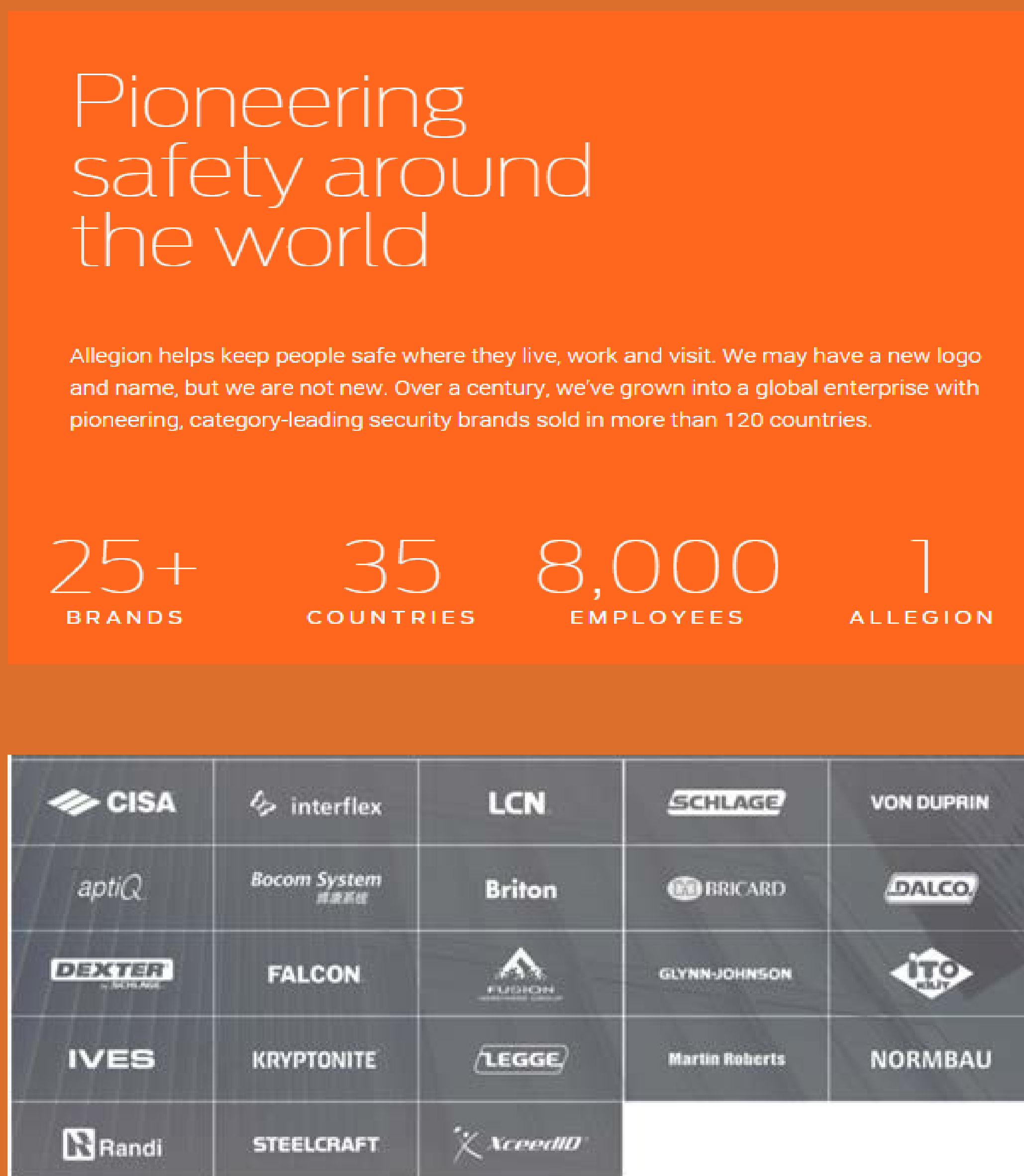
Application of Value Analysis/ Value Engineering principles to Cylindrical Lock Product

Mr. Subbiah Gopalakrishnan
Mechanical Engineer



Application of Value Analysis/Value Engineering principles to Cylindrical Lock product

Mr. Subbiah Gopalakrishnan

Mr. Subbiah Gopalakrishnan a Certified Associate Value Specialist, holds a Bachelor degree in Mechanical Engineering with 9 years of professional experience in the field of Consumer & Industrial, Security Systems Product design, Value Engineering, Value analysis, Project Management and Cost Management and also a GE six sigma Green Belt certified professional.

