy, a training and development program for facilitators and support personnel was created. The methodology, and roles and responsibilities for the new organization were defined and documented, including the creation of a scorecard system.

Results

Argo developed a strategy and process to migrate the organization from engineer-to-order to a hybrid catalog (configure-to-order) product offering combined with traditional (customized) product offering. The client reduced part numbers from >13,000 to less than 900 and realized $24M in savings.





VE ON CONFIGURED PRODUCT LINES

With a controlled number of available options, the client can benefit from:

- More focused VE efforts – maximizing benefits out of each project
- Increased shared and common components across each product family, leading to high volume material purchase
- Reduced setup time and improved manufacturing efficiency
- Maximized number of SKUs that can benefit from each Engineering Change
- Reduced complexity of Engineering Changes
- Minimized number of future Engineering Changes

AND OFFER THEIR CUSTOMERS:

- Highly competitive price
- Rapid Delivery

Summary

Cost pressures from a declining market make it difficult to compete with highly customized engineered-to-order products. By employing Argo's intensive proprietary methodology for Value Engineering and developing a hybrid configure-to-order product strategy, the client significantly reduced their costs, enhanced customer support, and increased their margins, maintaining their industry leading position in an unprecedented difficult market.

ARGO CONSULTING

Product Innovation & Value Management White Paper

Chapter 2
Lean Product Development - Project Management and Set-Based Development

RESULTS AT A GLANCE

$160 Million
Increase in annual New Product Revenue

42%
reduction in product development lead time

39%
Increase in projects completed annually with a constant size workforce

11%
Reduction in average cost/project

The Situation

Development teams at the client faced many challenges. The Organizational Culture had evolved through a long history of mergers and acquisition, there were 7 primary product lines, tightly controlled regulatory and customer requirements, general resistance to change and obfuscated accountability. Geographically, the organization faced Western/Eastern Hemisphere management cultures, their teams were spread across 13 time zones, and teams suffered a lack of autonomy at the working level.

Slow technology development caused long time to market resulting in loss of revenue, customers, and market share. Development delays also reduced the value of the business cases because products were not delivered during the market growth phase with adverse effects on the organization's competitiveness and ability to secure tender awards.

Project Managers had a diminished role in the organization, there were significant tracking/reporting delays with limited visibility of project status. Project Managers were primarily focused on providing monthly updates of projects to management, with limited team interaction. There were no mechanisms for identifying and solving project problems and there was a heavy reliance on engineering supervisors to 'manage it all'.

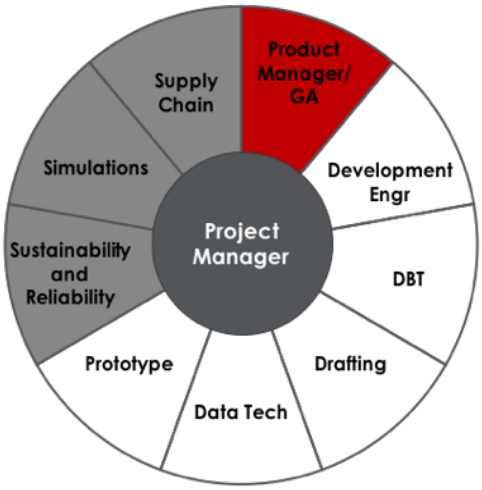
Argo's Actions

Argo helped the client reorganize into cross functional teams with clearly defined roles and responsibilities called Product Development Teams (PDTs). Focus groups were used to navigate the organizational complexities and create the structure for strong collaboration.

Project Management Focus

Cross-functional team: a group of people with different functional expertise working toward a common goal

