How to Prepare for a Design Review

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MSD I
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Design Reviews

- Objectives
- Participants
- Logistics
  - Materials for review
  - Optimized review structure (time)
  - Running the review
  - Actions / Issues / Decisions
  - Documentation
- Examples & Templates
- Style

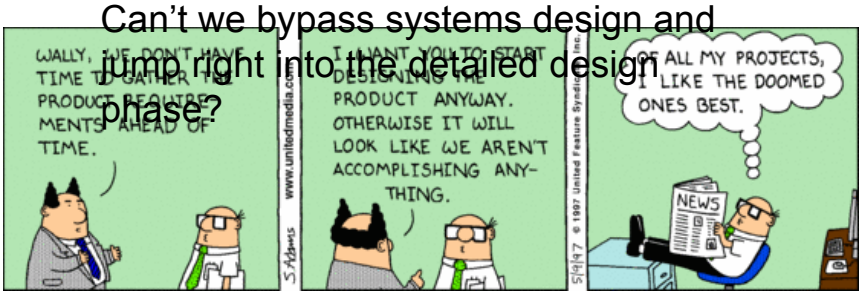
Design Review Objectives

- Design reviews take significant time… why do them?
- Key Objectives:
  - Confirm Functionality, Robustness, Engineering Specifications and Customer Needs
  - Cross-disciplinary review
  - Document & communicate design approach
  - Catch mistakes early at the design stage
  - Organizational & Team learning
  - A better product done more quickly

Ready, Fire, Aim

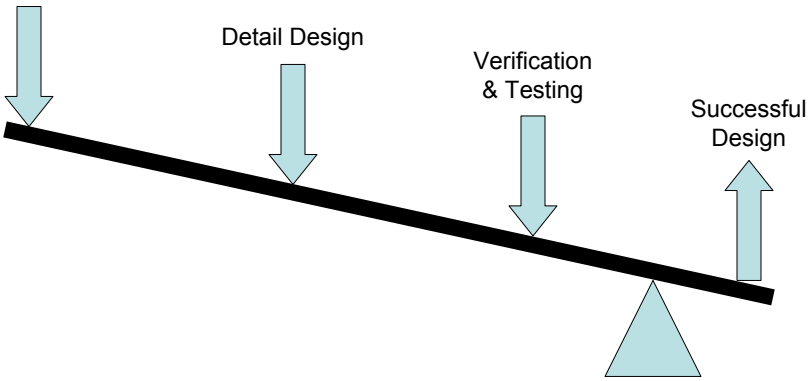
The week 5 design review is a tollgate to starting the detailed design

We already know what we need to do. Can't we bypass systems design and jump right into the detailed design phase?



The Leverage of Good System Level Design

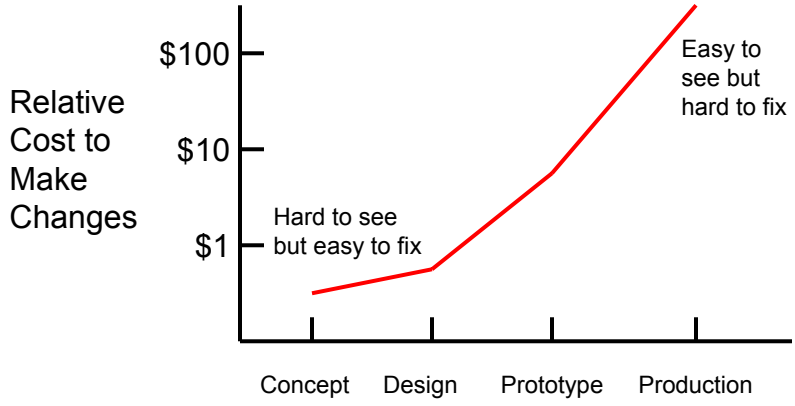
Product Definition
- Customer needs understood
- Risks understood
- Engineering specs defined
- Alternative concepts explored
- Concept selected



When is it easiest to spot design mistakes?

