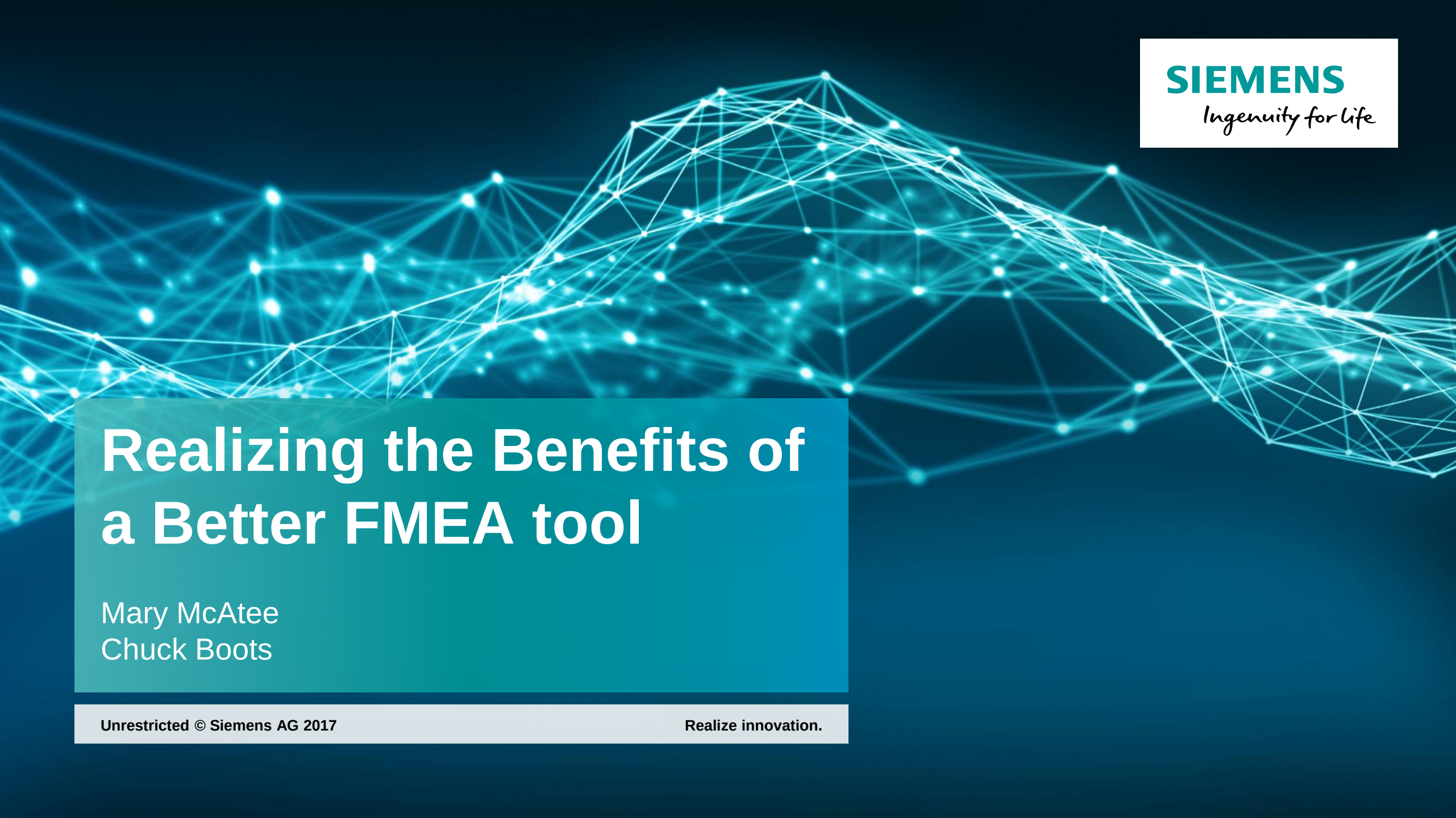

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Realizing the Benefits of a Better FMEA tool

Mary McAtee
Chuck Boots

Introduction: Chuck Boots

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Chuck Boots: Technical Presales Consultant II

- 20+ years of manufacturing/quality experience
- Bachelor of Science, Business Management
- 5 years as Siemens customer 3 years in current role
- Apollo RCA, Int/Ext/Supplier auditing, Six Sigma

Charles.boots@siemens.com

Introduction: Mary McAtee

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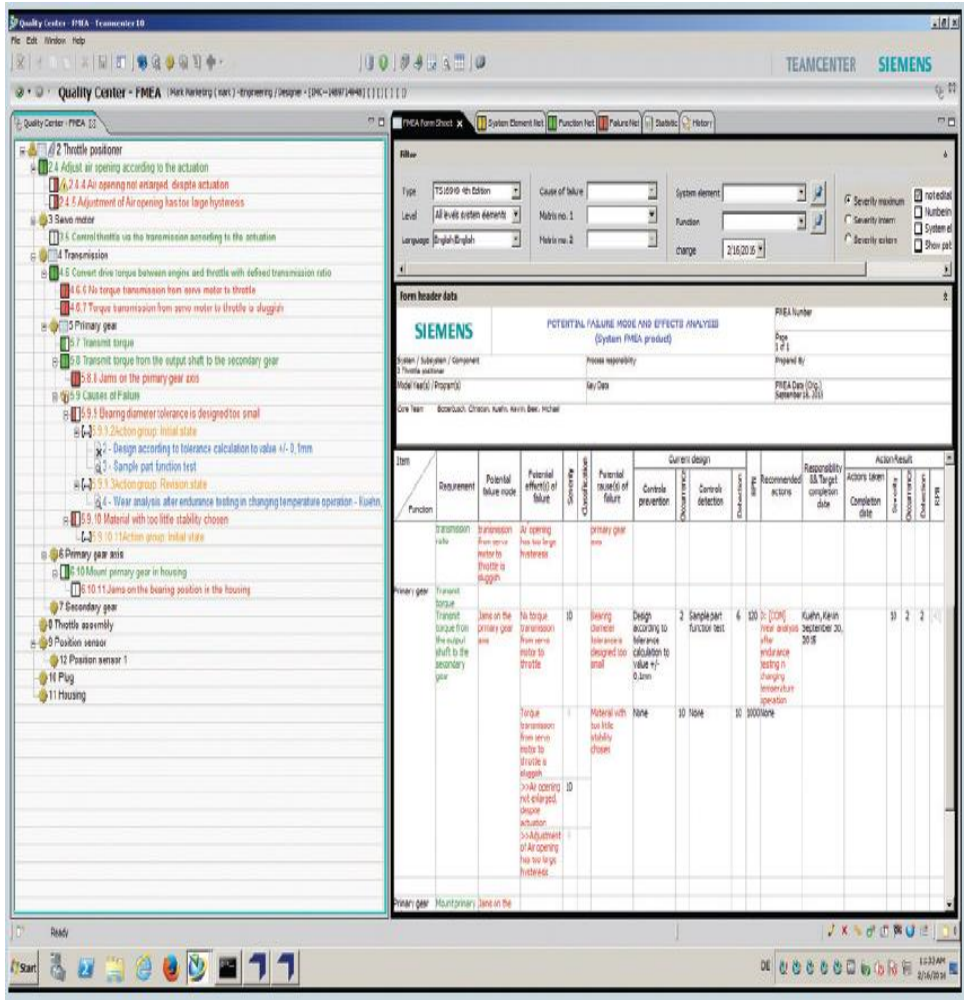
Mary V. McAtee: Technical Presales Consultant II

QM/FQC/LQC

- Mechanical Engineer with 30+ years Quality and Reliability Engineering Experience
- New England Research Center: R&D Infrared Detector Development
- MA/Com Space Center: Leading Provider of High Reliability Microelectronics
- Lead Assessor: ISO 9001, ISO 14001, OHSAS 18000, TS 16949

Mary.mcatee@siemens.com

FMEAs and Risk Management: Not just for the Automotive Industry Anymore



- Failure Modes Effects Analysis (FMEA), both Design FMEAs and Process FMEAs evolved from the defense industry in the late 60s.
- The Automotive Industry embraced the concept for design, manufacturing and safety risk assessment.
- FMEAs have proved their worth and are increasingly becoming the standard in other industries including aviation, medical device and energy.

Spreadsheets the Historical Tool of Choice

Historically Design and Process FMEAs and Control Plans have been developed in Excel spreadsheet formats which has some inherent drawbacks:

- Spreadsheets are not optimal for collaborative working groups.
- Spreadsheets are limited in providing functionality that supports intelligent reuse and qualification by similarity
- Change Management across the process can be challenging.