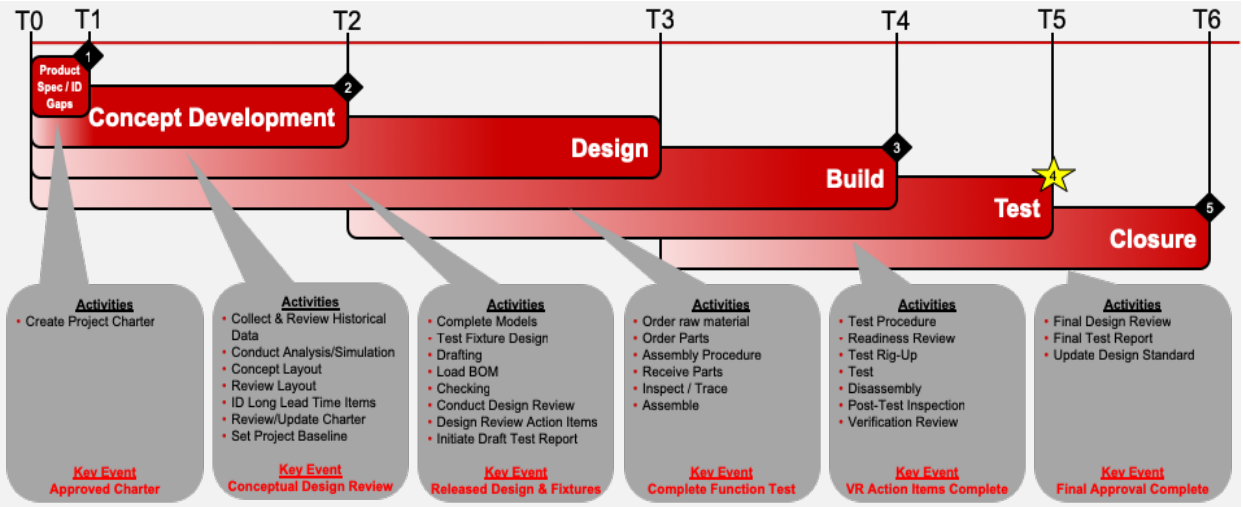
- PDT (Product Development Team)
- Co-locate
- Collaborate
- Integrate VOC
- Minimize and simplify documentation requirements



A standard project cadences was developed and implemented. Although most projects were very similar in terms of resource requirements and activities, every project had an independently constructed development plan. The duration of similar activities for different projects varied widely and were typically independently scheduled in a sequential sequence. For example, long lead material procurement, would not begin until the design was 100% complete and signed-off. The rationale was that raw materials could not be ordered until the Design stage was completed, because design reviews could potentially cause a material change. In reality, the material to be used was typically understood very early in the development process, and in virtually all cases material selection was limited to 2 choices – one simply a higher strength alloy.

ARGO CONSULTING

Simultaneous /Cadence Development



• Significant events • Parallel processing/early start • Front load/level load

Proponents of the status quo insisted that ordering 2 kinds of raw material was WASTEFUL since only one would be used. This failed to recognize the significant VALUE of shorter project durations, which easily off-set the cost of additional material let alone that it could be used on another project.

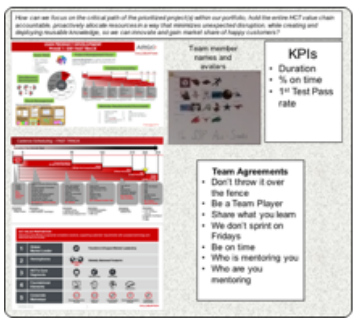
A Holistic Approach Example

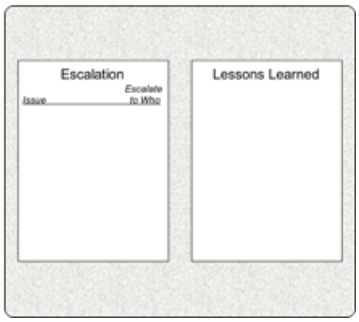
At some time in its history, the organization decided that it could reduce drafting costs by out-sourcing drafting to a low-cost country based on a significantly lower hourly rate. Evaluating the singular metric of 'Drafting Dollars Spent' showed significant savings, although somewhat less than anticipated. However, the outsourcing forced development teams to communicate with drafters 11 time zones away. Every interaction with drafting resulted in a full day lag regardless of how big or small the request. Drafting is a highly iterative process and was very tedious for the development teams causing significant delays in projects. Many engineers struggled within the boundaries set up by this scheme. Out of frustration, others created a work-around by doing their own drafting, realizing they could complete the work much faster themselves. It becomes obvious that the cost of drafting is much HIGHER than simply an hourly rate. It was better to pay engineers to do the drafting locally than deal with all the delays even though is was paid at an engineer rate and pulled a critical resource from actual development work. The solution was simple; (re-)hire drafters and integrate them within the PDTs. The teams have cited this example as a major contributor to their reduced project lead time.

