Application of Value Engineering Studies, Design for Manufacturability Assessments, and Should Cost Analyses during Product Development

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1.0 Abstract

The Nuclear Renaissance is underway and Westinghouse Electric Company is positioned to be a world leader in providing safe, clean, reliable nuclear energy. The new **AP1000**® Advanced Passive Reactor, innovative Small Modular Reactor, and growing replacement equipment and/or new component markets for the Nuclear Services, Nuclear Automation, and Nuclear Fuels product lines provide many opportunities for the application of Value Engineering (Product Function versus Cost), Design for Manufacturability (which in Westinghouse's terminology includes both Design for Manufacture and Design for Assembly), and "Should Cost" concepts. During the early stages of equipment and/or product development, both Value Engineering and Design for Manufacturability can be utilized to provide cross-functional teams with evaluations of design alternatives, as well as insight into product costs. As equipment and/or product development progresses, Value Engineering and Design for Manufacturability concepts are deployed to optimize the design and provide critical "Should Cost" information to the Sourcing Team. This paper outlines Westinghouse's implementation of Value Engineering, Design for Manufacturability, and "Should Cost" concepts for use within this dynamic period in the nuclear industry and provides some examples of how this implementation has already begun.

2.0 Executive Summary

Westinghouse Electric Company provides fuel, services, technology, plant design, and equipment to utility and industrial customers in the worldwide commercial nuclear electric power industry. Westinghouse product lines include Nuclear Power Plants, Nuclear Services, Nuclear Fuels, Nuclear Automation, and Research and Technology (R&T).

Across various product lines there are many challenges to providing reliable and robust components and assemblies at competitive prices. Supply Chain Management is tasked with sourcing these components correctly the first time while meeting budget and time constraints. In order to address these challenges, Westinghouse has incorporated and developed the use of Value Engineering principles and workshops into standard work practices. Value Engineering applies a multidisciplinary approach to product development and sourcing by incorporating Design for Assembly and Design for Manufacture considerations. This process has been successfully implemented during new product development of a two-piece spider within the Nuclear Fuel (NF) product line where various design options were compared on the basis of cost as well as product functional requirements. This activity resulted in the selection of the best value option with a 95% part count reduction while also, avoiding large costs associated with high part counts and complicated, expensive assembly methods.

Other examples have shown that by using Value Engineering, Design for Manufacturability, and "Should Cost" assessments, the New Power Plant (NPP) Product Line's Small Modular Reactor (SMR) avoided unmanufacturable designs, the Nuclear Automation (NA)Product Line's folding keyboard tray assembly for their control room seismic cabinets had a 72% part count reduction, and the Nuclear Services (NS)

Product Line’s steam generator nozzle dam realized a substantial reduction in estimated cost versus quoted cost.

Value Engineering and Design for Manufacturability processes utilize “Should Cost” concepts and evaluations throughout the product lifecycle. Post Value Engineering workshops and Design for Manufacturability analysis, options under consideration are run through the “Should Cost” process utilizing the Boothroyd-Dewhurst, Inc. (BDI) Design for Manufacture and Assembly (DFMA®) software and spreadsheets. This allows Supply Chain personnel to negotiate pricing with potential suppliers from a knowledge-based position.

This interleaved usage of advanced Concurrent Engineering principles and concepts allows Westinghouse to develop first-of-a-kind, one-of-a-kind, and repeat manufacture components effectively and efficiently to meet the technical demands of our industry while achieving the best cost per function that is aligned with our business goals.

3.0 Westinghouse Update

3.1 AP1000® Advanced Passive Reactor

The **AP1000®** reactor (Figure 1) is the safest and most economical nuclear power plant available in the worldwide commercial marketplace (Reference 1).

Within the past year, the U.S. Nuclear Regulatory Commission (NRC) issued Design Certification for the **AP1000®** design. This represents the first and only Design Certification for a Generation III+ reactor issued by the NRC in over 30 years. The NRC has also issued two combined construction and operating licenses: one to Southern Company for two **AP1000®** reactors at its Vogtle site near Atlanta, Georgia, and one to South Carolina Electric and Gas (SCE&G) for two new **AP1000®** reactors at its Virgil C. Summer site near Columbia, South Carolina. This brings the number of **AP1000®** reactors currently under construction to eight (8); with: four (4) in the United States and four (4) in China.

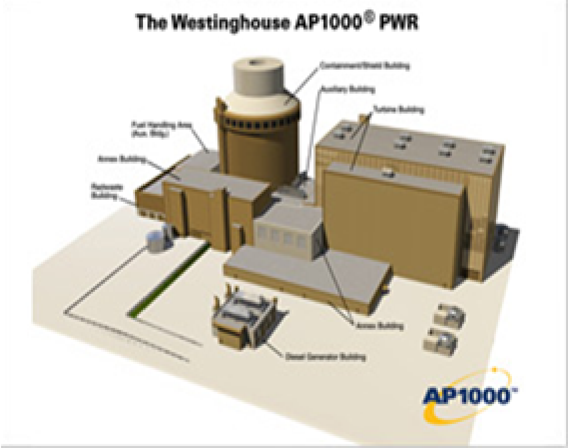


Figure 1: The Westinghouse AP1000® PWR

The AP1000® reactor builds and improves upon the established technology of major components used in current Westinghouse-designed plants with proven, reliable operating experience over the past 50 years (Reference 1).