Abstract

ND is a major cylindrical lock product in Schlage commercial portfolio which offers a variety of functions. Among them is a ND offering that can accommodate a competitor Cylinder. This product claims its importance in a situation where a customer wants to replace the existing lock with a Schlage lock while retaining his old key system. Customer complaints surrounding installation difficulties, misalignment and interference of components resulted in the discontinuation of this function. A root cause analysis performed on the failure, along with application of a VAVE approach not only gave us a robust design that addresses all the concerns but also allowed us to arrive at a cost effective design thus, efficiently bringing the product back to the market.

Pre-Workshop Activity: An analysis of warranty returns was conducted and the project was identified. Team was formed and high level objectives were set

Information Phase: The necessary information (such as product information, quality information and cost information) were gathered pertaining to the project. The teardown and benchmarking design tools were effectively utilized to gather necessary information on the competitor products and ensure that our product exceeds the market expectations.

Function Analysis Phase: The functional analysis phase helped us to identify the functions of the component, sub-assembly and assembly level in the form of verb and noun. FAST diagram was plotted on the basis of the functional analysis. The Function-Cost Analysis aided us to identify the important top spending function and subsequently a worth of each function within the product was discussed with the team.

Creativity Phase: Numerous concepts were generated from the Brainstorming sessions conducted on top functions finalized from Function-cost worth analysis.

Evaluation Phase: All the short listed ideas were filtered through Idea Feasibility Ranking matrix. The final concept was selected based on the rating of each concept against weighted criteria evaluation.

Development Phase: The engineering analysis (tolerance analysis, DFMEA etc.) was completed; Prototype Testing was also carried out.

Presentation Phase: The detailed report was prepared and design review was conducted with cross functional team. Received approval from stake holders to proceed.

Post Workshop (Documentation & Implementation): Production validation Testing and all necessary documentation (PPAP, Mfg. readiness, First Article Inspection etc.) were completed. The Function cost was updated.

Conclusion - Root Cause Analysis combined with the Value Engineering methodology is a powerful tool for resolving system failures and improve the functionality of any process or product

Project Background

Schlage offers Cylindrical Lock to suit Competitor Key systems. One of the product offerings displayed performance issues resulting in warranty returns and eventually putting itself "On Hold". Major customer complaints were collected and validated through performance testing along with fit and functional check. The root cause for this failure was identified through 8D process. Ideas to address the identified causes were generated and the most viable design was chosen. The cost reduction aspects for the chosen design were addressed by effective use of VAVE methodology.

Introduction to Value Analysis and Value Engineering

Value Analysis (VA) / Value Engineering (VE) is defined as an organized effort directed at analyzing the functions of systems, equipment, facilities, services, and supplies for the purpose of achieving the essential functions at the lowest life-cycle cost consistent with required performance, quality, reliability and safety. VE is a technique directed toward analyzing the functions of an item or process to determine "best value," or the best relationship between worth and cost.

Value Methodology Job Plan

Adherence to the job plan focuses efforts on a decision making process that contains the right kind of emphasis, timing, and elements to secure a high-quality product..

The job plan is briefly described below.

- Pre-Workshop
- Information Phase
- Function Analysis Phase
- Creativity Phase
- Evaluation Phase
- Development Phase
- Presentation Phase
- Post Workshop (Documentation & Implementation)

Pre-Workshop

The objective of the Pre-workshop in Value Methodology process is to identify the correct project to achieve maximum monetary savings or improved value. The selection of resources (team members) is also critical in this phase. This value study team uses the value study part of the job plan to examine the activity. The value study generates alternatives that show promise of increasing the value of the activity. Each activity needs specific technical expertise and experience, customer involvement, independence, and team facilitation resources to obtain optimum performance of the value study team.

Product Line

The ND-Series Grade 1 Commercial Lock is Schlage's best-selling mechanical locks for its tough, durable and fits a wide variety of applications. The Schlage Commercial Cylindrical Lock product offers various functional offering to our customers. One of them is the lock to suit competitor key systems. If a customer wants to retain their existing key systems, but wanted to use a Schlage cylindrical lock, then this product plays a key role.