Argo's Actions (continued)

Upon evaluating the development process and rationalizing it against Lean Development Principles, Visual Management was initiated so the organization could 'see the work', and 'see the issues'. This included clear KPI's and dashboards aligned from working teams to global reporting levels. Visual Management enabled the Product Development Teams to effectively manage projects in real time, allowing the organization to see at a glance the progress and status of every project in an intuitive and understandable way. Visual Management created a mechanism within the development organization for a complete understanding of the development efforts across the product portfolio. Visibility enabled effective management of the work dynamics by adjusting and addressing issues as they arose in real-time.

Visual Management

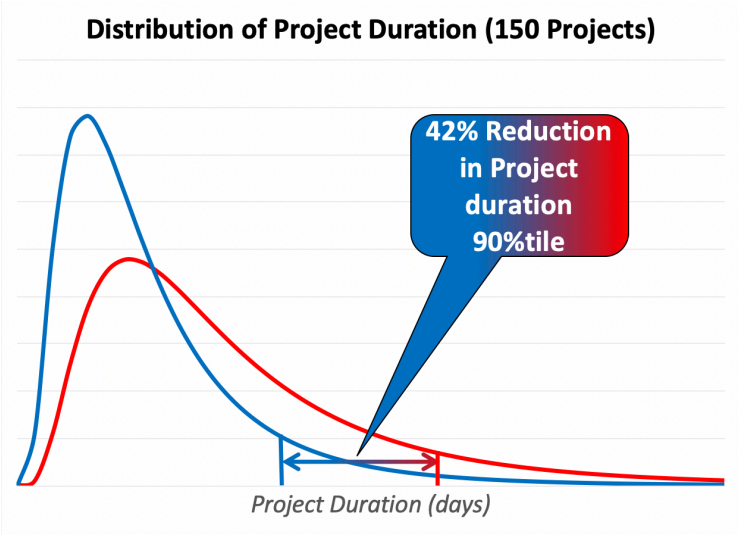




1. Create systems that show abnormalities
2. Quickly solve problems & improve the system
3. Share the learning
4. Leadership integral to success of the system

Results

Through the application of Lean Product Development principles and team/individual coaching, the organization learned to see and address the critical issues, hold the entire Value Chain accountable, and proactively allocate resources in a way that minimizes unexpected disruption while creating and deploying reusable knowledge. This resulted in greater innovation and increased market share with satisfied customers.



In addressing the client organization's methods and culture by implementing principles of Lean Product Development they were able to **reduce development lead time 42%**. This allowed the same organization to **deliver 39% more projects** while only increasing spending 24%, resulting in an average **reduction of the cost per project of 11%**.

ARGO CONSULTING

Product Innovation & Value Management White Paper

Chapter 4
Lean Product Development - Visible and Re-Usable Knowledge

RESULTS AT A GLANCE

$ Savings
Realized in reduced project lead time due to fewer iterations

46%
Reduction in verification test failures in Product Line 1

27%
Reduction in verification test failures in Product Line 2

Sustainment
Dedicated project teams continue to study and close knowledge gaps, creating limit and trade off curves for design standards

The Situation

The client continued their Lean Product Development journey as Argo introduced principle of Visible and Re-Usable Knowledge. The client used a traditional, iterative approach to 'point-based' design. When a new opportunity was identified, the development team would modify a previous design in an attempt to meet the new set of requirements. As the full performance envelope of each design was not known, each new development required undertaking the the entire development process to ensure the new design functioned at the new point. Visible and Re-Usable Knowledge tests to find LIMITS, allowing knowingly designing within the limits while understanding the physics and economics constraints of a design. Eliminating the "try something" to see how it works mentality.