When is it easiest to fix design mistakes?

The Cost to Correct Mistakes

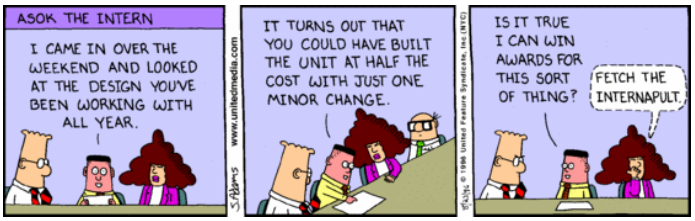


Participants for a Successful Review

- Who should be included in design reviews?
- It will depend on the stage of development Disciplines to consider:
  - Electrical, Mechanical, Software, Computer
  - Manufacturing
  - Marketing (represents Customer)
  - Regulatory / Quality/ Safety
  - Focus on key risks or unfamiliarity
- *Don't hold the review without the right participants* Team *owns* this!

Invite Alternate Points of View

It could be your most senior SME



Or…..

the co-op that makes a key difference

Logistics – Running a Successful Review

- What Materials should you distribute *before* the review?
  - Agenda with times
  - Relevant Specifications
  - Detailed design drawings, schematics, simulations, flow charts, test plans, etc.
  - Known issues, discrepancies with specifications, conflicts with other disciplines
- Why?

Logistics – Running a Successful Review

- Selecting a meeting time (1.5 hrs minimum)
  may be in multiple parts held on different dates
- Start on time and stay on schedule
- Not a formal Presentation → Invite discussion
- Focus on improving the design
  avoid defensiveness & personal attacks
- Allocate time to the most critical areas
  avoid wasting time on boilerplate
- If you run out of time… schedule a follow-up!

Logistics – Running a Successful Review

- Document Actions / Issues / Decisions
  - Team member assigned to take notes
  - Action items for changes, items to check, functionality changes, etc.
  - Decisions about design approach, specification changes, trade-offs, etc.
  - Agree on readiness to move to next phase *before leaving meeting*
  - Update Edge with copies of materials

Typical Design Review Agenda (Week 5)

- Your expectations for the design review
- Project background or introduction
- Problem to solve or key project objective(s)
- Team member roles and responsibilities
  - Critical customer needs and associated engineering specs
  - Concept selection process
- Systems architecture to realize selected concept
  - Functional architecture with key subsystems
  - Physical architecture showing functional elements
    - Validation of engineering specs
- Feasibility analysis / engineering or technology analysis
- Issues, challenges, risks with mitigation plans.
- Next steps and updated schedule for rest of quarter

See https://mycourses.rit.edu/d2l/lms/content/preview.d2l?tId=1288642&ou=245652

Examples

Project Background

Xerographic digital printers are very energy intensive, specifically the **fusing sub-system**. This is largely due to the fact that during the fusing process toner is heated to well above its melting point, to enable heat flow, and allow the toner to adhere to the paper.

- **Senior Design Project as Stated on Edge:**

"Re-consider the design of an extremely low power, non-thermal fusing system"

https://edge.rit.edu/content/P09505/public/Home

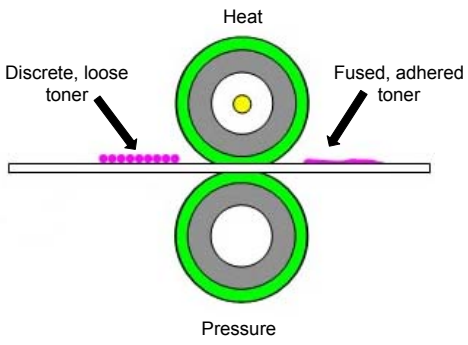
Example from Low Energy Printing Project P09505

Project Scope

The purpose of this project is develop a fusing sub-system that uses **pressure** instead of thermal energy to fuse toner to paper. The new design should fit into the current Xerox Workcentre 245/55 Pro printer, however if due to design constraints the new design in unable to be fit internally it my be externally attached to the Xerox Workcentre 245/55 Pro printer.

