CENTRAL OREGON
community college

ENGR 102
INTRO TO ENGINEERING II

Week 3

Discussion- Why do engineers need Guard Rails?

- Over time Engineers have adopted methods of analysis for complex systems
- These methods attempt to manage the risk of making bad designs.
- These “Guard Rails” can be thought of as “Best Practices” for how to design complex things.

Guard Rails

- Going into great detail on all the various codes and standards out there is beyond the scope of this course.
- I am going to mention a few of the bigger ones to paint a landscape of controls that affect what engineers do on a daily basis.
- Top Tier – Legal codes
  - Federal codes for products (FMVSS for automobiles, FAA Part 25 for airliners, Mil-Stds for military equipment) as examples
  - State by State Professional licensure rules. building codes, Boiler codes.

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  - State by State Professional licensure rules. building codes, boiler safety codes. https://reason.com/2019/01/02/judge-confirms-that-oregon-engineer-has/
- Second tier – Industry regulations
  - ISO 9002, AS9100, QS9000, Business and Quality standards
  - ASME, ASQ, SME, ASME industry standards,

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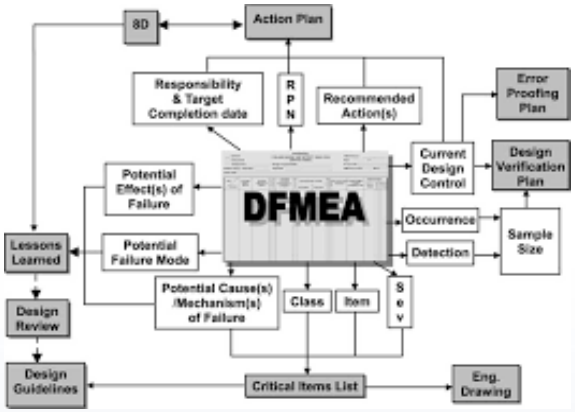
- Third tier – Internal Company standards

Design Engineering Best Practices

- In recent years, many best practices have been incorporated in company engineering standards. In fact many companies will stipulate in purchasing agreements that certain best practices be used by sub-contractors.
- Examples are many including as just a small subset:
  - Design for Manufacturability (DfM)
  - Design for Assembly (DfA)
  - Design for Maintainability (DfM)
  - Design for Disposal (DfD)
- One important technique used extensively in automotive and aerospace is **Design Failure Modes and Effects Analysis**

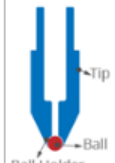
DFMEA / FMEA

- Design Failure Modes and Effects Analysis (DFMEA)
  - A systematic format to evaluate every design decision as to the risk of a mistake being made in the design process and what the potential consequences of that mistake are
    - Typically done on a large spreadsheet
  - Performed by the engineers during the design process
    - Assumes an almost perfect world where any design is turned into a product manufactured perfectly; the only errors occur when the designer makes a mistake
- Failure Modes and Effects Analysis
  - Same method except assumes a perfect design and all errors occur in the manufacturing process selection and control



DFMEA / FMEA

- Design Failure Modes and Effects Analysis (DFMEA)

Product Number: PT34325-4053			Market: Japan				Team: Alex Drinal, Peter Loombard, Katie Samdras, Lin Woodlord											
Product Name/Description: Ball Point Pen							Design Engineer Leader: Lin Woodlord				Document Number: DF325-12			Orginal Date: Feb 10, 2019				
Model: HandFree-P6			Year: 2019				Approved by: Mike Handson				Revision No.: 002			Revision Date: May 14, 2019				
														Action Results				
Item / Function	Requirements	Potential Failure Mode	Potential Effect(s) of Failure	Severity	Classification	Potential Causes(s) of Failure	Current Design Controls Prevention	Occurrence	Current Design Controls Detection	Detection	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Actions Taken & Effective Date	Severity	Occurrence	Detection	RPN
Pen tip / disperses ink onto paper smoothly 	Delivery proper ink amount onto paper	Not enough ink	Pen skip or Required heavy pressure while writing	7	A	Ball diameter is too big	Study tolerance of ball diameter and line weight and color	6	Writing test to detect if problem occurs	3	126							
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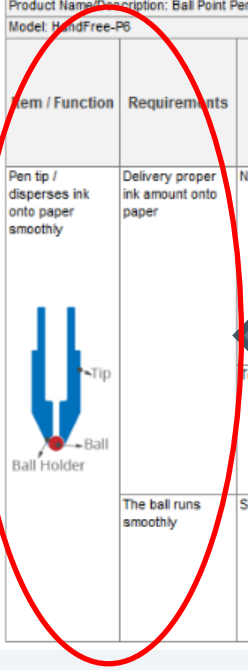

In a Design FMEA we assume a perfect factory and that all potential failure modes are a result of poor choices by the designer.

Every Design Element is described, and each design requirement for that element is documented.

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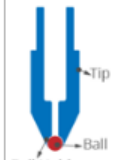
Pen tip / disperses ink onto paper smoothly 	Delivery proper ink amount onto paper	Not enough ink	Pen skip or Required heavy pressure while writing			eter is too	Study tolerance of ball diameter and line	6	Writing test to detect if problem occurs	3	126							
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For each Design Element, The designer must ask, ”What could go wrong with this element if I design it incorrectly?”