Sample Spreadsheet FMEA

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POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(PROCESS FMEA)

Part Number: _____ FMEA Number: 116409.02

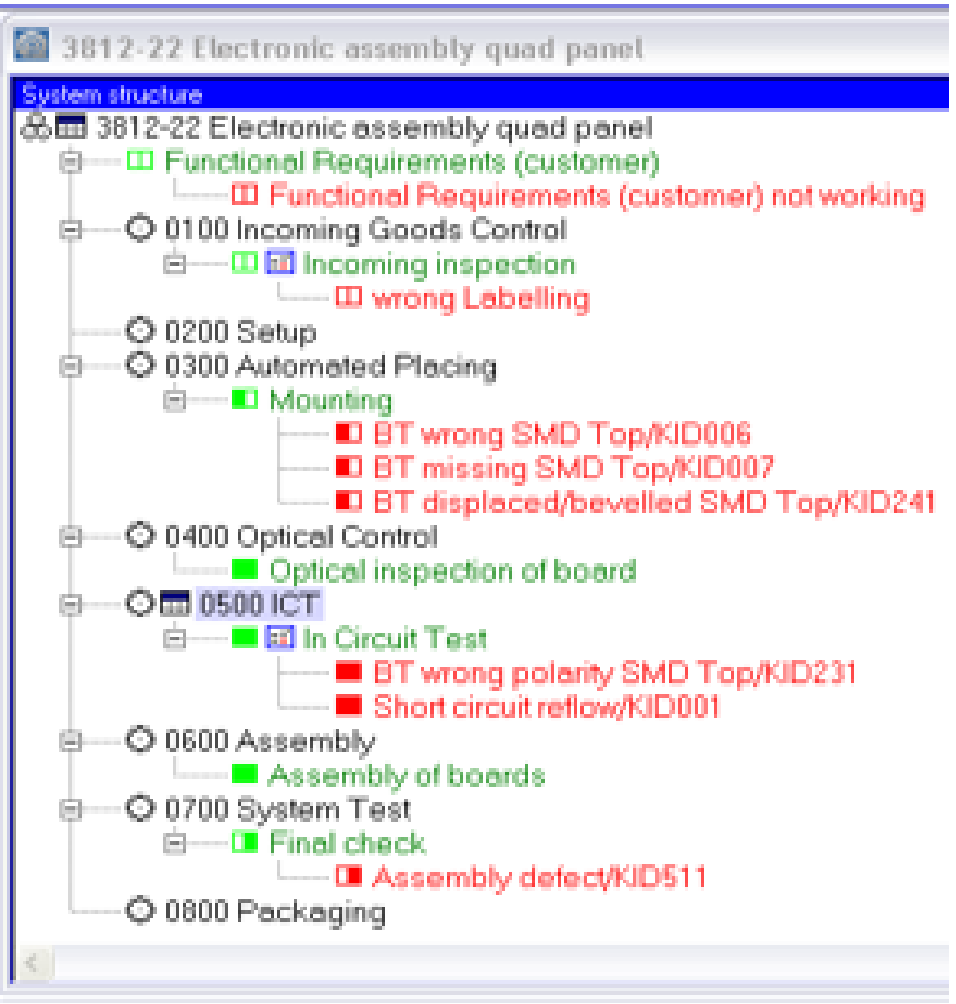
Part #: _____ Process Responsibility: _____ Prepared by: _____

Part Description: _____ Key Date _____ Date (Orig.) _____

Core Team: _____ Date (Rev.) _____

Process Step	Process Function/Requirements	Potential Failure Mode	Potential Effect(s) of Material Failure	Sev	Class	Potential Cause(s)/Mechanism(s) of Failure	Occur	Current Process Controls Prevention	Current Process Controls Detection	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
														Actions Taken	Sev	Occ	Det	R.P.N.
1-A	Chemicals Unload and verify freight	Unload wrong quantities	Inventory level incorrect within manufacturing system	1		Receiving Technician error	2	Training on receiving procedures	Visual freight verification to shipment documentation (Packing Slip, Bill of Lading)	8	16	None						
		Damage freight	Unusable product	1		Improper handling techniques	2	Fork-lift Training / Licensed Drivers	Visual freight verification	8	16	None						
	Input receiving data and forward paperwork	no input or input of wrong quantities or part number	Inventory level incorrect within manufacturing system	1		Receiving Technician error	2	Training on receiving procedures	Cycle count, physical inventories, and visual and operator feedback	8	16	None						
1-B	Door Beams Unload and verify freight	Unload wrong quantities	Inventory level incorrect within manufacturing system	1		Receiving Technician error	2	Training on receiving procedures	Visual freight verification to shipment documentation (Packing Slip, Bill of Lading)	8	16	None						
		Damage freight	Unusable product	1		Improper handling techniques	2	Fork-lift Training / Licensed Drivers	Visual freight verification	8	16	None						
1-C	Brackets Unload and verify freight	Unload wrong quantities	Inventory level incorrect within manufacturing system	1		Receiving Technician error	2	Training on receiving procedures	Visual freight verification to shipment documentation (Packing Slip, Bill of Lading)	8	16	None						
		Damage freight	Unusable product	1		Improper handling techniques	2	Fork-lift Training / Licensed Drivers	Visual freight verification	8	16	None						
	Place freight in storage location	Place in wrong location	Unable to locate material when needed	1		Operator Process Error	2	Delivery address, rack label, visual map, or item number Plant Address/Locator System	Physical Inventory	8	16	None						
	Determine run sequence and quantity	Schedule incorrect quantity or sequence	Parts not available when needed	1		Operator Process Error	3	Daily shop floor schedule/ parts needed list, Kanban red zones	Visual hot boards, Customer ratings, On-time delivery reports	7	21	None						
2-A	Load Formula Chemicals	Wrong Formula Selected	Out of Spec. Material	3		Operator Error	1	Operator Training	Material Performance INS-2001	5	15	None						
		Formula will not load on computer	Machine will not operate	2		Prior weigh-up not discharged	1	Operator Training & TPM system	X5 alarm (maximum residue exceeded)	1	2	None						

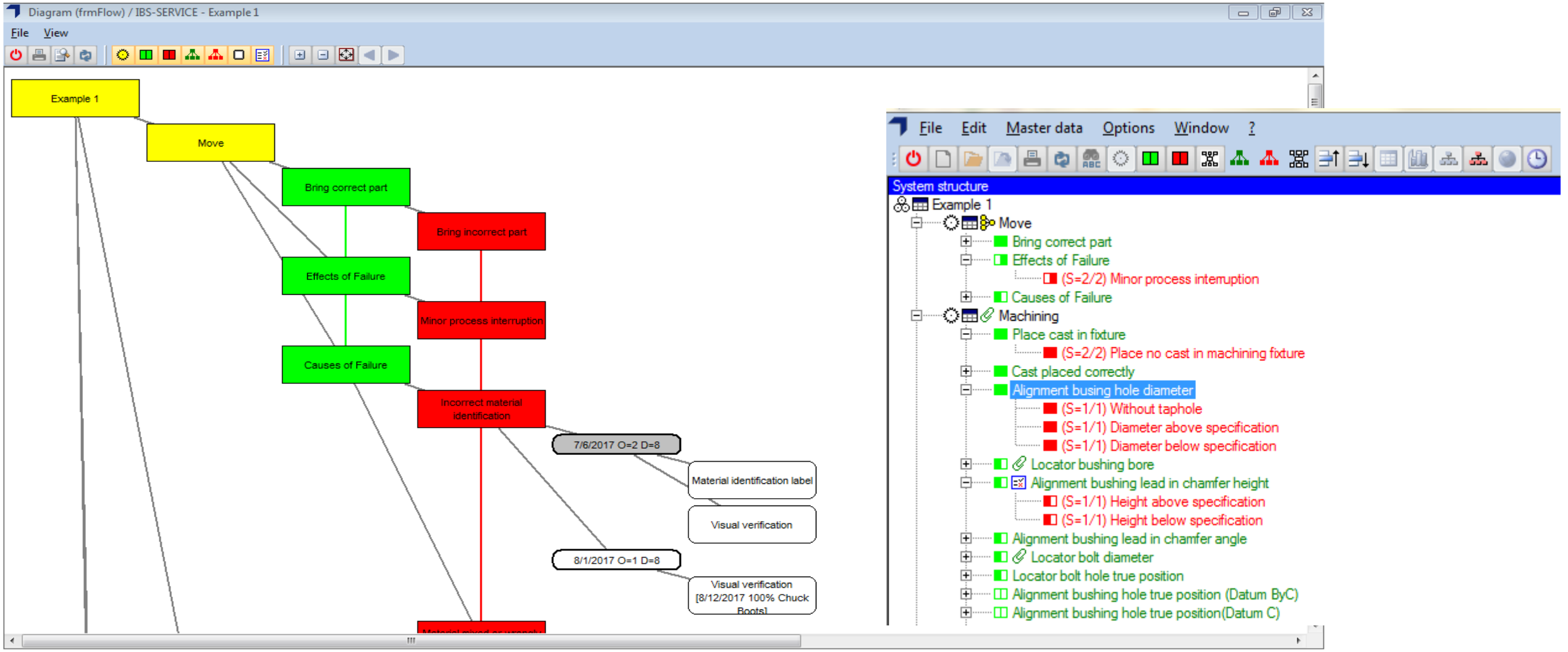
Tree Structure Design and Process FMEA Advantages