Example from Low Energy Printing Project P09505

How a Fusing Sub-System Works



Traditional Toner Fusion:

Temperature
+
Pressure
+
Heat
=
Fused, Adhered Toner

Image by: David Thompson, Xerox Corp.
Information by: David Thompson, Xerox Corp. and Dinesh Tyagi, Eastman Kodak Company

Example from Low Energy Printing Project P09505

Customer Requirements

Number:	Need Type:	Need:	Customer Weight
1	Print Quality	Paper is not damage	9
2		Image be Xerox quality	3
3		Print has a low gloss	1
4	Compatibality	Fit into current Xerox Workcentre 245/55 Pro	3
5		Use pressure only to fuse toner to paper	9
6		Accept paper in orientation it currently enters fuser (SHF / LHF)	3
7		Compatible with other Xerox models (prefered color printer of same size)	1
8	Cost	Sub-system cost less then current system	3
9		Easy of manufacturing	3
10	Misc.	User must be able to safely clear jam in fuser	9
11		Low Energy - non-thermal	9
12		Technology can be used up and down along Xerox stream	1
13		Fuser last life of product (roughly 3 million prints) at least 100,000 prints	1
14		Standard office grade paper (20/24 pound paper)	9

3 Most Important Customer Requirements:

- Paper is not damaged
- Fit into current Xerox Workcentre 245/55 Pro
- Use pressure only to fuse toner to paper

Example from Low Energy Printing Project P09505

Engineering Metrics

Engineering Metrics	Technical Targets Measurements	Techanical Targets
Paper Curl	Deflection of Paper	< 0.5"
Paper Damage		
Change in Paper Thickness	% Change	< 50%
Cost	Dollars	< $50.00
Adhesion of Toner to Paper	Change in Optical Density	
Cohesion of Toner to Paper	Change in Optical Density	
Speed of Process	Pages per Minute	35 pages/minute
Amount of Smearing	Change in Optical Density	
Heat Produced by Process	Celsius	< 50C
Uniform Half Tone	Change in Optical Density	
Reflectivity	Std. Gloss Meter	
Length of System	Inches	12"
Width of System	Inches	5"
Height of System	Inches	5"
Weight of System	Kilograms	
Utility of Cost Incurred by Customer	Watts/hr	
Size of Paper Accepted by System	Inches	11" x 11"
Number of Parts	N/A	≤ current
Ability to Release Pressure	Newtons	
Accident Incidences	Reported Injuries	< 100/year
# of Prints Before Failure	N/A	100,000 prints
Durability of Fix	Weeks	At least 1 week
Compatibility w/Xerox Manu. Proc.		