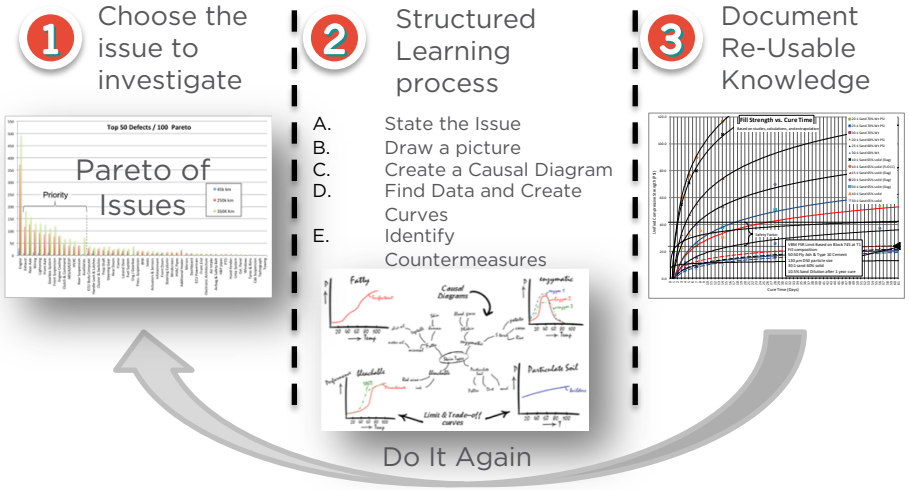
The Key Benefits of Visible and Re-Usable knowledge are:

- Deeper technical expertise
  - Acquired more quickly
  - Shared across projects
- Efficient understanding of design space – know the limits
  - Better Designs, Delivered Faster, Predictably
  - More Reliable
- More Economical Designs
  - Optimized for cost, quality, and performance

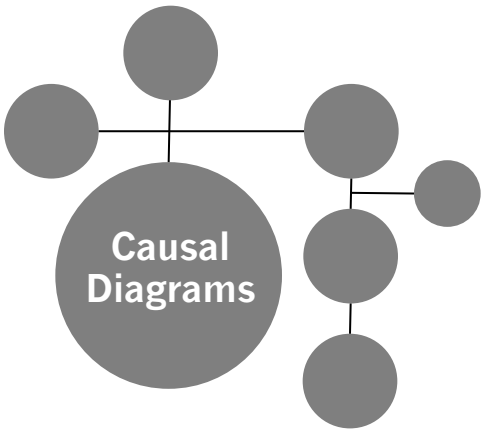
Argo's Actions

The prime candidates for pilot projects were identified together with the client. This began with a pareto analysis of Verification test failures to highlight what needed to be learned. A systematic approach was applied to identify the design parameters in relationship to the customer needs and wants. 'Knowledge owners' were created to drive the learning and understanding of the design limits. This replaced the historic development process consisting of many iterations of design-build-test-failure iteration loops. Now each learning iteration was planned with specific criteria for discovery necessary to build on the knowledge base, shared from project to project, with each design drawing on knowledge created by the previous project and contributing knowledge to the next project.

Create Visible and Re-Usable Knowledge



Two key product lines were selected for an initial study. Each study began with a causal diagram developed in conjunction with the knowledge owners (the client Subject Matter Experts - SMEs) to identify knowledge gaps. The Causal Diagram depicted an exhaustive list of potential areas of study and several of the most significant knowledge gaps were selected to study based on their impact on first time pass at verification testing. Additionally, the studies drove the organization to integrate materials and simulations research resources which had been underutilized to help close the knowledge gaps.



Component Design Standardization Program

- Establish base standards for component design and qualification. Inclusive of supporting establishment of a robust simulation modeling process and material assessment/development for component design and application.

Fundamentals of Mechanical Design and Testing

- Analysis of historical component design
- Understanding of:
  - Critical geometry
  - Component system interaction
- Defined learning based methodology of component design
- Evaluate and optimize fixture design and test methods
- Define Target platform

Fundamentals of Material Characterization for Design and Simulations

- Generate FEA material data sets
- Engineer elastomeric materials with optimum properties
- Establish rapid laboratory scale testing methods
- Predict system level functional life
- Identify failure modes (various conditions) at end of functional life
- Scope, create, and characterize composite / thermoplastic materials

Fundamentals of Engineering Mechanics and Simulations

- Establish D.O.E methodologies
- Define physics of functional criteria for material interactions independent of component design
- Improve representation of component material in a simulation environment
- Step change in FEA by:
  - Evaluating current approach and identifying areas for improvement
  - Developing automatic remeshing capabilities
- Develop a scaling relationship between derivative designs and successful base designs