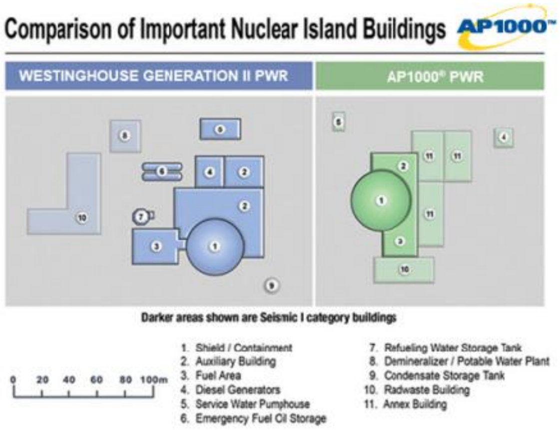


Figure 2: Comparison of Important Nuclear Island Buildings

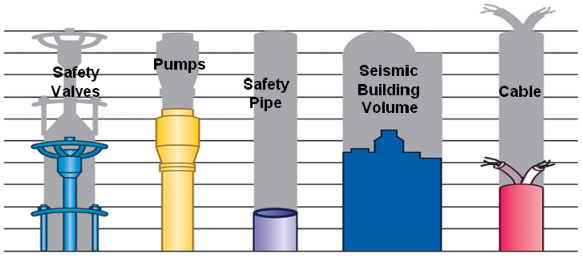


Figure 3: AP1000 Primary Components

3.2 Small Modular Reactor (SMR)

The Westinghouse Small Modular Reactor (SMR) is a 200 MWe class, integral pressurized water reactor that uses control rods for load follow and plant shutdown. The reactor, with all primary components located inside the reactor vessel, is protected by redundant passive safety systems and housed within a compact containment vessel that is located completely below grade. The design uses many of the key features from the Westinghouse **AP1000®** plant, all previously realized and licensed, including modular construction techniques, passive safety systems, and proven standardized components to achieve the highest level of safety and reduced number of components possible.
It also leverages the latest U.S. NRC-licensed safety and security features. Small-scale nuclear reactors offer alternatives for providing affordable, secure sources of emissions-free power generation for the worlds rapidly growing energy needs. (Reference 2)

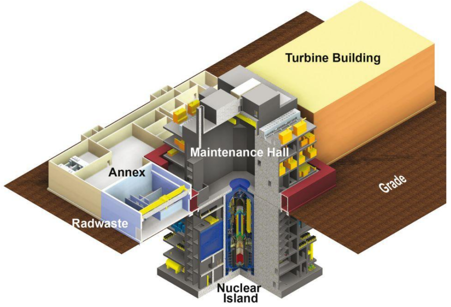


Figure 4: Small Modular Reactor Footprint

The Westinghouse SMR eliminates a complete class of potential accidents typically associated with traditional nuclear steam supply systems which use large-bore piping to connect the system components. All of the components associated with the reactor coolant system are contained within a single pressure vessel.

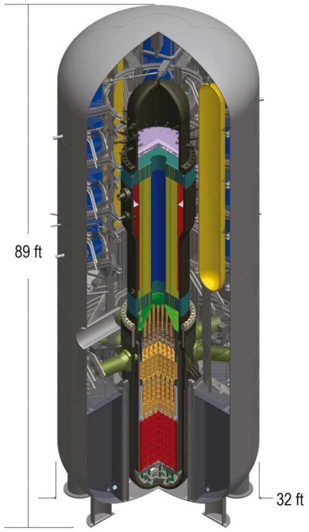


Figure 5: Small Modular Reactor Pressure Vessel

SMR with Value Engineering, Design for Manufacturability, and Design for Assembly concepts employed

The most safety…
The NRC-licensed safety design featured in the industry-leading Westinghouse **AP1000®** design extended to a 200 MWe class reactor
The greatest efficiency…

The Westinghouse 200 MWe class SMR optimizes the intersection of equipment costs with the greatest energy output

The most certainty…

The rail-shippable scale allows for efficient factory fabrication and delivery that guarantees quality control levels not available with on-site construction

The least complexity…

Simple, compact design gives operators the most function with innovative packaging of proven components

The least cost…

Simple, compact system configuration reduces operations and maintenance requirements

The least time in process…

Standardized, modular approach provides for rapid project development and construction in changing and diverse markets

4.0 Westinghouse Concurrent Engineering Process

The Westinghouse Concurrent Engineering process is a gated project, product and process development procedure requiring various activities to be performed during different phases. Examples of phases are Concept Phase, Preliminary Design Phase, Intermediate Design Phase, and Detailed Design Phase. At the end of each phase is a stage gate, and each stage gate requires specific deliverables to be met. Value Engineering, Design for Manufacturability, and "Should Cost" Studies are integrated within the Concurrent Engineering process.