Resources

Fig 1

Team Member	Title	Location
Leif Selstad	Product Management Leader	Carmel
Greg Hebner	Product Manager	Colorado
David Hurlbert	Engineering Manager	Colorado
Subbiah G	Mechanical Engineer	Bangalore
Snehil Solanki	Mechanical Engineer	Colorado
Randy Davis	Test Technician	Colorado
Steve Couch	Technical Support	Colorado
Yelenia Heras	Planner	Mexico
Oscar Adrian Ibarra	BOM Leader	Mexico
Roberto Rodriguez	Quality & Manufacturing	Mexico
Elvira Silva	BOM Leader	Mexico
Elfego Ubaldo	SQE	Mexico

Information Phase

The objective of the Information phase of the Value Methodology Job plan is to acquire knowledge of the design to be studied and to assess its major functions, cost and relative worth. This phase is intended to provide a thorough understanding of the system, operation or item under study by an in-depth review of all of the pertinent factual data. During the information phase, we completed the below set of activities Information gathering related to product, process and components

  - Current Assembly process
  - Current Installation process
  - Fixtures involved in assembly
  - Component & Assembly drawings
  - Estimated Annual Usage Data
  - Control Plan
- Bill of Materials of the product
  - Assembly cost
  - Component Cost
  - Material Cost, Mtl. Overhead cost, Outside processing cost & Resource cost
- CTQ's identified
- Identified Key risks & deliverables

Challenges with the current product

- Mis-Alignment between components
- Difficult to Install
- Difficult in assembling the levers
- Interference (driver bar on lever catch) issues
- Push button Activation issue

Fig 2

Component	Existing Cost ($)
A	9.3
B	7.10
C	2.18
D	2.12
E	2.25
Total	22.95

Teardown and Competitor Analysis

A teardown session was conducted to identify the factors such as product features (assembly & installation), product specifications, safety features, security features, standards & compliances and costed BOM. Strengths Weaknesses Opportunities Threats (SWOT) Analysis was completed.

Major report out items are listed below

- Detailed information study of product features
- Detailed analysis of component costs
- Attachment methods evaluation
- Installation study of all cylinder types

Below the snapshot of the report (competitor analysis document).

Fig 3

Features	Current Product	Competitor A	Competitor B	Competitor C	Competitor D
Driver Bar Attachment	Within Spindle (with 4 components)	Press fit	Steel Screw Cap	Push and fit two legs	Within Spindle
Ease of Assembly	No	Yes	Yes	Yes	No
Ease of Installation	No	Yes	Yes	Yes	Yes
Cost	High	Low	High	Low	High

Function Analysis Phase

Function Analysis is a technique used to identify and understand the needs of the product or service, (what does it do, what must it do). Function Analysis is an essential component of the Value Engineering/Value Analysis process.

In Function Analysis, functions are described in two- word Verb - Noun definitions that describe the needs of the product or service being examined. The two words used to describe a function include an active verb and a measurable noun. The measurable noun identifies something that can be described and quantified. Although the function of a project, product or service could be provided in a descriptive paragraph, a verb-noun definition ensures concise descriptions that focus on one function at a time.

We started the analysis of the product by identifying the important functions of a product or service. The function analysis process includes

- Identified Basic and Secondary Functions
- Developed FAST (Function Analysis System Technique) diagram
- Allocated function cost and function worth
- Cost-function analysis ranking

