COLLECTIVE SYSTEM DESIGN SIMULATION

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Learning Outcomes for Physical Simulation

• Experience the process for designing your own system to meet/sustain customer needs.

• Understand the importance of collective agreement to define a system’s design – requirements and solutions

• Experience collective leadership through conscious observation of actions and work.
Simulation Instructions

• Customer wants the following parts:
  • 8 Red
  • 8 Green
  • 8 Blue

• Time per shift: 3 minutes 12 seconds

• We are simulating one shift

• But, one problem, there are defects…
Simulation Layout

Fixed Time to Replenish

Supplier
- C = 6
- Fallout = 16%

Assembly
- C = 4
- Fallout/downtime = 10% on average

Customer
- 8R, 8G, 8B in 3 min, 12 sec

24 sec
ROUND 1 – Make as many as you can

• Make as many as you can to maximize resource utilization!
Reflection - ROUND 1 – Make as many as you can

1. How many parts did you produce for each color?
   Red =  
   Green = 
   Blue = 

2. What requirements did you achieve?

3. What solutions did you implement?

4. What customer(s) did your system serve?

5. How did your team solve problems?

6. What would you do differently?
Round 2 – Achieve Customer Needs

• With your team, identify customer needs
• Design your system to achieve customer needs...
Round 2 – Achieve Customer Needs

JIT:
Make only what is needed, when it is needed, in the quantity that is needed. Produce to actual orders, not to forecast.

Jidoka:
Stop work when a problem is detected…use of “autonomation”… automation with a human touch… Human and Mechanical means.

TPS
Cost Reduction through the elimination of waste.

JIT
Kaizen & Improvement

JIDOKA

Level Production Std. Work in Cells

The Foundation is Single-Piece Flow in Cells w/ Single Minute Set Up Time
Our Language for System Design

**Functional Reqs. (FRs)**
- Define “What” the System Must Accomplish (i.e., purpose)
- Are Functions
- Cannot be Compromised for “Cost Reduction”
- First word starts with a Verb:
  - Achieve
  - Reduce
  - Increase
  - Control

**Physical Solutions (PSs)**
- Define “How” the System Accomplishes the FRs
- Are Physical Things
- May be changed to improve
- First word starts with a Noun:
  - Process
  - Procedures
  - Machines
  - Module
Round 2 – Collective System Design Language

Start by Understanding Customer Needs

Articulate the FR

A PS is Selected to Achieve each FR

Functional Requirement (FR); Performance Measure on FR is $M_{FR}$

Physical Solution (PS); Performance Measure on PS is $M_{PS}$

Standard Work

Performance measures are aligned with either the FR or PS
System Design Functional Requirements Derived from Customer Needs

FR1 – Provide a safe, healthy, clean environment - **Fundamental/Must have**

FR2 – Produce the customer-consumed quantity every shift (time interval) - **JIT**

FR3 – Produce the customer-consumed mix every shift (time interval) - **JIT**

FR4 – Do not advance a defect to the next customer of your work (time interval) – **Jidoka**

FR5 – Achieve FR1 – FR4 in spite of variation - **Robust**

FR6 – When a problem occurs in accomplishing FR1 – FR4, identify the problem condition immediately & respond in a standardized (pre-defined) way - **Feedback**

FR7 - Achieve FR1 – FR6 with the least time in system **Lead Time Reduction**
| FR1 – Provide a safe, healthy environment (Fundamental – Must Have) |
| FR2 – Produce the customer-consumed quantity every shift (JIT) |
| FR3 – Produce the customer-consumed mix every shift (JIT) |
| FR4 – Do not advance a defect to the next customer of your work (Jidoka) |
| FR5 – Achieve FR1 through FR4 in spite of variation (Robust) |
| FR6 – Rapidly identify problems and resolve them for the long term (Feedback) |
| FR7 – Achieve FR1 through FR6 with the least time in system (Lead Time Reduction) |