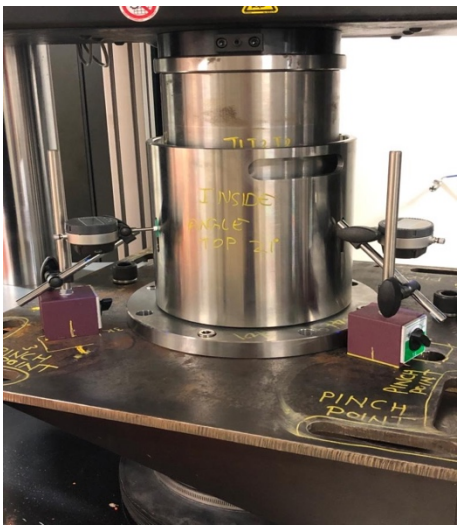
Results

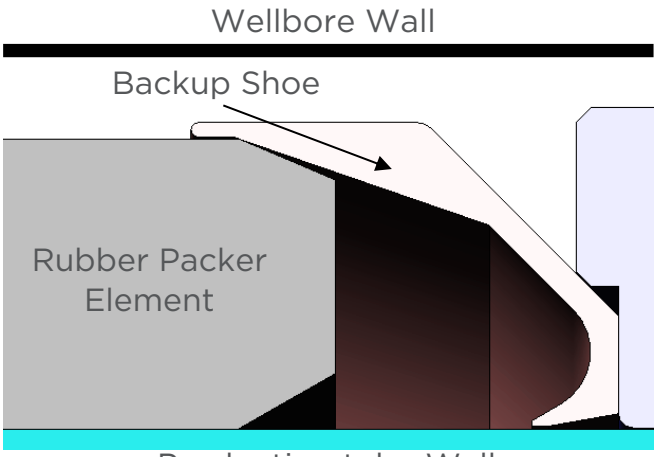
The client gained new insights in 2 key product lines that have helped them update their design standards, reduce time to market, and become more predictable by **reducing their test failures by 46% and 27%** respectively for each product line because they were knowingly able to design within limits. The many proprietary limit and trade off curves they have created serve as their knowledge base for future design work. The client continues with dedicated teams re-analyzing failure mode pareto diagrams determining the next areas of study as they continue their never-ending journey to excellence with Lean Product Development.