Fig 4

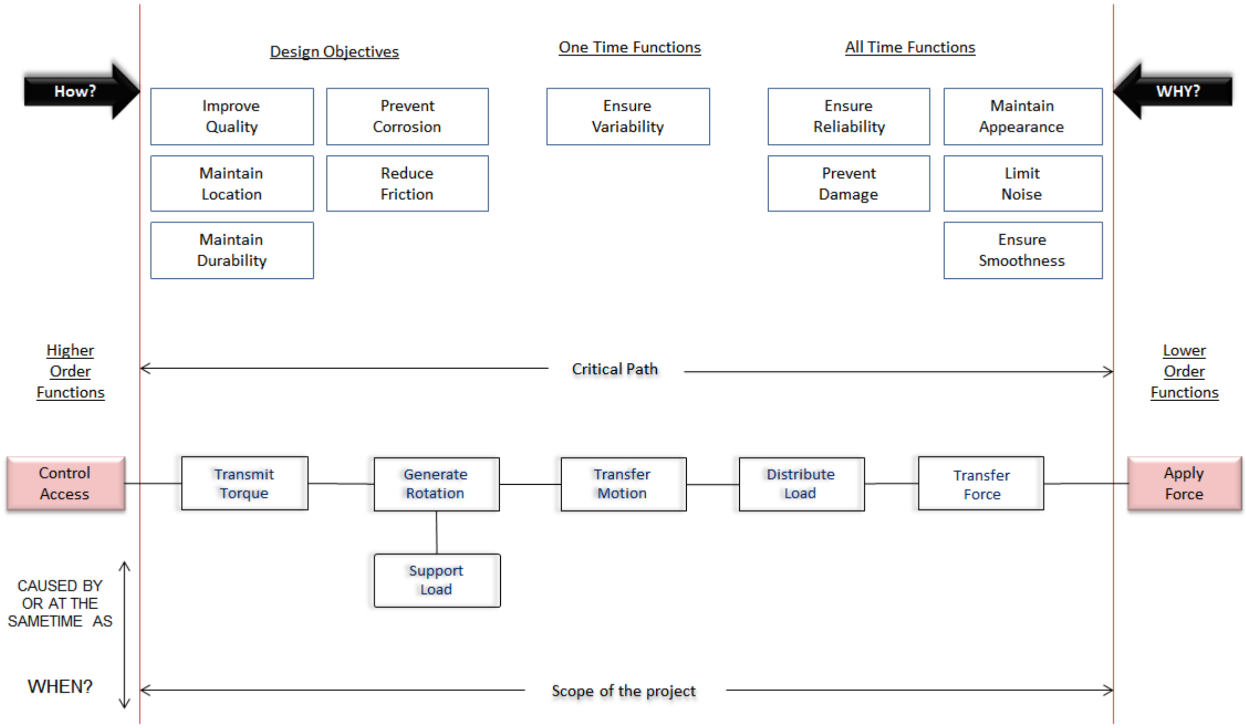
Component	Function		Basic/Secondary
	Active Verb	Measurable Noun	
Driver Bar	Transmit	Torque	**Basic**
	Maintain	Location	Secondary
	Prevent	Corrosion	Secondary
	Reduce	Friction	Secondary
	Ensure	Smoothness	Secondary
	Distribute	Load	Secondary
	Ensure	Variability	Secondary
	Transfer	Motion	Secondary
	Ensure	Reliability	Secondary
	Limit	Noise	Secondary
	Generate	Rotation	Secondary
	Support	Load	Secondary
	Maintain	Appearance	Secondary
	Maintain	Location	Secondary
Slotted Pin	Maintain	Location	**Basic**
	Distribute	Load	Secondary
	Maintain	Durability	Secondary
	Support	Load	Secondary
	Limit	Noise	Secondary
	Ensure	Smoothness	Secondary
Retainer	Maintain	Location	**Basic**
	Reduce	Friction	Secondary
	Distribute	Load	Secondary
	Support	Load	Secondary
	Maintain	Durability	Secondary
	Improve	Quality	Secondary
	Transfer	Force	Secondary
Catch	Maintain	Location	**Basic**
	Prevent	Damage	Secondary
	Support	Load	Secondary
	Ensure	Smoothness	Secondary
	Limit	Noise	Secondary
	Maintain	Apearance	Secondary
	Distribute	Load	Secondary
Clip	Maintain	Location	**Basic**
	Transfer	Force	Secondary
	Maintain	Durability	Secondary
	Distribute	Load	Secondary

FAST Diagram

FAST is a diagramming technique which reveals the relationships and interrelationships of all known functions. The FAST diagram technique helped us to accomplish the following:

- Design relationships of all functions with respect to each other
- Understand the problem to be solved