As the name implies, Concurrent Engineering involves the integration of many functions from many parts of our business. Traditional equipment and/or product development may only engage design engineering until the design was complete and then hand off a detailed design to the Supply Chain organization to source products; Supply Chain would then provide these components to the manufacturing organization to complete the assembly. Concurrent Engineering engages all of these organizations throughout the development and launch of new equipment and products to leverage lessons learned from previous work and manufacturing experiences to improve the current design. Additionally, this approach allows for new manufacturing processes, cost models, and design concepts to be brought to market in a more rapid manner,, as the exchange of information happens much earlier in the process. Within Westinghouse, Supply Chain has developed the tools and processes around the use of Value Engineering and Design for Manufacturability and worked with the Design Engineering body to integrate these into the Concept, Preliminary, and Intermediate, and Detailed Design Phases of the new equipment and product introduction process.

Specific to the Concept Design Phase of the Westinghouse Concurrent Engineering process, the integration of Value Engineering and Design for Manufacturability enables the rapid creation of new ideas and subsequent evaluation of these concepts to insure that in addition to regulatory and customer requirements both the technical (design, manufacturing, and quality) and business (cost and schedule) objectives are satisfied during the development portion of our product lifecycle. Concurrent Engineering allows for the broad experience of this cross-functional organization to quickly narrow the options from the possible many to the probable few. These options can then be more efficiently and effectively run through the "Should Cost" process.

The “Should Cost” process requires these few design options to be evaluated on the basis of their prospective impact to the business by the evaluation of their Value Chain and Total Cost of Ownership (TCO). This evaluation then allows a design option to be iteratively refined through the development cycle while always maintaining alignment to the business through the product lifecycle. Understanding the TCO proactively drives informed business decisions about a design and assures that new designs meet not only the technical objectives but also the business objectives that face our industry during this dynamic period.

Design Engineering now routinely involves Supply Chain Management’s Supplier Manufacturing and Value Engineering (SM&VE) group in new and revised designs, resulting in reduced issues with manufacturing, assembly, lead times, cycle times, initial costs, and recurring costs. .

The drawing review process was previously the only involvement that Supply Chain’s Supplier Manufacturing and Value Engineering had in the prior product development cycle. In the current and updated Concurrent Engineering process, Value Engineering determines which features offer the most functionality and value. Design for Manufacturability also has been added and now helps provide critical input into the “Should Cost” process, resulting in designs that have been optimized for assembly, manufacture, and value (costs).

5.0 Case Studies/Examples

5.1 Value Engineering

The Rod Cluster Control Assembly (RCCA) in the Westinghouse **AP1000®** Pressurized Water Reactor provides these basic mechanical and operational functions:

1. Support and position the absorber rods in the proper array for insertion into the fuel assembly guide tubes and upper internal guide cards to provide core reactivity control.
2. Provide for normal shutdown of the core by inserting absorber rods into the fuel assemblies in the core using Control Rod Drive Mechanisms (CRDMs).
3. Provide for rapid shutdown of the core by “tripping” or “scramming” the RCCAs thereby releasing them from the CRDM and dropping them rapidly into the fuel assemblies due to gravity.
4. Mate with the drive rod couplings within the reactor upper internals so that axial positioning using CRDMs is accomplished.
5. Absorb residual kinetic energy of the RCCA after a scram to prevent fuel assembly damage.
6. Restrain the absorber rods against ejection from the core.

One of the key components of the RCCA is the spider. Traditionally, the spider has consisted of 41 separate pieces that are welded and brazed together at the Westinghouse Columbia Fuel Fabrication Facility in Columbia, South Carolina to form the spider assembly. [Figure 6] This process is very labor intensive and often results in excessive rework to achieve acceptable assemblies.

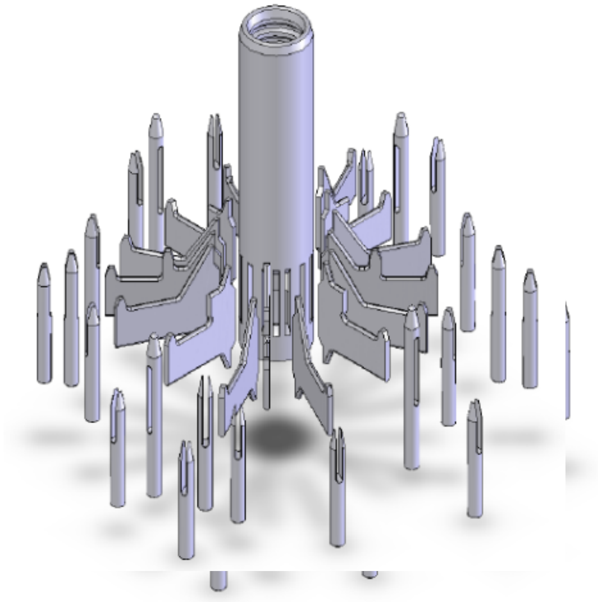


Figure 6: 41 piece spider

For the Next Generation RCCA, the design team sought a more efficient solution for both manufacturing and Supply Chain. A one-piece casting was originally chosen as the desired solution. However, late in the project it became clear that the positional tolerances required by design could not be achieved with the casting and a new solution was needed.