Moving to a tool that utilizes a tree structure methodology provides many advantages:

- Tree structure FMEAs can take in content from block diagrams to form the backbone of the Process FMEA.
- Design & Process FMEAs can seamlessly take in content and updates from Bill of Materials (BOM) and Bill of Process (BOP) data maintained in other systems including ERP and PLM Systems such as SAP and Teamcenter.
- Querying and reusing data is much more straight forward and real time to facilitate collaborative team efforts.
- Output can display in a variety of required regulatory formats including AIAG and VDA.

Tree Structure FMEA and Block Process Flowchart Diagram



AIAG Example Output Format

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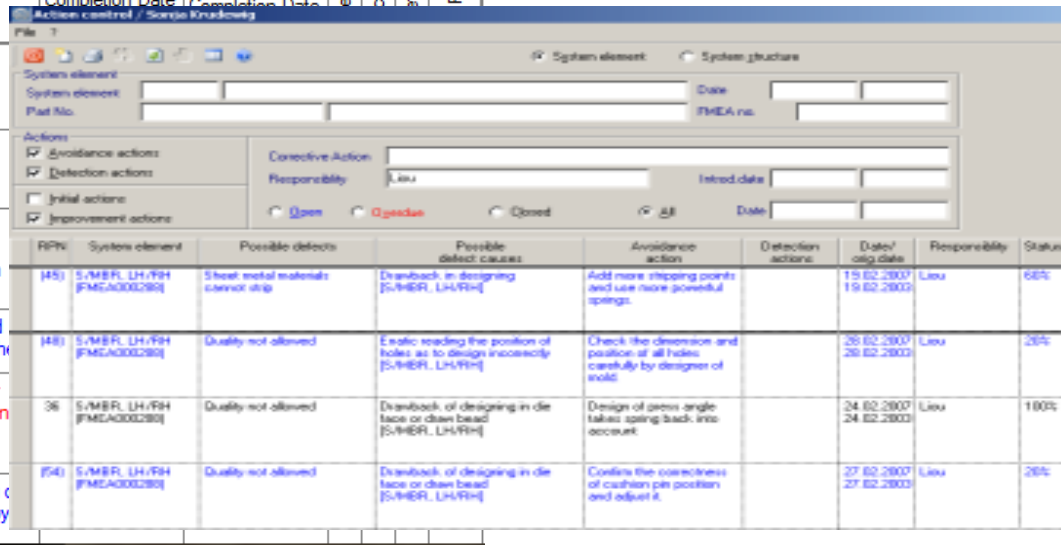
Process step/ Function	Requirement	Potential Failure Mode	Potential Effect(s) of Failure	S	C	Potential Cause(s) of Failure	Controls Prevention	O	Controls Detection	D	RPN	Recommended Actions	Responsibility & Target Completion Date	Actions Taken Completion Date	S	O	D	RPN
SIEMENS Ingenuity for life			POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS (Process FMEA)										FMEA Number FMEA000207					
													Page 1 of 1					
System Structure **Example 1**													Creat./modif.date 2017-06-22					
Item **Example 1**							Process Responsibility						Prepared By					
Model Year(s) / Program(s)							Key Date 2017-07-06						FMEA Date (Orig.) 2017-06-23	2017-09-06				
Core Team R.Valle, I.Duarte, A.Tercero, J.Valdez, Chuck Boots																		
Process step Function	Requirement	Potential Failure Mode	Potential Effect(s) of Failure	Severity	Classification	Potential Cause(s) of Failure	Current Process: Controls Prevention	Occurrence	Controls Detection	Detection	RPN	Recommended Actions	Responsibility & Target Completion Date	Action Results: Actions Taken Completion Date	Severity	Occurrence	Detection	RPN
Process 70.01: (1) Move (FMEA000209)	Bring correct part	Bring incorrect part	Minor process interruption	2	⌂	Incorrect material identification	Material identification label	2	Visual verification	8	32							
						Material mixed or wrongly identified	Material identification label	2	Visual verification	8	32	None						
Process 70: (2) Machining (FMEA000208) Documents: •BLACKBEARPASS2.JPG	Place cast in fixture	Place no cast in machining fixture	Minor process interruption	2		Process step skipped	Operator training	4	Visual verification	8	64	D: Last machining detection in leak test						
	Cast placed correctly	Cast misplaced in fixture	Machine crashes	7		Process step skipped	Operator training	4	Visual verification	8	224	P: Standard opetarion sh						
						Fixture allows loading of the part incorrectly	None	8	Visual verification	8	448	P: Install air sensoring on machining fixture						
						Fixture cleanliness, chips in fixture	None	8	Visual verification	8	448	P: Cleaning the fixture by rinsing,						

View in action list



AIAG v3 & v4, VDA 96 supported

Team Collaboration and Efficient Reuse of Data

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Team	Team Awesome
Team no.	5
Color	

Name	GID no.	Role ID	Department descr.	Role descr.	Email
Chuck Boots	Chuck.Boots	1		Quality Engineerir	charles.boots@siemens.(
Mac Don	Mac.Don	3		Production Super	charles.boots@siemens.(
Test 4	Test.4	6		Planner	
I.Duarte	I.Duarte	2		Manufacturing En	
Test 5	Test 5	7		Machine Operato	
Test 1	Test.1	5		Buyer	

Tree structure FMEAs permit locking lines of the FMEA during editing to assure only appropriate changes are made by the team.

- Revision controls and archive functionality can keep the team oriented and facilitate design by similarity activities.
- Drag and drop of components, subassemblies and assemblies as well as processes and sub processes from one FMEA to another permits easy reuse of data.
- The resulting “where used query net” is extremely valuable when assessing the potential impact of a proposed Engineering Change.