Fig 5



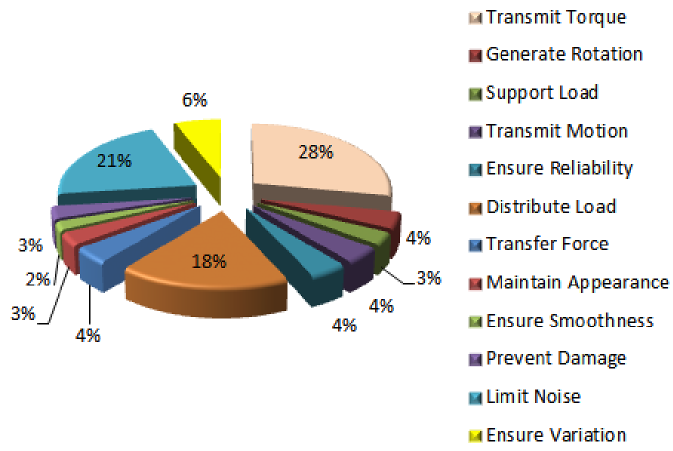
Function Cost worth Analysis

The cost for each function was allocated after this evaluation and we understood the worth of the product. Worth is a notional cost pertaining to the function and not to the corresponding part. We selected few of the critical functions which had maximum value gap or cost-to-worth mismatch. Here, we analysed the Value Index and Value Gap based on the worth of the assembly under consideration. Function worth is defined as the lowest possible cost to perform any given functions or set of functions. The value index and Value Gap is a relationship of function worth to function cost.

Fig 6

Function		Existing cost $	Worth $	Achieving Worth	Value Gap (Cost-Worth)	Value Index (Cost/Worth)	Rank
Active Verb	Measurable Noun						
Transmit	Torque	A	A1	Alternate design	7.23	4.65	1
Generate	Rotation	B	B1	Combine Parts	0.6	2.35	9
Support	Load	C	C1	Material Change	1.025	2.64	5
Transfer	Motion	D	D1	Optimize design	1.1	2.59	4
Ensure	Reliability	E	E1	Optimize design	0.65	1.73	8
Distribute	Load	F	F1	Optimize design	4.25	3.49	3
Transfer	Force	G	G1	Optimize design	0.85	2.35	6
Maintain	Appearance	H	H1	Alternate design	0.25	1.60	11
Ensure	Smoothness	I	I1	Material Change	0.15	1.00	12
Prevent	Damage	J	J1	Optimize design	0.8	2.86	7
Limit	Noise	K	K1	Alternate design	5.45	4.18	2
Ensure	Variability	L	L1	Optimize design	0.5	1.73	10
		$33.38	$10.52		$22.86		

Fig 7



The top three functions from the analysis are:

a) Transmit Torque
b) Limit Noise
c) Distribute Load

Creativity Phase

The processes completed in the phase are mentioned below:

- Use creative brainstorming by function for the highest cost functions as prioritized by the Cost/Function Worksheet per above.
- Compilation of all the ideas and sketches

Fig 8 – Ideas by Function

Transmit Torque

- Heat treated steel
- Casted Steel
- Increase the area of section
- Use longer bar
- Machine the profile out of solid bar

Limit Noise

- Use snap fit or tape
- Weld components
- Use Magnet
- Staking components
- Use threads

Distribute Load

- Use screw
- Increase bearing surface for guide
- Round profile for surface contact
- Design guiding features

Brainstorming Session and Idea categorization:

- Ideas Generated = 67
- Shortlisted Feasible ideas = 14

Fig 9

Team Memebers for Brainstorming Sessions on below functions

Transmit Torque

Limit Noise

Distribute Load

Team Member	Title
Greg Hebner	Product Manager
David Hurlbert	Engineering Manager
Subbiah G	Mechanical Engineer
Snehil Solanki	Mechanical Engineer
Jason C	Mechanical Engineer
Brian W	Mechanical Engineer
Kent B	Mechanical Engineer
Steve Couch	Technical Support
Yelenia Heras	Planner
Roberto Rodriguez	Quality & Manufacturing
Elfego Ubaldo	SQE

Evaluation Phase

After brainstorming, we eliminated all the concepts which were not feasible through preliminary evaluation using Idea Feasibility Ranking Matrix.