The Westinghouse SM&VE group partnered with a specific supplier to develop a prototype two-piece welded spider. Various manufacturing methods were explored, but in the end, it was proposed that the lower vane section would be machined with a high pressure water jet and then welded to a turned hub. This concept has many benefits such as the following.

- Simplifying the value chain for Westinghouse by providing a “turn key” supplied component for assembly into the RCCA.
- Providing a lower Total Cost of Ownership by reducing lead times, inventory, inspection costs, administration costs, etc.

Over the next 13 months, the team followed the Nuclear Fuel Concurrent Engineering process to complete the spider design, functionally test the product, qualify the manufacturing process, and deliver a batch of spiders for the first **AP1000®** reactor core.

For a new first-of-a-kind component like the spider, Value Engineering is an integral part of Phase 2 - Preliminary Design of the Concurrent Engineering process at Westinghouse. Value Engineering is a systematic process used by a multidisciplinary team that focuses on improving value by identifying the most resource efficient (6Ms – Machine, Method, Material, Man Power, Measurement, and Mother Nature) way to reliably accomplish a function that meets the performance expectations of the customer.

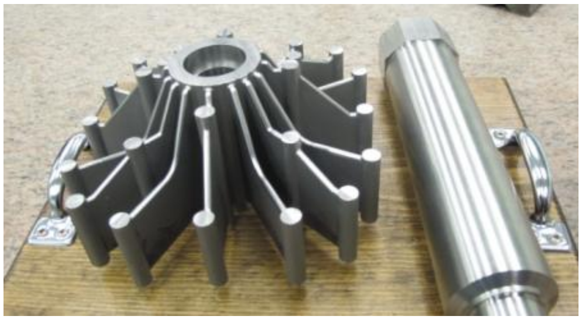


Figure 7: 2 piece spider

The Value Engineering process utilizes techniques such as Quality Function Deployments (QFDs), benchmarking, T-charts, and Function Analysis System Techniques

(FAST) that enable a project team to provide the highest value products, projects, processes, and services to the customer.

Two Value Engineering workshops were held on this product: one at Westinghouse, and one at the supplier site with the team consisting of Product Design Engineering, Supplier Quality Engineering, SM&VE, and the supplier. The Westinghouse Value Engineering guideline recommends the use of different methods and/or analyses at each phase of the workshop [Figure B]. The Value Engineer or facilitator can use those tools to tailor the activity to garner the most benefit from the workshop.

Westinghouse Value Engineering Workshop Process

Information Phase:

Quality Function Deployment, Benchmarking

Strengths, Weakness, Opportunities, Threats (SWOT)

Evaluation Phase:

T-Charts, Pugh Analysis, Kepner-Tregoe

Function Analysis Phase:

Function Analysis System Technique (FAST),

Function Matrix, Failure Modes & Effects Analysis

Creative Phase:

Brainstorming, TRIZ

Development Phase:

Design for X-ability, Process Plan Estimates, Cost Comparison Worksheets

In the case of the spider, the workshops focused on Design for Manufacture, Design for Assembly, Design for Inspection, and Process Failure Modes and Effects Analysis (PFMEA).

Many value enhancing ideas were generated inside and outside the workshops as the design evolved. For example, seemingly simple features such as radii and blending of surfaces become complicated when they contribute to the function of the component and impact machining time or complexity. Figures 8 and 9 show changes to the vane, finger, and hub blend geometries that were implemented by the team.

All of these changes were made to decrease machining time, standardize tools, and enhance quality by avoiding potential issues that were identified in the PFMEA.

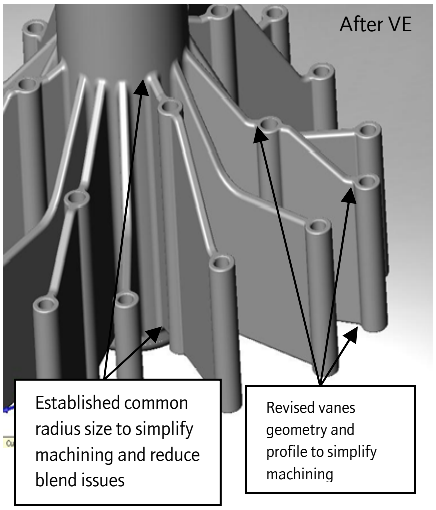


Figure 8: 2 piece spider design modifcations

Each characteristic of the spider was systematically reviewed to ensure it was correctly classified as:

- Critical to Quality
- Major
- Important to Manufacturing Only

Tolerances and gauging methods were established to ensure that the characteristic was not over-specified for the required function and classification, thus containing cost.

The product/process/inspection qualification of the spider was guided by the rigor of the Westinghouse Supplier Production Qualification Process (SPQP). SPQP (which is a Westinghouse adaption of the Automotive Industry's Production Part Approval Process [PPAP] but for the nuclear industry) demands that various aspects of the process such as measurement system analysis, process capability analysis, and special process qualifications such as welding and cleaning are studied to ensure that the supplier has developed a robust process that will deliver acceptable components in production.