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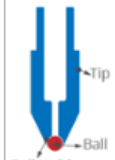

For each possible failure mode, The designer must ask, ”What happens if the failure occurs?”

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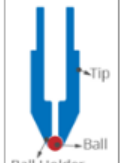

Each Potential Effect is rated as to how it may impact the customer (Lower numbers typically mean mild or annoying; higher numbers can mean dangerous or even deadly).

Additional classifications of severity can be used

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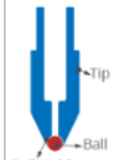
Pen tip / disperses ink onto paper smoothly 	Delivery proper ink amount onto paper	Not enough ink	Pen skip or Required heavy pressure while writing	7	A	Ball diameter is too big	Study tolerance of ball diameter and line weight and color		st to detect occurs	3	126							
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Each failure mode is reviewed by the designer as to what errors in material choice, dimension, or tolerance could cause the failure.

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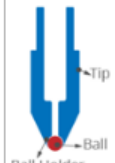

Each failure mode is also reviewed by the designer to say what design techniques are used by to make their design choices.

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Based on previous experience, each failure mode is ranked by how often the designer makes the wrong design choice using the current technique.

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For each Failure Mode, what tests are currently used to validate the designer's choices.

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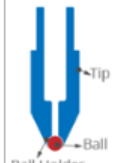

For each Failure Mode, how effective are current tests are at finding problems with the designer's choices.

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Ball
Ball Holder

For each Failure Mode, the designer multiplies the Severity of the failure, the frequency of Occurrence for the failure, and how good the failure Detection test is to create an RPN ranking

RISK PRIORITY NUMBER (RPN)
This is what we use to make decisions !

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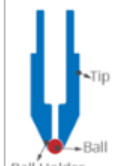
Pen tip / disperses ink onto paper smoothly	Delivery proper ink amount onto paper	Not enough ink	Pen skip or Required heavy pressure while writing			Ball diameter is too big	Study tolerance of ball diameter and line weight and color		g test to detect m occurs	3	126							
										10	280	Writing Test with varying pen angles of the pen	Katie Nov, 24		7	3	2	42
											56							
											63							
						the pen too much	range			3	63							
	The ball runs smoothly	Smoothly	Inconsistent line Skip or Glob left behind	8		Inproper selection of dimenson of the ball and ball socket	Study the tolerance of ball and ball socket and select the correct range		g test with imuum presure on the paper	2	64							
						Improper selection of the ball roughness tolerance	Select surface roughness base on the standard	2	Check the prototype capability of ball surface	3	48							

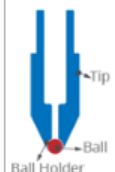


The remainder of the columns document recommended changes to reduce the RPM, who is responsible for implementing the changes and what the revised RPN and its factors are after the change is implemented.

DFMEA / FMEA

- Failure Modes and Effects Analysis (FMEA, sometimes called Process FMEA)

Product Number: PT34[illegible]953			Market: Japan				Team: Alex Drinal, Peter Loombard, Katie Samdras, Lin Woodlord											
Product Name/Description: [illegible]nt Pen							Design Engineer Leader: Lin Woodlord				Document Number: DF325-12			Orginal Date: Feb 10, 2019				
Model: HandFree-P6			Year: 2019				Approved by: Mike Handson				Revision No.: 002			Revision Date: May 14, 2019				
														Action Results				
Item / Function	Requirements		Potential Effect(s) of Failure	Severity	Classification	Potential Causes(s) of Failure	Current Design Controls Prevention	Occurrence	Current Design Controls Detection	Detection	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Actions Taken & Effective Date	Severity	Occurrence	Detection	RPN
Pen tip / disperses ink onto paper smoothly	Delivery proper ink amount onto paper	Not enoug				Ball diameter is too big	Study tolerance of ball diameter and line [illegible] color	6	Writing test to detect if problem occurs	3	126							
										10	280	Writing Test with varying pen angles of the pen	Katie Nov, 24		7	3	2	42
						[illegible]					63							
						[illegible]		3	Writing test with high presure	3	63							
	The ball runs smoothly	Smoothly	Inconsistent line Skip or Glob left behind	8		Inproper selection of dimenson of the ball and ball socket	Study the tolerance of ball and ball socket and select the correct range	4	Writing test with miniumum presure on the paper	2	64							
						Improper selection of the ball roughness tolerance	Select surface roughness base on the standard	2	Check the prototype capability of ball surface	3	48							



DFMEA / FMEA

Everything Marks This Same way except as DFMEA now we assume a perfect design and all potential failure modes are a result of poor choices in the factory processes and its engineers

DFMEA Experience

- Now it's your turn. We will break up into 3 teams of 5. Each of your teams will be responsible to create a Design FMEA for a product that your will be given.

- **Assume a world that makes stuff is perfect and never makes mistakes. It always makes things the way you design them.**
- **Assume the only people who can screw up the design are the design engineers**
- **Dissect all the functions of the product you will be given and break it down into components and what they do.**
- **Review all the features and dimensions of each component and determine all the dimensions and specifications that you as a design engineering team have responsibility for and then assess the risks you may create by screwing up.**