The processes followed under Evaluation phase are:

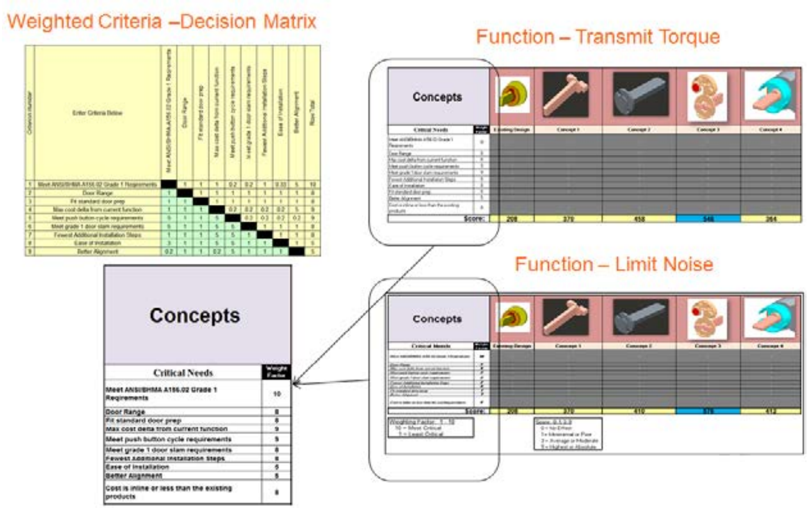
- Evaluate all the ideas using Idea Feasibility Ranking Matrix
- Identified the criteria and weighted the criteria
- Developed concepts and rated against weighted criteria
- Selected the best concept

The parameters used for evaluation are listed below:

- Meet ANSI/BHMA A156.02 Grade 1 Requirements
- Door Range
- Max cost delta from current function
- Meet push button cycle requirements
- Meet grade 1 door slam requirements
- Fewest additional installation steps
- Fit standard door prep
- Better Alignment
- Cost is inline or less than the existing products

Fig 10

Cut-off Point = 30								
Idea Feasibility Ranking - Function "Transmit Torque"								
	Criteria							
	Ideas	Technical Feasibility	Implementation Probability	Implementation time	Tooling Costs	Estimated Cost Benefits	Total Points	Ranking
Ideas from Creative Phase	Concept 1	6	6	6	5	6	29	8
	Concept 2	6	7	6	6	4	29	5
	Concept 3	7	3	5	2	5	22	14
	Concept 4	6	6	6	6	7	31	3
	Concept 5	8	3	6	6	5	28	9
	Concept 6	6	8	5	6	2	27	10
	Concept 7	8	5	6	6	7	32	2
	Concept 8	8	6	6	4	6	30	4
	Concept 9	6	3	5	3	8	25	11
	Concept 10	5	8	7	5	8	33	1
Idea Feasibility Ranking - Function "Limit Noise"								
	Criteria							
	Ideas	Technical Feasibility	Implementation Probability	Implementation time	Tooling Costs	Estimated Cost Benefits	Total Points	Ranking
Ideas from Creative Phase	Concept 1	6	5	3	6	4	24	13
	Concept 2	7	4	3	6	3	23	14
	Concept 3	8	5	5	7	4	29	6
	Concept 4	5	8	8	5	6	32	2
	Concept 5	4	7	6	4	5	26	9
	Concept 6	9	6	5	6	4	30	3
	Concept 7	3	7	6	5	5	26	11
	Concept 8	8	7	8	7	8	38	1
	Concept 9	6	7	6	4	5	28	7
	Concept 10	5	6	3	7	8	29	5



Development Phase

The processes completed in the development phases are below:

- Modelling & Drafting
- Design Failure Mode & Effect Analysis (DFMEA)
- Finite Element Analysis
- Technical Risk Analysis
- Tolerance Analysis
- Concept Validation Testing

Presentation to the Stakeholders

The project report and design review was completed with the Cross Functional Team. All the engineering analysis completed by the team was presented to the management for review and approval.