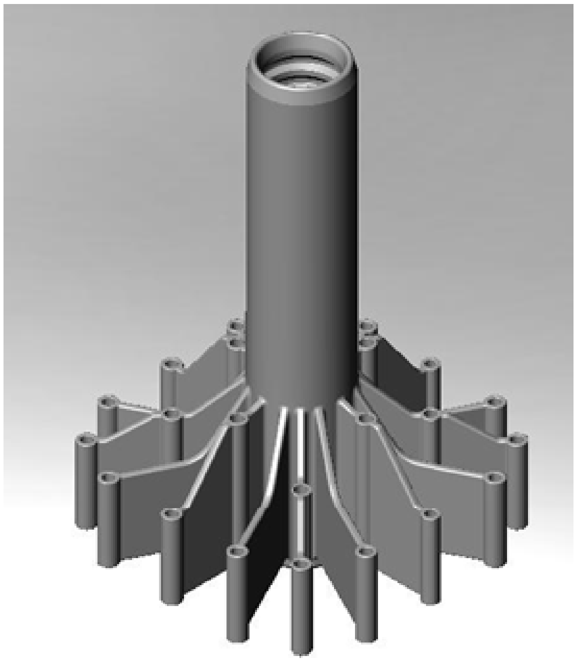


Figure 9: Complete 2 piece spider

The original design, comprising 41 separate components, was reduced to two pieces which resulted in a 95 percent part count reduction versus the original design thus simplifying the supply chain, eliminating previous process bottlenecks, and significantly reducing costs and complexity. The drive to reduce part counts required the use of Design for Manufacture (DfM) and Design for Assembly (DfA) principles in order for the end goal to be reached. Ultimately, the Westinghouse Columbia Fuel Fabrication Facility was able to build and deliver the first core of **AP1000®** reactor RCCAs on time with no significant issues.

5.2 Design for Manufacturability

The Nuclear Automation product line utilizes a folding keyboard tray assembly mounted to the front of instrumentation and control cabinets for ease of access and safe movement through the aisles. This keyboard tray assembly was targeted by the SM&VE group as a good candidate for evaluation and improvement due to the number of parts and complexity of the assembly. With the aggressive construction of **AP1000®** reactors, optimizing these assemblies was desired. Because the project was on a compressed timeline, an efficient method was needed to quickly and accurately give the design team recommendations. Using the Boothroyd Dewhurst, Inc. (BDI) Design for Manufacture and Assembly (DFMA®) software ,the SM&VE Engineers were able to develop these recommendations in less than a day.

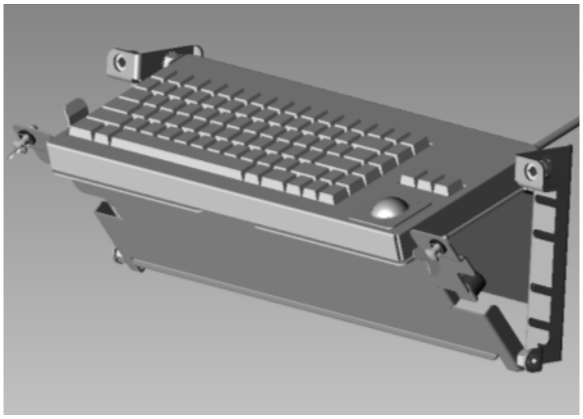
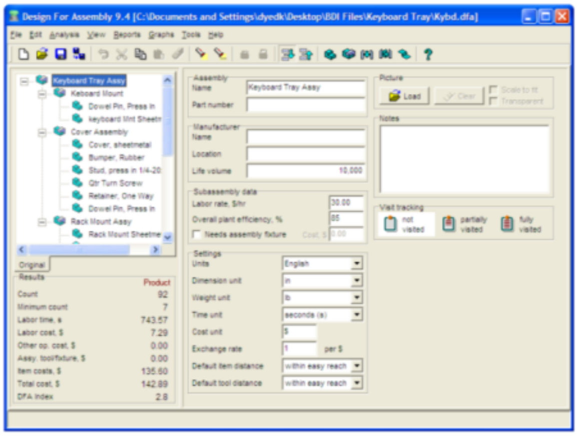


Figure 10: Keyboard Tray Assembly

The analysis followed the standard approach of adding the bill of material for the current design into the BDI DFMA® software using the Design for Assembly module.



- Keyboard Tray Assy
  - Keboard Mount
    - Dowel Pin, Press in
    - keyboard Mnt Sheetm
  - Cover Assembly
    - Cover, sheetmetal
    - Bumper, Rubber
    - Stud, press in 1/4-20
    - Qtr Turn Screw
    - Retainer, One Way
    - Dowel Pin, Press in
  - Rack Mount Assy
    - Rack Mount Sheetme

Assembly
Name: Keyboard Tray Assy
Part number:

Manufacturer
Name:
Location:
Life volume: 10,000

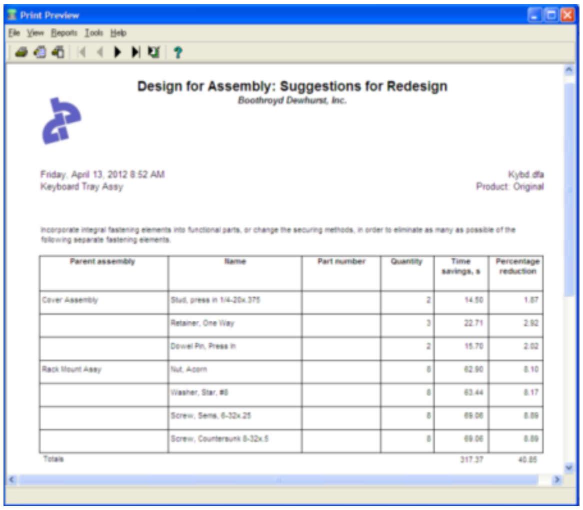
Subassembly data
Labor rate, $/hr: 30.00
Overall plant efficiency, %: 85
☐ Needs assembly fixture Cost, $ 0.00

Settings
Units: English
Dimension unit: in
Weight unit: lb
Time unit: seconds (s)
Cost unit: $
Exchange rate: 1 per $
Default item distance: within easy reach
Default tool distance: within easy reach

Results	Product
Count	92
Minimum count	7
Labor time, s	743.57
Labor cost, $	7.29
Other op. cost, $	0.00
Assy. tool/fixture, $	0.00
Item costs, $	135.60
Total cost, $	142.89
DFA Index	2.8

Figure 11: Design for Assembly DFMA Analysis

After initial input, the SM&VE Engineers used the reporting functionality contained in the Design for Assembly software to generate concepts for product redesign. Part combination and elimination strategies were employed. Many features that were "bolt on" or required fasteners and additions in the previous design were incorporated into the sheet metal structure by the use of various forming techniques. Still other parts that served a redundant function were eliminated altogether.



Design for Assembly: Suggestions for Redesign

Boothroyd Dewhurst, Inc.

Friday, April 13, 2012 8:52 AM
Keyboard Tray Assy

Kybd.dfa
Product: Original

Incorporate integral fastening elements into functional parts, or change the securing methods, in order to eliminate as many as possible of the following separate fastening elements.

Parent assembly	Name	Part number	Quantity	Time savings, s	Percentage reduction
Cover Assembly	Stud, press in 1/4-20x.375		2	14.50	1.87
	Retainer, One Way		3	22.71	2.92
	Dowel Pin, Press in		2	15.70	2.02
Rack Mount Assy	Nut, Acorn		8	62.90	8.10
	Washer, Star, #8		8	63.44	8.17
	Screw, Sems, 6-32x.25		8	69.06	8.89
	Screw, Countersunk 8-32x.5		8	69.06	8.89
Totals				317.37	40.85

Figure 12: DFMA Redesign Suggestions

The improved design reduced part count and assembly complexity dramatically. A total of 56 fasteners and 10 other parts were eliminated.

Initial Part Count	92
Part Count after DFA analysis	26
% reduction	72%

5.3 Should Cost Process

Westinghouse has been performing "should costs" at the request of both Sourcing and Program Management. The most common request occurs when supplier's quotes are higher than expected. When a buyer is looking for leverage for use in a negotiation with a supplier, a cost estimate can be useful. If a Buyer has an estimate that is half of a supplier's quote, he or she can often review this with the supplier. A lower quote will likely be the result; it is often still higher than the estimate, but lower than the original quote.

Engineers and Supply Chain personnel can perform cost estimates in a variety of ways. Sourcing, or whoever has asked for the estimate, will want to understand the basis for the quote as this further enhances their ability to enter negotiations. In 2010, Westinghouse began taking steps to make cost estimates more consistent.

Procedure

The "Should Cost" estimate guideline contains a series of steps from the time the request for the estimate is received through the presentation of the estimate to the requestor. This begins with the SM&VE group manager assigning an engineer to perform the estimate.

The engineer receives and reviews with the requestor all information regarding design, quantities requested, and time frame to ensure a mutual understanding of expectations.. The engineer will determine which portions, if any, will be estimated using a bottoms up method, which involves estimating labor rates and times for a series of manufacturing steps to create the part. Some parts, such as standard hardware and off-the-shelf items, may simply involve plugging in purchasing information. The emphasis will be on the parts that drive the cost, not a commercially available low-priced bolt.

The assigned engineer will create a process map prior to performing any calculations. Using a visual process map makes it less likely that steps in the manufacturing process will be overlooked. After the steps have been defined, the engineer can utilize the cost estimating software to determine times for each step such as rough machining.

Once an estimate has been created, the engineer documents it, along with assumptions used to create the estimate. Assumptions include material cost and labor rate estimates. By knowing what assumptions were made the requestor understands the scope of an estimate. The estimate may only cover a portion of the assembly; it may or may not include the cost of material. Known or assumed labor rates may be used. SM&VE may or may not include rates for overhead and profit, as these are different for every company. If these rates are used, the assumption will be documented.

Example

A nozzle dam is a part used to plug a steam generator during an outage. The assembly uses several off-the-shelf parts, including fasteners and electronics. The bulk of the cost comes from the large machined components shown.