Example from Low Energy Printing Project P09505

QFD - Correlation Matrix

	Customer Requirements	Customer Weights	Engineering Metrics: Paper Curl	Paper Damage	Change in Paper Thickness	Cost	Adhesion of Toner to Paper	Cohesion of Toner to Toner	Speed of Process	Amount of Smearing	Heat Produced by Process	Uniform Half Tone	Reflectivity	Length of System	Width of System	Height of System	Weight of System	Utility Cost Incurred by Customer	Size of Paper Accepted by System	Number of Parts	Ability to Release Pressure	Accident Incidences	# of Prints Before Failure	Durability of Fix	Compatibility w/Xerox Manu. Proc.
1	Paper is not damage	9	9	9	9		3	3	9		3		3				1		9		9		9		
2	High quality image (Xerox quality)	3	3	3			9	9	9	9	9	9	9						9		1		9	9	
3	Image has a low gloss	1	1	1	9		9	9	9	3	9	3	9										3	3	
4	Fit into current Xerox Workcentre 245/55 Pro	3							3					9	9	9	3		1	3					1
5	Use pressure only to fuse toner to paper	9	3	3	9		9	9	3	9	3	9	3				1	3			3		1	9	
6	Accept paper in orientation it currently enters fuser (SHF / LHF)	3	1	1	1				9	1				9	1	1			9						
7	Compatible with other Xerox models (preferred color printer of same size)	1							1		1			9	9	9	3		1						1
8	Sub-system cost less then current system	3				9			1									1		9					
9	Easy of manufacturing	3				9			1											9					
10	User must be able to safely clear jam in fuser	9	3	3	1						3					3	1				9	9			
11	Low Energy - non-thermal	9							9		9	3						9					1	9	
12	Technology can be used up and down along Xerox stream	1				1			1		1			3	3	3	1		1	1					9
13	Fuser last life of product (roughly 3 million prints) at least 100,000 prints	1							3								1						9		
14	Standard office grade paper (20/24 pound paper)	9	9	9	9		1		9	9		1	9	9	1	1			9					3	
		Raw score	229	229	273	55	153	144	353	195	200	147	171	147	51	78	41	111	221	64	192	81	138	219	13

House of Quality (QFD) - Excel Document

Example from Low Energy Printing Project P09505

Concept Selection – Round 1

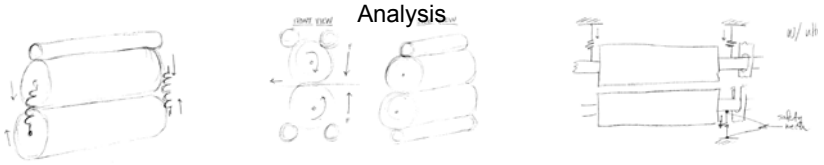
Key Criteria for Comparison
Compact Size
Uniformity of Pressure
Availability of Tech/Info
Minimal Height
High Speed Process
Simplicity of Design
Minimal Force required to generate Required Pressure
Reliability in producing good prints
Potential to Damage Paper
Low Power Consumption
Potential to Smear
Adjustability to Paper Size

Design Concept Rating Scale:
(++) = Concept is Much Better Than Datum Concept
(+) = Concept is Better Than Datum Concept
(s) = Concept is the Same as Datum Concept
(--) = Concept is Much Worse Than Datum Concept
(-) = Concept is Worse Than Datum Concept

Example from Low Energy Printing Project P09505

Concept Selection – Round 1

Top 3 Design Concepts Based on PUGH Analysis



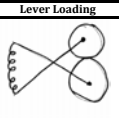
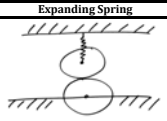
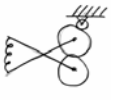
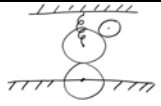
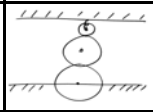
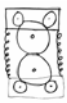
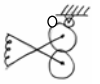
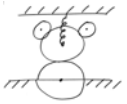
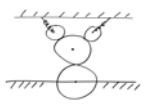
Bottom 3 Design Concepts Based on PUGH Analysis

Concept Selection PUGH

Example from Low Energy Printing Project P09505

Concept Selection – Round 2

Loading Design Generation

Number of Rollers	Method of Loading: Side Loading w/Springs	Lever Loading	Expanding Spring	Indirect Spring Loading
2 Rollers				N/A
3 Rollers				
4/6 Rollers				

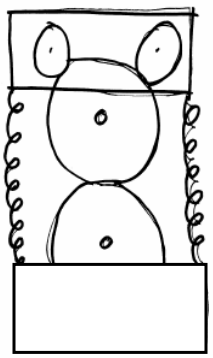
Key Criteria for Comparison:

- Potential for Compact Size
- Uniformity of Pressure
- Simplicity of Design
- Low Individual Spring Force
- Stability of Loading
- Minimize Damage Print-Making Rollers
- Minimal Friction Created

Example from Low Energy Printing Project P09505

Concept Selection – Round 2

Designs which received a positive score were chosen, all others were thrown out.