**FR: Requirement**
What we must achieve (starts with a verb)

**FR’: Requirement**

**PS: Solution**
Planned means to achieve the requirement (defined by a noun)

**Implementation Sequence**
Reflection - ROUND 2 – Achieve Customer Needs

1. How many parts did you produce for each color?
   
   Red =  
   Green =  
   Blue =  

2. What requirements did you achieve?

3. What solutions did you implement?

4. What customer(s) did your system serve?

5. How did your team solve problems?

6. What would you do differently?
ROUND 3 – Refine System Design and Improve Standard Work

• Focus on the way work is done to achieve FR’s
Reflection - ROUND 3: Refine System Design and Improve Standard Work

1. How many parts did you produce for each color?
   
   Red =  

   Green =  

   Blue =  

2. What requirements did you achieve?

3. What solutions did you implement?

4. What customer(s) did your system serve?

5. How did your team solve problems?

6. What would you do differently?
Flame Model of CSD: Overview of the Design Process

Conscious Choice to Change

Design

Tone

Thinking

Structure

Work / Actions

Diagnosis
Continuous Improvement through Plan – Do – Check – Act (PDCA)

A PS is a hypothesis to achieve an FR

FR1 FR2 FR3
PS1 PS2 PS3

Plan

Check

Do

Act

What needs to change?

Green Sheet

White Sheet

Study results using $FR_M$ and $PS_M$

Implement the Plan

Update $FR_M$ / $PS_M$

Change the work

Change FR

Change PS

Standard Work

Standard Work is the beginning Plan in PDCA
Collective System Design Steps

Step 1: Senior Leadership Makes a Conscious Choice to Change

Step 2: Define Stakeholders & System Boundary / Value Stream(s)

Step 3: Establish Tone and Values

Step 4: Identify Customers and their Needs

Step 5: Determine Functional Requirements (FRs)

Step 6: Map the Physical Solutions (PSs) to FRs

Step 6.1: Evaluation of Design Matrix

Step 6.2: Is the Design Acceptable?

Step 6.3: Is the Decomposition Complete?

Yes

No

Review FRs / PSs

Step 7: Define Performance Measures (FRMs & PSMs)

Step 7.1: Evaluation of Design Matrix

Step 7.2: Is the Plan Acceptable?

Yes

No

Update FRMs / PSMs

Step 8: Define Organization Structure based on CSD Map

Step 9: Continuous Improvement: Plan, Do, Check, Act (PDCA)

Step 9.1: (Plan) Implement PSs with Standard Work

Step 9.2: (Do) Complete the Standard Work

Step 9.3: (Check) Check Against the Measures

Step 9.4: (Act) Modify Design as Needed

Step 10: Evaluate the Cost of Not Achieving the FRs

Step 11: Prepare Resource Re-allocation Plan

Step 12: Feedback for Sustainability and Growth

SUMMARY

- The Collective System Design (CSD) Language Guides an implementation to become Lean

- We Use the 7 FRs of Achieving Customer Needs to Guide Our Manufacturing System Design

- The Collective System Design Map (MSDD) Guides What to Measure

- The System is Sustained by Continuously by Seeking to Achieve the FRs through Standard Work and PDCA

- Collective System Design seeks to enhance Lean-Sigma implementation rather than replace it
Continuous Improvement and Learning with Plan, Do, Check, Act (PDCA)

**PLAN**
- Identify Stakeholder Needs
- What we want to achieve to meet those needs (FR)
- How we are going to achieve (PS)
- Establish measures that reinforce what we want to achieve (FRm) and how we will (PSm)

**DO**
- Steps that we will take

**CHECK**
- Check and study results

**ACT**
- Decide what needs to change

**Legend:**
- FR = Functional Requirement – Defines what we want ETCS to achieve.
- PS = Physical Solution – Proposed or planned solution, hypothesized to achieve FR.
- FRm = Measure of the Functional Requirement
- PSm = Measure of the Physical Solution

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Questions?

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