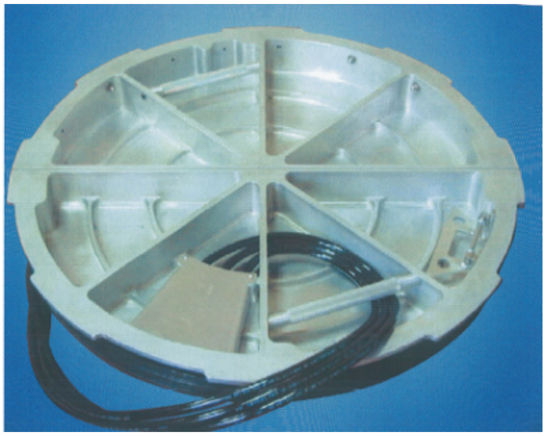
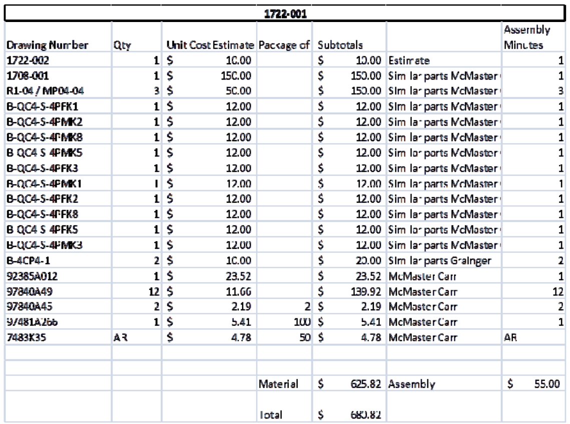


Figure 13: Nozzle Dam

Other peripheral equipment including controllers, manifolds, laptop computers, and other electronics are not shown in the picture.

Many of these components can be found in commercial parts catalogs and other locations since they are off-the-shelf parts. Here is an example from the full bill of material:

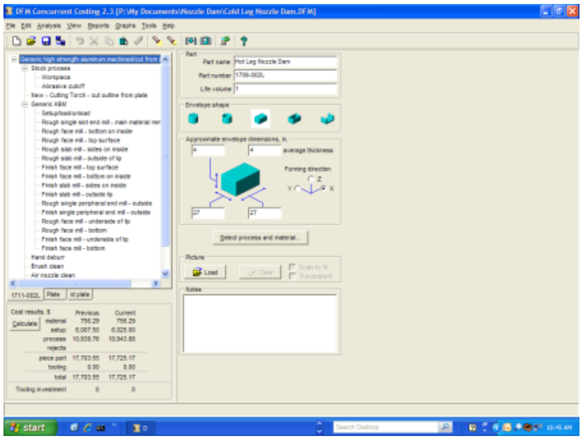


1722-001

Drawing Number	Qty	Unit Cost Estimate	Package of	Subtotals		Assembly Minutes
1722-002	1	$ 10.00		$ 10.00	Estimate	1
1708-001	1	$ 150.00		$ 150.00	Similar parts McMaster	1
R1-04 / MP04-04	3	$ 50.00		$ 150.00	Similar parts McMaster	3
B-QC4-S-4PFK1	1	$ 12.00		$ 12.00	Similar parts McMaster	1
B-QC4-S-4PMK2	1	$ 12.00		$ 12.00	Similar parts McMaster	1
B-QC4-S-4PMK8	1	$ 12.00		$ 12.00	Similar parts McMaster	1
B QC4 S 4PMK5	1	$ 12.00		$ 12.00	Similar parts McMaster	1
B-QC4-S-4PFK3	1	$ 12.00		$ 12.00	Similar parts McMaster	1
B-QC4-S-4PMK1	1	$ 12.00		$ 12.00	Similar parts McMaster	1
B-QC4-S-4PFK2	1	$ 12.00		$ 12.00	Similar parts McMaster	1
B-QC4-S-4PFK8	1	$ 12.00		$ 12.00	Similar parts McMaster	1
B QC4 S 4PFK5	1	$ 12.00		$ 12.00	Similar parts McMaster	1
B-QC4-S-4PMK3	1	$ 12.00		$ 12.00	Similar parts McMaster	1
B-4CP4-1	2	$ 10.00		$ 20.00	Similar parts Grainger	2
92385A012	1	$ 23.52		$ 23.52	McMaster Carr	1
97840A49	12	$ 11.66		$ 139.92	McMaster Carr	12
97840A45	2	$ 2.19	2	$ 2.19	McMaster Carr	2
97481A266	1	$ 5.41	100	$ 5.41	McMaster Carr	1
7483K35	AR	$ 4.78	50	$ 4.78	McMaster Carr	AR
			Material	$ 625.82	Assembly	$ 55.00
			Total	$ 680.82		

Figure 14: Nozzle Dam bill of materials

The bulk of the cost is due to large custom machined components. These were estimated using BDI's DFMA cost estimating software.