Reusing Data and Lessons Learned through Linkage

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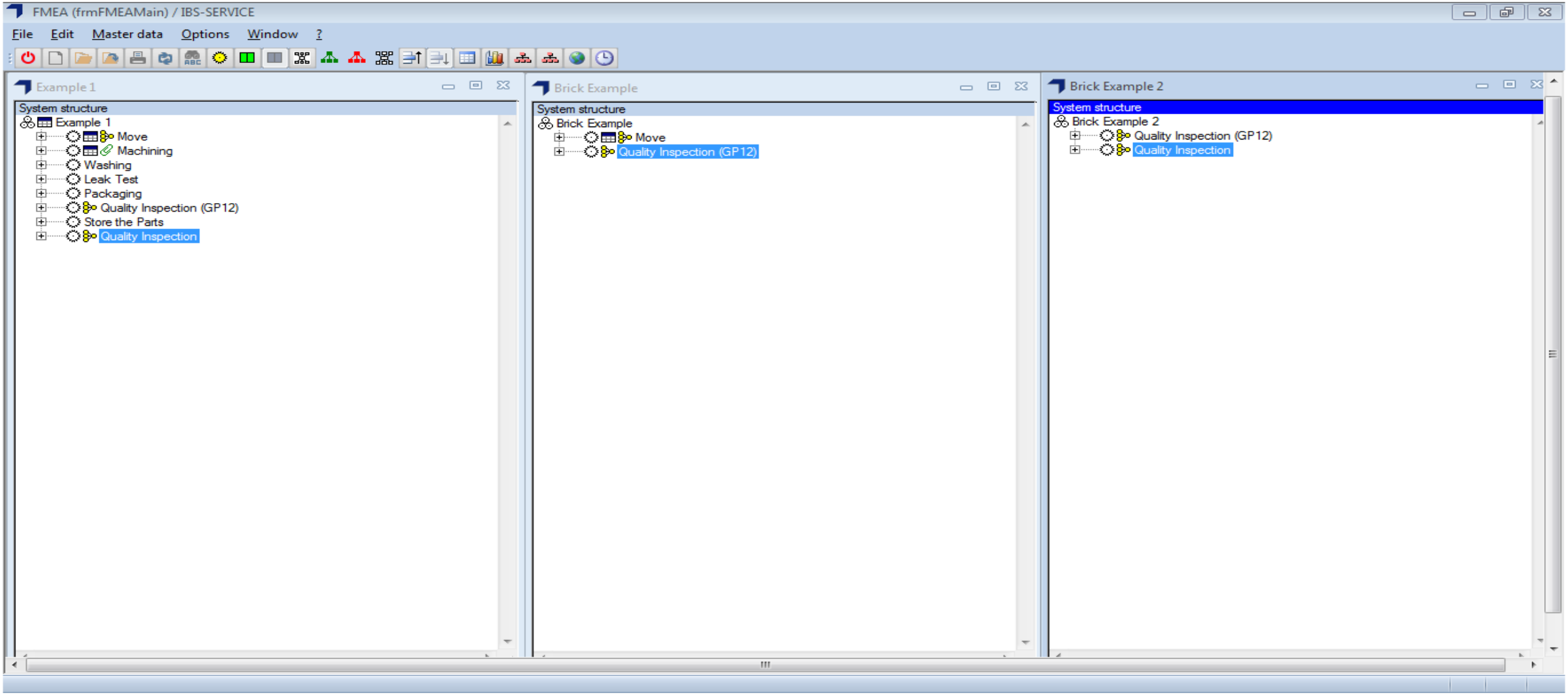
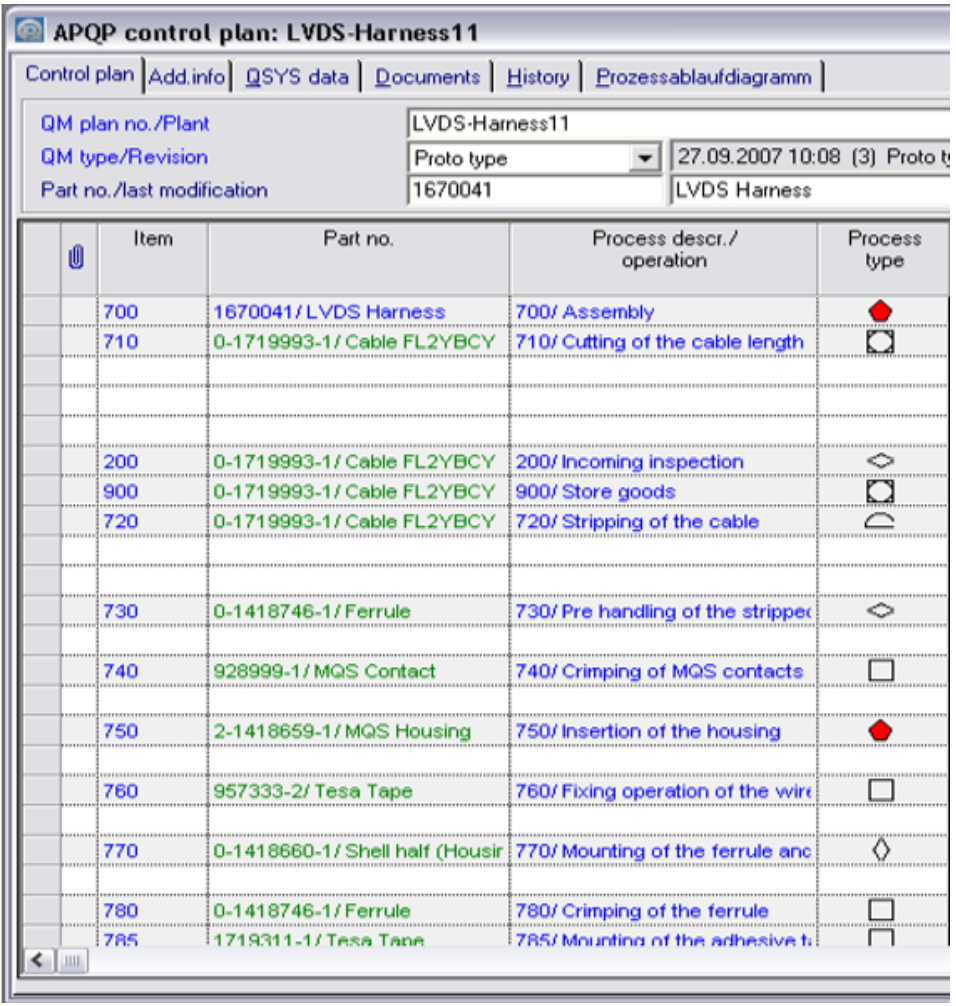


Why Family FMEAs?

Common Processes that Scale across products such as plating, paint and coatings are good candidates for family FMEAs.

- They can be readily referenced across products and when changed cascade through all the impacted products resulting in:
  - Less errors because a product where the process was changed was missed.
  - Easy queries on these processes can provide useful information when making an environmental or safety assessment of where certain processes and chemicals are used.
  - This is increasingly important with the advent of REACH and RoHS in the EU and other parts of the world.