Wellbore Packer Example

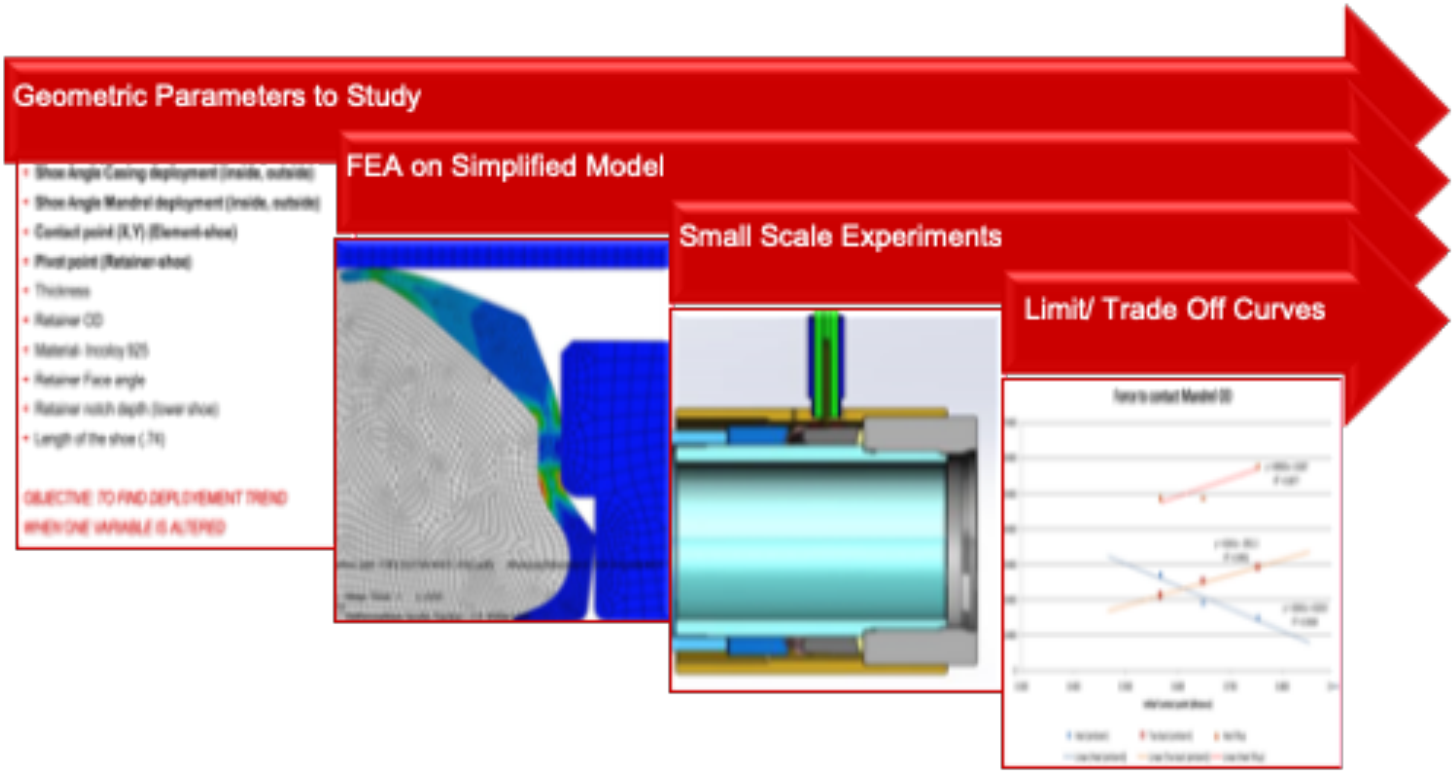
A study of test results indicated that the leading failure mode for wellbore packers was extrusion of the rubber sealing element into the annulus between the packer assembly and the wellbore wall. As the packer is deployed and the rubber element expands, metal backup shoes are designed to move and expand bridging the annulus gap. Failure to properly deploy the backup shoes allows the rubber to extrude into the gap which directly leads to the failure of the packer to seal.

The team set out to study the impact of different geometric parameters of the shoe and interfaces on the Setting Force (Increase/decrease) and to determine the dominant geometric parameters affecting setting force.





Through empirical analysis correlated with physical experimentation, the team was able to understand previously unknown dynamics in how the shoe rotates and deforms. We learned the critical geometric features and their limits.



Summary

Applying the Principles of Lean Product Development and Product Innovation and Value Management, the Argo Team not only helped one of the world's leading Oil & Gas Service Providers to survive but thrive despite harsh economic conditions. Through portfolio rationalization, they are better suited to quickly respond to many new business opportunities with little to no additional development costs, at higher margins. Thanks to their great strides on their journey to LPD, they can achieve their customers' expectations with speed and confidence, holding strong to their market position. This effort delivered a 40:1 ROI for the client.

About the Authors

GREG ESPER, P.E. is Director of Product Innovation and Value Management at Argo. He has responsibility to deliver sustainable results with clients through team engagement. Greg has more than 35 years of experience in Mechanical Product and Manufacturing Engineering and Management and has spent 17 years advising and assisting global clients with Lean New Product Development and Manufacturing Excellence. g.esper@argoconsulting.com

DANTAR OOSTERWAL, Senior Vice President & Partner, is Argo's Lean Innovation & Product Development Practice Leader. He is highly regarded as a global thought-leader in Lean Innovation & Product Development systems. d.Oosterwal@argoconsulting.com

ANDREAS DÖRKEN, Senior Vice President & Partner, is Argo's Head of Operations Europe and Co-Head of the Product Innovation & Value Management practice. He has over 25 years of experience working in industrial firms and consulting. a.doerken@argoconsulting.com

ARGO
CONSULTING

Argo is an operations improvement consulting firm that breaks through the traditional barriers of the consultant-client relationship. We are hands-on consultants who deliver real results and no excuses.