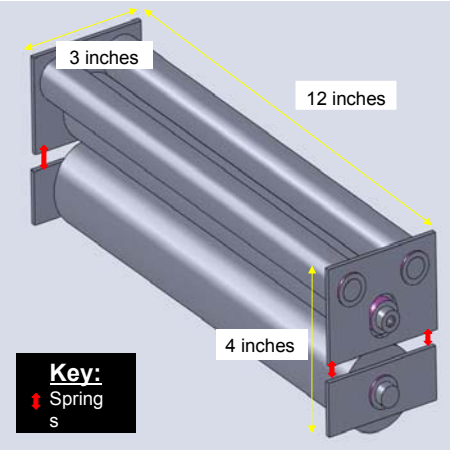


- **Round 2 PUGH Analysis Findings:**
  - Only one design received a positive score.
  - A four roller system was the only design to receive a positive score.

Example from Low Energy Printing Project P09505

Concept Selection

- 4 Roller System
- Spring Loaded
- Base Roller is Fixed to Frame



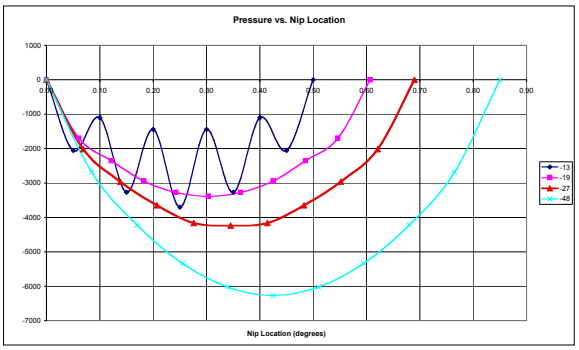
Example from Low Energy Printing Project P09505

Roller Analysis

- Assumptions:
  - 2-D Model
  - Uniform Loading
- Materials Used:
  - Steel
  - 24 lb paper

	Roller	Paper
Material	Steel	24 lb paper
E (Mpsi)	29	0.5
Radius (in)	0.75	--
Thickness (in)	--	0.0025

Results



Example from Low Energy Printing Project P09505

Power Calculations

- Assumptions:
  - Each page requires 1.5 page lengths to include a gap between the pages, in order to print one page, 16.5" of roller will have to pass through the nip.
  - Roller diameter of 2", passing 1.5 page lengths through the printer requires 2.54 revs of the roller.

To achieve 35 pages per minute, a rotational velocity of 88.9 rpm would be required.

$$35[ppm] \times 2.54\left[\frac{rev}{printed\ page}\right] = 88.9[rpm]$$

Using an estimation of 17 Newton-meters for the torque required to turn a steel roller system, a very rough calculation for power can be obtained.

$$Power\ [watts] = Torque\ [N \cdot m] \times \omega\ \left[\frac{rad}{s}\right]$$

$$P = 17 \times 88.9$$

$$P = 158\ [Watts]$$

Example from Low Energy Printing Project P09505

Risk Assessment

- How are we going to load the springs?
  - Use screws to tighten springs
- Will rollers fit in Workcentre Pro?
- How are we going to drive the rollers?
  - Will not be able to use drive train from printer.
  - Do we have room to fit another motor in the printer?

Example from Low Energy Printing Project P09505

Templates

- Agenda template
- Meeting notes template
- Both available in Word format on Mycourses

Style

- Does style matter?
- Effective communication does matter
- Efficient use of your time does matter
- Should design reviews be PowerPoint?

Design Review Best Practices

(How best to have the discussion you want?)

How to have a discussion that matters

- Talking in a lab with flip charts
- Projecting your design via CAD station
- Showing parts and prototypes
- Standing in front of a machine
- Showing simple mocked up concepts