Inheriting Data

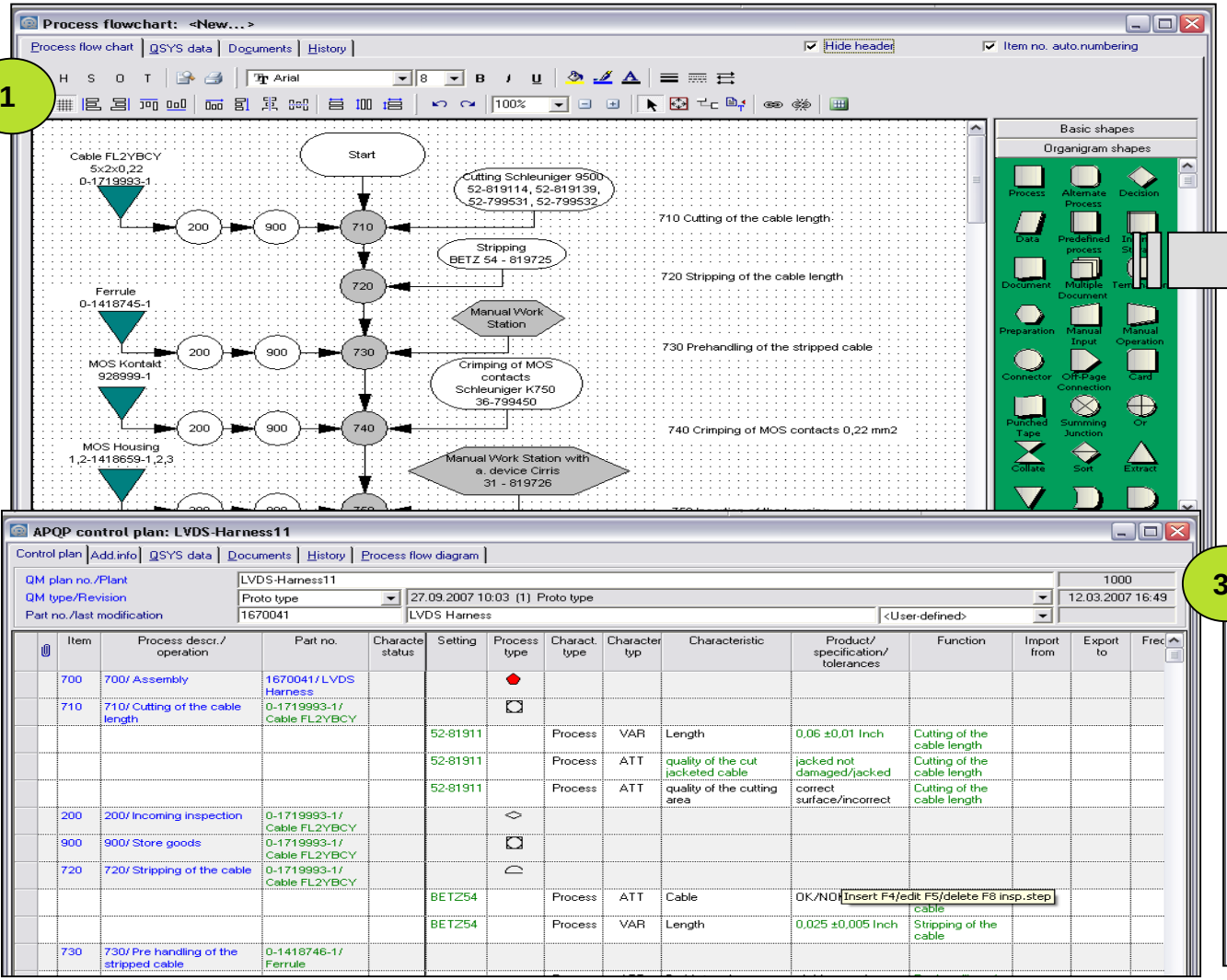


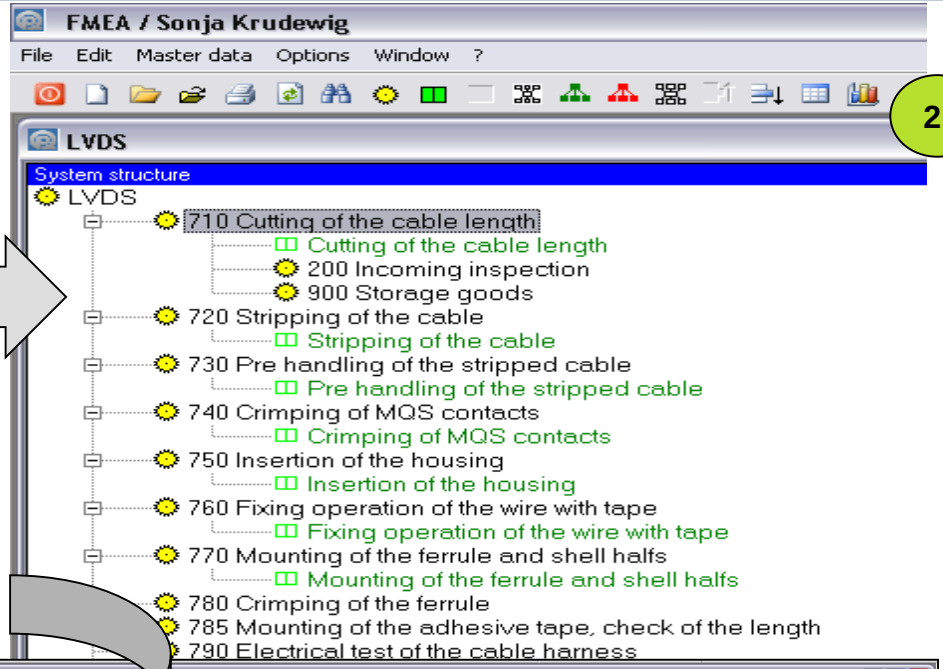
Tree structure approaches to managing FMEAs and Control Plans can leverage the ability to inherit required data from a process FMEA into a Control Plan.

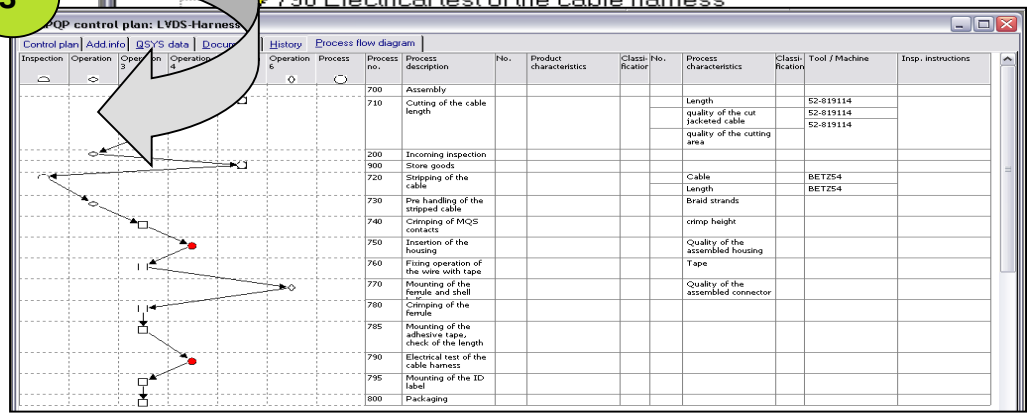
This eliminates redundant data entry and reduces opportunities for errors during the transfer of content.

Data flow from a Design or Process FMEA into a Control Plan can also continue the process further by bringing the data into Inspection Plans.

Process Flowchart to FMEA to Control Plan Relationship







Control Plans to Inspection Plan

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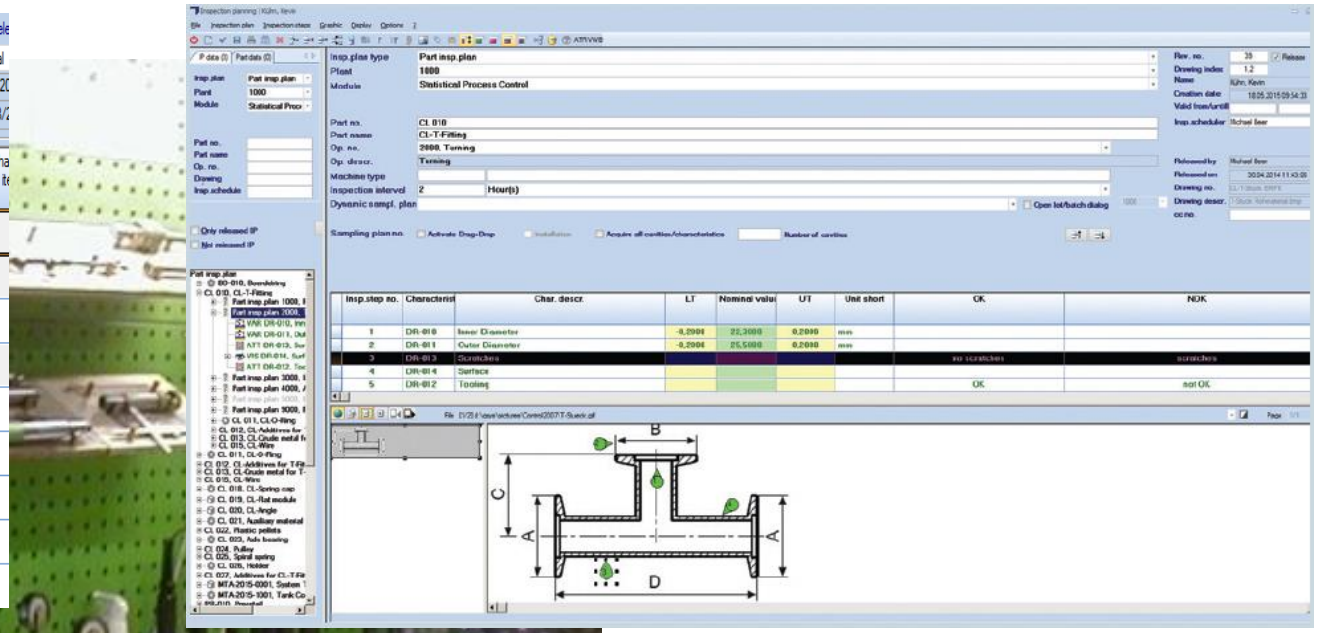
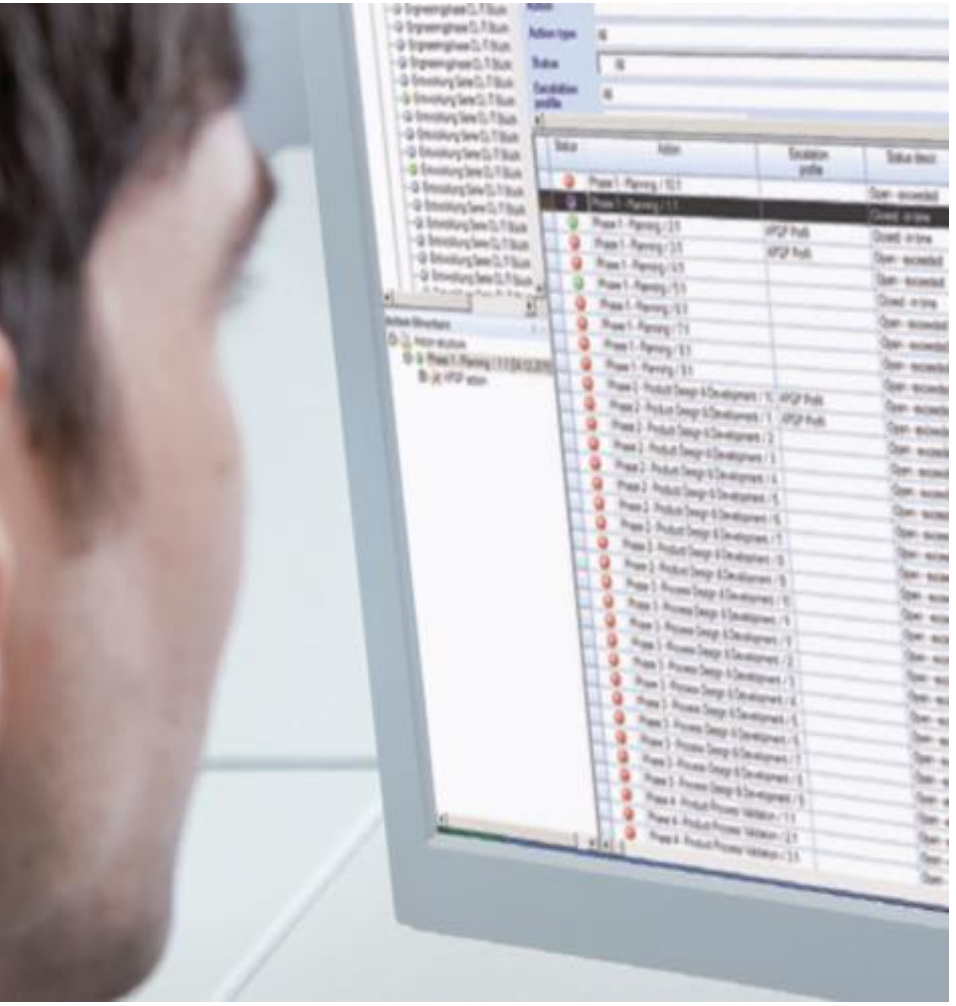
Control plan group | Hidden | Released
Control plan no. | 207 | 38225039 | General
CP type/Revision/Gen. date | Production | 7/20/2017 14:12 Production << | 7/6/20
Part no./Descr./Draw. date | 38225039 | Cover Assist | 8/3/2