DFM Concurrent Costing 2.3 [P:\My Documents\Nozzle Dam\Cold Leg Nozzle Dam.DFM]

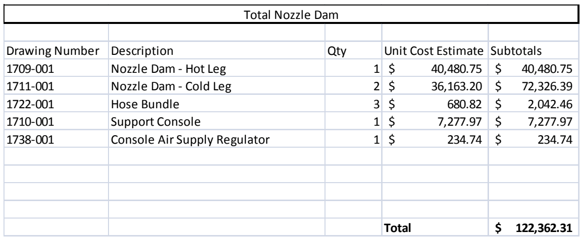
Part name: Hot Leg Nozzle Dam
Part number: 1709-002L
Life volume: 1

Approximate envelope dimensions, in: 4; 4 average thickness; 27; 27

Cost results, $	Previous	Current
material	756.29	756.29
setup	6,007.50	6,025.90
process	10,939.76	10,943.88
rejects		
piece part	17,703.55	17,725.17
tooling	0.00	0.00
total	17,703.55	17,725.17
Tooling investment	0	0

Figure 15: Nozzle Dam Cost Estimate from DFMA

The total cost estimate for this assembly is shown as follows:



Total Nozzle Dam

Drawing Number	Description	Qty	Unit Cost Estimate	Subtotals
1709-001	Nozzle Dam - Hot Leg	1	$ 40,480.75	$ 40,480.75
1711-001	Nozzle Dam - Cold Leg	2	$ 36,163.20	$ 72,326.39
1722-001	Hose Bundle	3	$ 680.82	$ 2,042.46
1710-001	Support Console	1	$ 7,277.97	$ 7,277.97
1738-001	Console Air Supply Regulator	1	$ 234.74	$ 234.74
			Total	**$ 122,362.31**

Figure 16: Total Cost Estimate for Nozzle Dam

In this case, the estimate represents the cost alone. Mark-ups for profit and overhead are not included. Design Engineering, Supplier Manufacturing Engineering, and Supplier Quality Engineering hours required are also not included. This is carefully documented when the estimate is provided to the requestor. The estimate is low by definition since some items are not included and can be used as a starting point during supplier negotiations.

6.0 Conclusions & Lessons Learned Summary

Westinghouse Supply Chain Management has demonstrated that using Value Engineering principles and the application of Design for Manufacturability throughout the product development cycle, the effectiveness of "Should Cost" assessments are improved dramatically.

Previously, "Should Cost" analyses were insufficient due to the lack of Value Engineering studies and standardized design for manufacture and assembly activities. With the incorporation of Value Engineering studies and Design for Manufacturability analyses into the process, designs and costs are optimized for both value and function. The output from the BDI DFMA software can be utilized to drive redesigns of both product and process and ultimately drive negotiations with potential suppliers. Also, suppliers can now benefit from the output, as they will be quoting a more manufacturable design with the production process better aligned with the final product characteristics.

An unexpected benefit is that Supply Chain Management's Sourcing and Supplier Management personnel are spending less time quoting and analyzing designs that are either not able to be manufactured or are too expensive, thus eliminating duplication of efforts.

The key to a successful product or project is that Supply Chain Management (SCM) Sourcing and Supplier Management and Supplier Manufacturing and Value Engineering both must be brought into the process early. Before a new equipment and/or product design is sent out for procurement, a robust design will always take into consideration the Supplier's feedback via the Sourcing and Supplier Management and/or Supplier Manufacturing and Value Engineering processes. Also, communication of cost information should be customized to reflect the type of estimate under evaluation. For example, forms used to evaluate design options require more information, including baseline estimates, than those used to simply estimate a supplier price for proposal validation.

Early Supply Chain Management involvement helps avoid costly redesigns later in the process when costs are much higher and the design is potentially unable to be manufactured. While the product may be functional without this upfront involvement, the long term costs associated with producing it greatly affect both the quality levels the customer experiences and profit margins Westinghouse requires.

In summary, Value Engineering, Design for Manufacture, and Design for Assembly disciplines are instrumental in the Westinghouse "Should Cost" process. The "Should Cost" process is a powerful method allowing product teams to make informed decisions regarding product and process value and costs early in the design phase in order to affect the TCO.

7.0 Acknowledgements

1. Steven King, Westinghouse Global Director, Supplier Manufacturing and Value Engineering

8.0 References

1. “Westinghouse AP10000” Westinghouse Electric Company LLC 2012, http://ap1000.westinghousenuclear.com/ap1000_glance.html.
2. “Westinghouse SMR Design” Westinghouse Electric Company LLC, 2012, http://www.westinghousenuclear.com/smr/index.htm

9.0 List of Figures

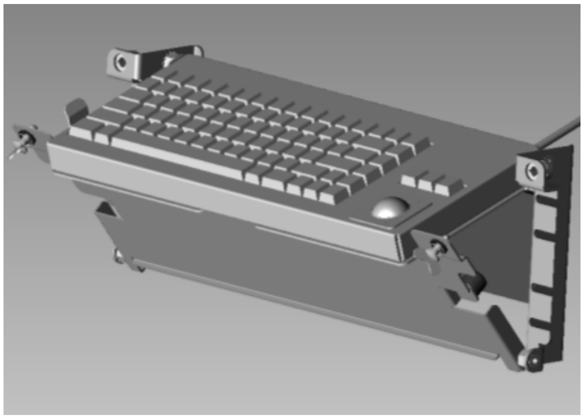


Figure 16: Total Cost Estimate for Nozzle Dam

10.0 Attributions Statement

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