Approvals from Stakeholders was obtained and project was moved forward to Implementation phase

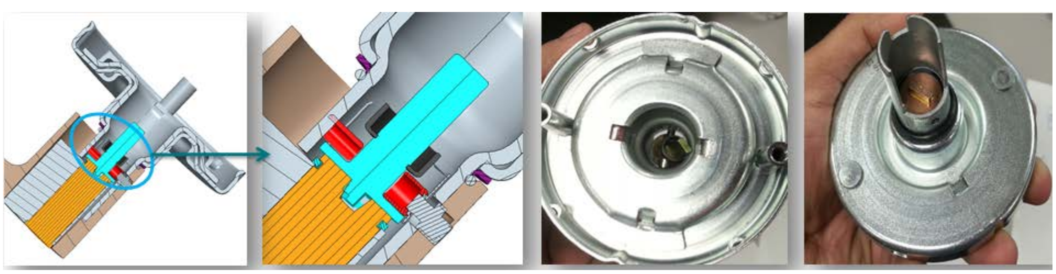
Fig 11

Component	Existing Cost ($)	New Cost ($)
A	9.3	7.30
B	7.10	
C	2.18	
D	2.12	
E	2.25	
F		5.63
G		4.25
H		0.75
Total	22.95	17.93

- Overall total product savings of $5.02 per lock assembly
- Part Number Count improved by 1 less component per lock assembly
- 1 less part results in additional savings related to drawing control, quality, logistics, packaging, assembly and material labour savings, etc.

Before VAVE and After VAVE

Before VAVE



After VAVE

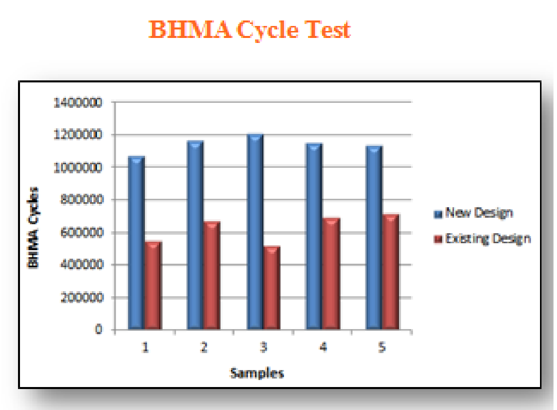
Fig 12 Before & After VAVE

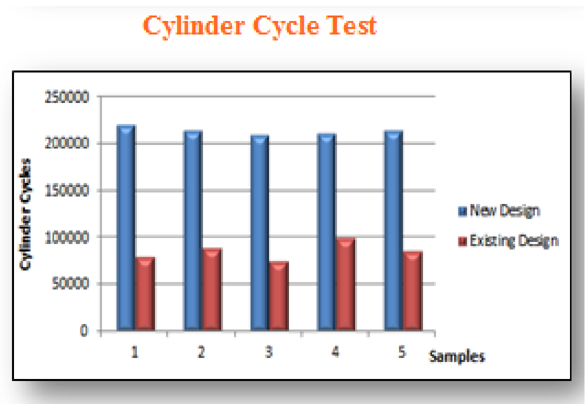
Post Workshop (Documentation & Implementation)

The implementation phase involved final set of activities listed below:

- Finalize design
- Release PO for tooling
- Tooling Development
- Design Validation Testing completed
- First Article Inspection Approved
- Pilot Run & Production Parts Approved (PPAP)
- Manufacturing Readiness Completed
- Product Launched

Fig 13





Post Workshop Audit

Benefits - $136,000 in annualized savings

- Improved Functionality
    - Component alignment issues resolved
    - Easier installation
    - Reduced plant assembly issues
    - Activation and interference issues resolved

Conclusion

Root Cause Analysis combined with Value Engineering methodology is a powerful tool for resolving system failures and improve the functionality of any process or product

➢ Effective Design & Quality

- Efficient retainer mechanism for outside & inside assembly
- Ease of Installation was achieved and reduced Installation time by 15%
- Value of product is increased by improving the Function and by reducing the cost

Bibliography

[1] Bill Phillips, The Complete Book of Locks and Locksmithing, Publisher: McGraw-Hill Professional Publishing, Published: 9/2005
[2] Schlage Lock Reference Study – VAVE Tools and Techniques
[3] VAVE Job Plan (SAVE)
[4] External Documents
i. ANSI A115.18 Specifications for Standard Steel Door and Steel Frame Preparation for Bored Locks and Latches with Lever Handles for 1 ⅜” and 1 ¾” Doors.
ii. ANSI/BHMA A156.2 for Bored and Preassembled Locks and Latches
iii. ANSI/BHMA 156.5-2014 Cylinders and Input Devices for Locks