Item	Part no.	Process Name/ Operation/ Description	Function	Process type	Linked to	Characteristic no.	Characteristic	Product/Proce Specification/ Tolerance	Importance	Characteristic status	No.	Cha
BOCAR	38225039/ Cover Assist	BOCAR/ 38225039										
70.01		70.01/ Move										
			Bring correct part			-	-					
70		70/ Machining										
			Place cast in fixture			-	-					
			Cast placed correctly			-	-					
			Alignment busing hole diameter			-	-					
			Locator bushing bore			-	-					
			Alignment bushing lead in chamfer height		PFC, CP, FMEA	Chamfer Height	Chamfer Height	0.5 ±0.25 mm	Critical			



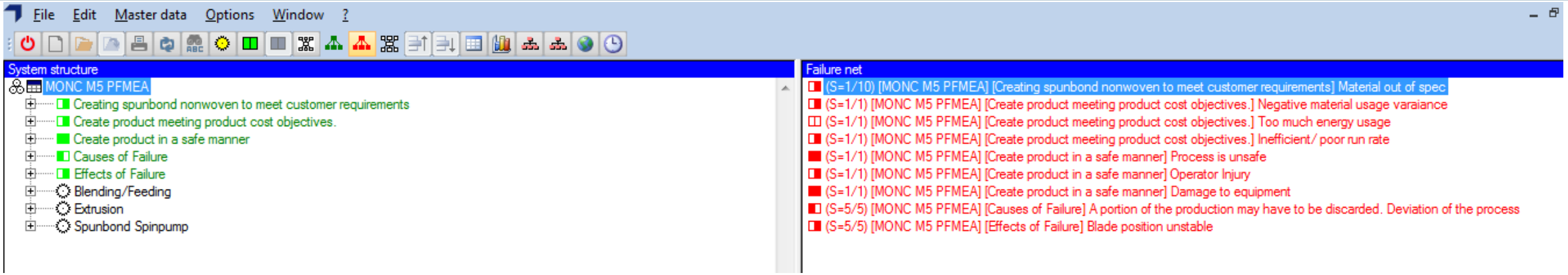
Closing the Loop and Change Management



Closed Loop Quality logic expects failures identified during inspection to be communicated back to Engineering closing the loop as lessons learned.

Providing Engineers a fast, reliable means of querying and seeing how failures and defects relate to specific products, and processes permit agile adjustments based on accurate representations of current state of experienced risk

Examples of Failure Feedback from Inspection to FMEAs

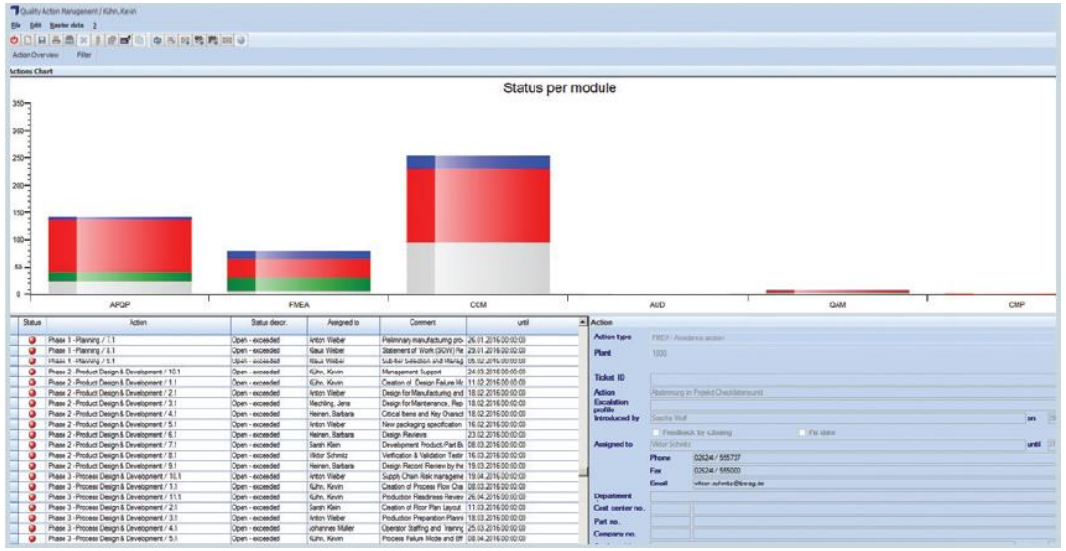


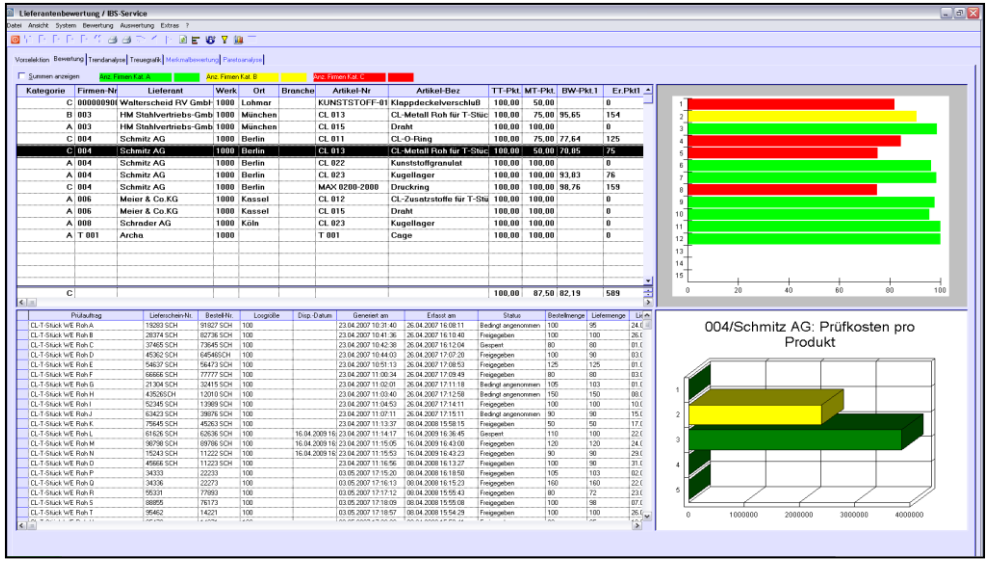
Change Management: Faster, Better Communication, and Understanding

When a Design or Process FMEA is changed:

- The entire team is made aware
- The changed FMEA becomes a new revision and the previous one is archived but available for future analysis.
- Data, when properly authorized, can flow into the Control Plan and then into the Inspection Plans.
- These changes are real time and that is crucial in distributed global manufacturing landscapes in place today.

Examples of Communication and Controls





Reporting and Analytics

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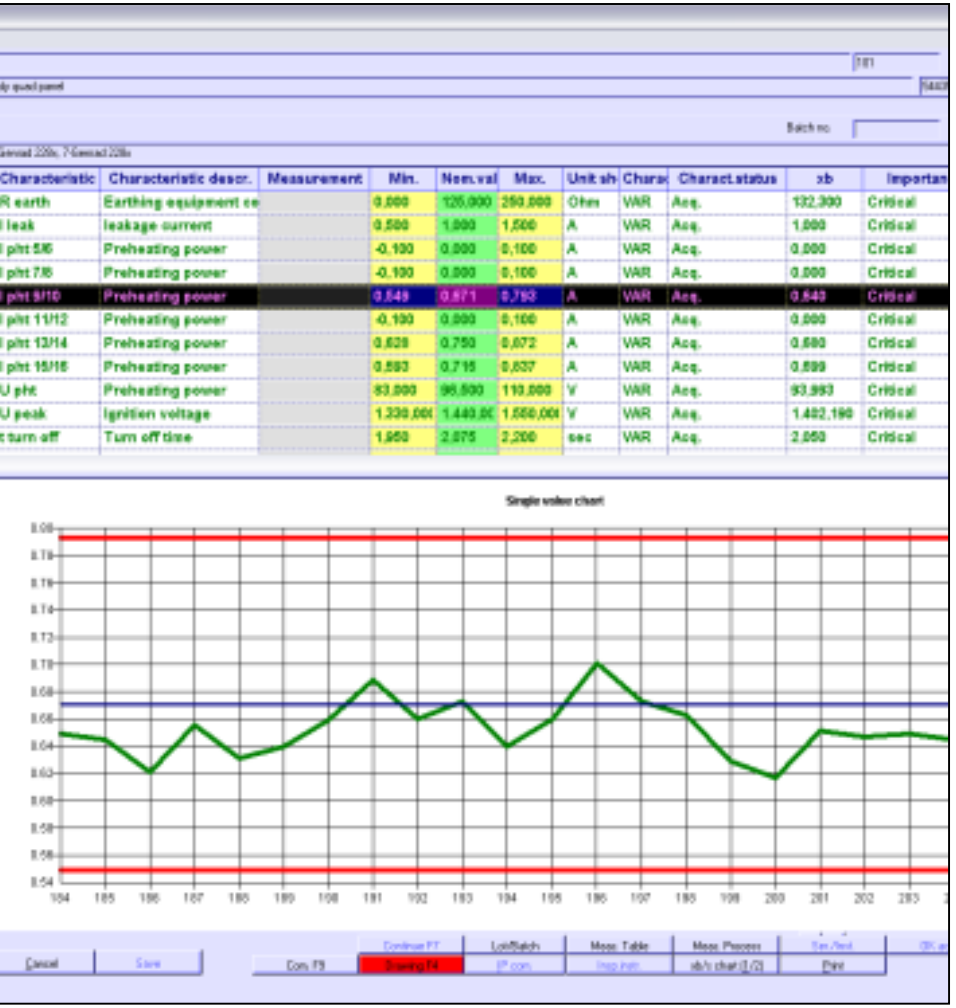


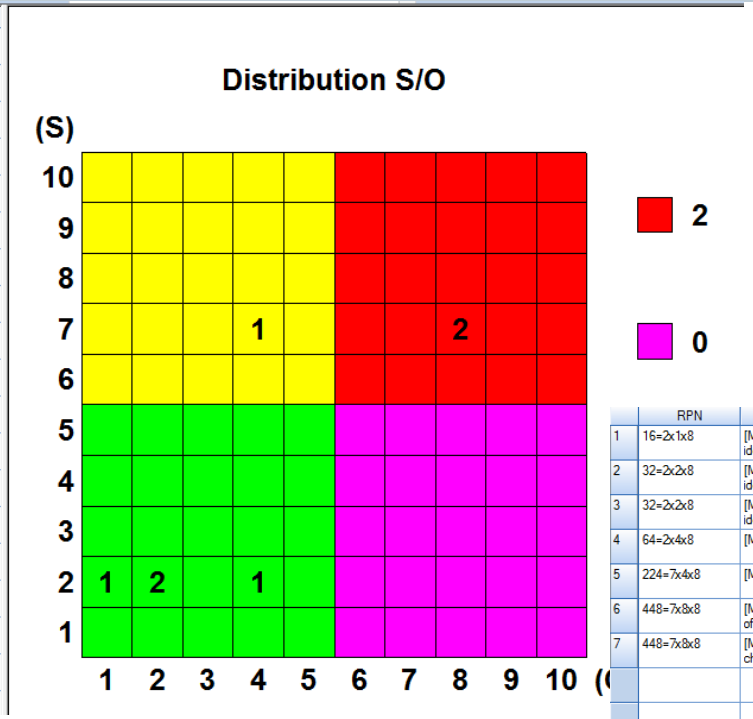
Data is only numbers until it becomes useful information.

Seeing real time tracking of data and information in trending and reports can drive change and confirm validity of risk assumptions and effectiveness of controls.

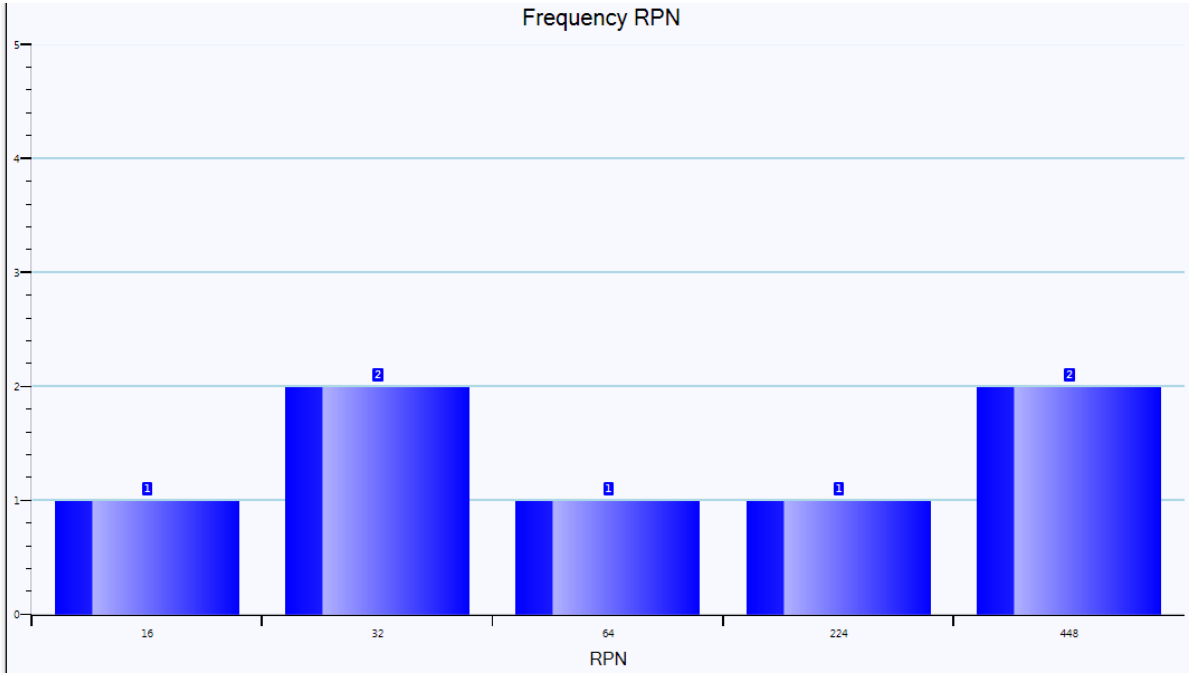
Sharing Outputs in formats required by customers seamlessly saves time and creates trust and confidence.

Examples of Outputs

	S/O	Cause of failure
1	7/8	[Machining] Fixture allows loading of the part incorrectly
2	7/8	[Machining] Fixture cleanliness, chips in fixture
3	7/4	[Machining] Process step skipped
4	2/4	[Machining] Process step skipped
5	2/2	[Move] Incorrect material identification
6	2/2	[Move] Material mixed or wrongly identified
7	2/1	[Move] Incorrect material identification



	RPN	Cause of failure
1	16=2x1x8	[Move] Incorrect material identification
2	32=2x2x8	[Move] Incorrect material identification
3	32=2x2x8	[Move] Material mixed or wrongly identified
4	64=2x4x8	[Machining] Process step skipped
5	224=7x4x8	[Machining] Process step skipped
6	448=7x8x8	[Machining] Fixture allows loading of the part incorrectly
7	448=7x8x8	[Machining] Fixture cleanliness, chips in fixture



Siemens and End to End Quality

Siemens has invested energy, capital and resources in developing the most comprehensive Design and Quality solutions that scale across both industry sectors and enterprises of all configurations and sizes.

- Product and Application Lifecycle Management for electro-mechanical and embedded technology designs.
- Design and Process FMEAs and Advanced Product Quality Planning (APQP)
- Inspection , SPC and Supply Chain Management including Production Part Approval (PPAP)
- CAD Design Management

All these systems working together, leveraging the same data sources result in a “single source of truth” with the analytics and reporting to confirm, improve and evolve your business.

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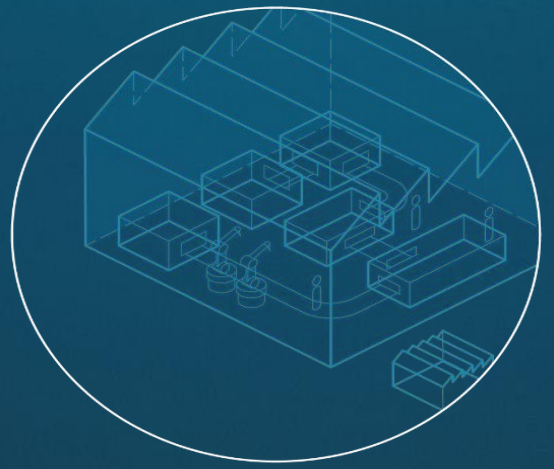
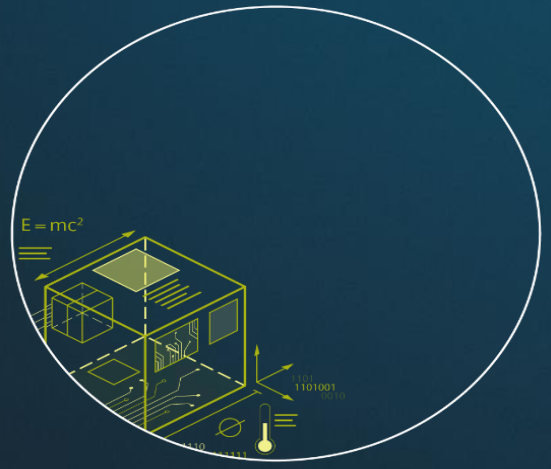
Quality Domains connected seamlessly across the Enterprise



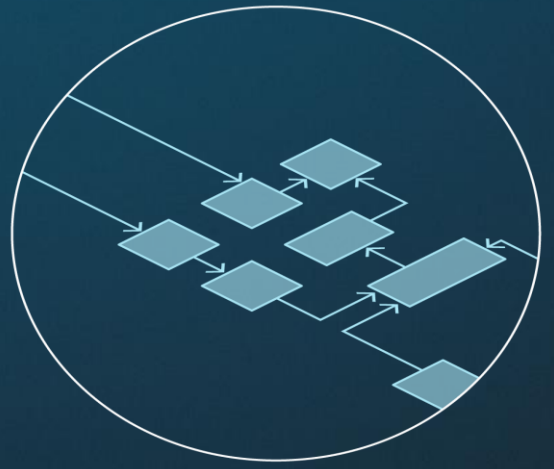
Manufacturing

Quality



Design

Quality



Process

Quality

Siemens Quality Management Drives

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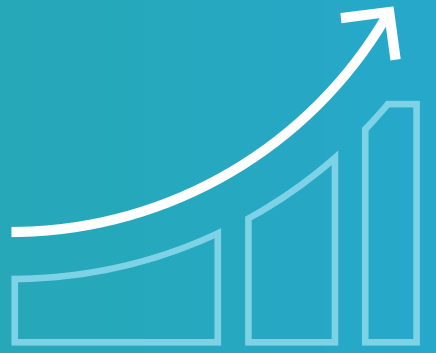
Speed

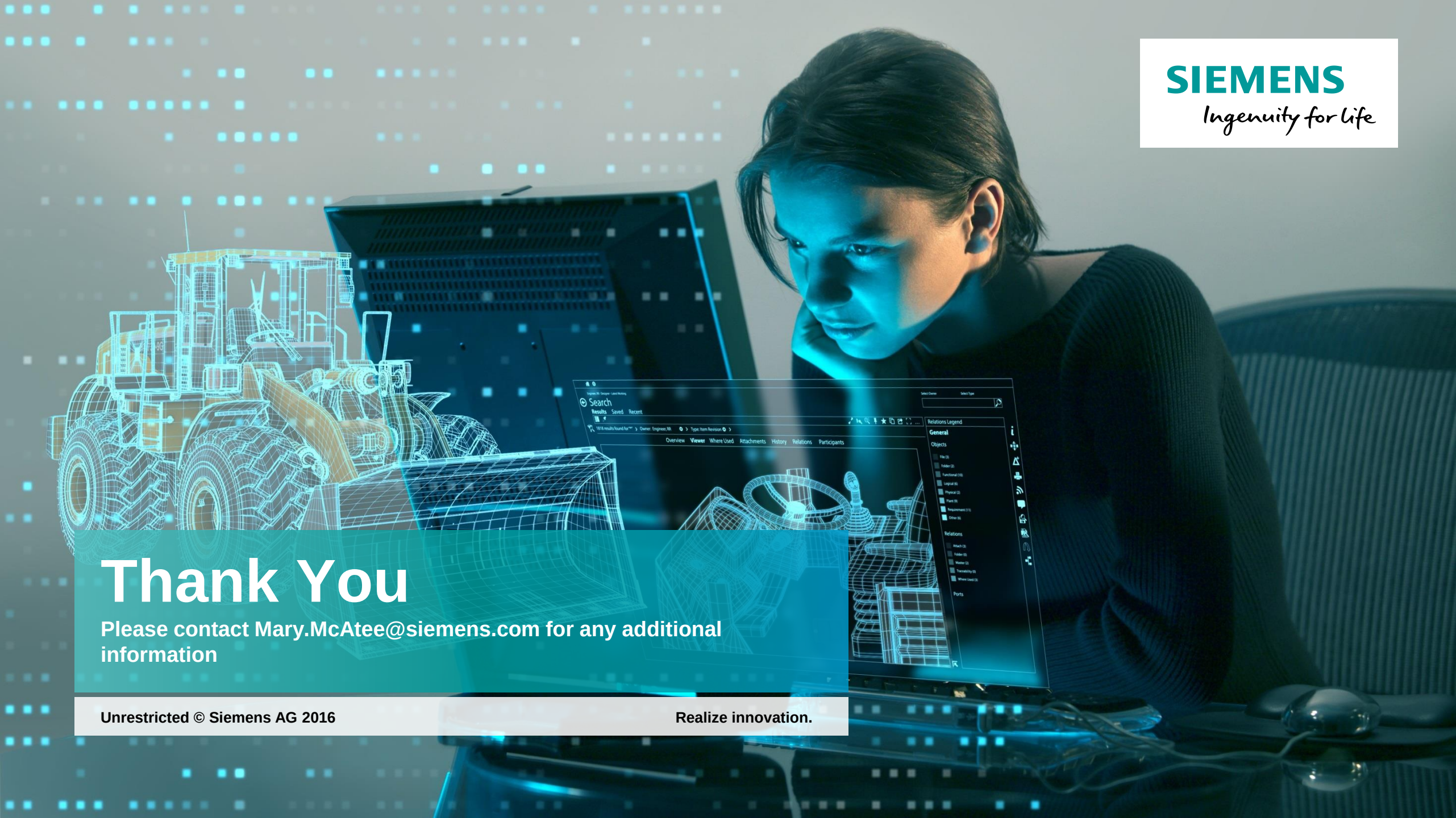
Flexibility

Quality

Efficiency



Security



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Thank You

Please contact Mary.McAtee@siemens.com for any additional information