# SIMULATION:
# LEAN DESIGN AND QUICK RESPONSE OFFICE CELL PRINCIPLES

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## PURPOSE

This paper describes a simulation exercise to instruct the engineering community in lean principles. The result of being involved in this simulation is that the people involved will have a good understanding of how to apply lean principles in the design process.

Similar simulations have been developed in the academic community to demonstrate lean principles in the manufacturing process, but no such simulations have been found to demonstrate lean principles in the design process. The exercise is meant to be an interactive, fun exercise, facilitating the participants' learning on their own from their personal experience in the exercise.

## PRINCIPLES

The following are principles of lean design cells, or Quick Response Office Cells (QROCs) that should be evident to participants in the exercise:

- Capture customer requirements with best practices (e.g. perhaps the participants will develop a worksheet to capture requirements, and eventually be able to suggest profitable value-add options) and properly communicate/cascade this to the organization. Unique requirements must be captured (e.g. different test plan than standard template – don't undertest).
- Lean cells are more effective than traditional structure to cope with customer variability (the customer changing requirements) and other variability such as vacation and emergencies.
- A process must be followed to develop a product to insure the best product is consistently developed (standard product platforms/templates or standard test plans that can easily be tailored to customer-specific applications).
- Roles and responsibilities are well-defined (for example, one point of contact for the customer – a program manager or sales manager).
- People divided functionally do not understand what necessary effort that functions accomplish (cross-functional, co-located teams are better than chimneys).
- Product designs must be well-understood and placed on a bookshelf to use again in order to gain efficiencies in the design process. This understanding can also result in simple checklists improve process repeatability – e.g. a checklist to capture customer requirements.
- Investing in proper tools up front is much more efficient then getting into a crisis mode later.
- Non-value-add steps should be eliminated from the processes (e.g. an engineering signing off on a drawing if requirements are captured properly in the beginning is non-value-add, do not do testing the customer does not think is important – over-testing).
- Project management methodology should be used to measure and track effectiveness (e.g. internal methods should be developed to track programs)
- Business mindset requires a supplier to "say no" or price much higher to projects that take a large amount of resources and are not applicable to any future customer projects. Documenting customer approval must be part of this process.
- Optimizing for a function may not optimize the whole system. Optimizing for the system may result in some processes being eliminated or shifted to other functional areas where it is more efficient. For example in this simulation, although having same paper for everyone results in a lower material cost, the labor cost is higher (takes longer to trace because not transparent).
- Suppliers must negotiate support (e.g. customer asks for frequent meetings with staff so supplier should negotiate limited attendance by program manager for whole team - representation for highest value-add).
- Design process must incorporate manufacturing input (Design for Manufacturing).
- Extra capacity should exist for bottleneck processes.
- Visual tools should be used to communicate status to everyone. For example, just as an andon light might flash red, everyone on the design team should know the commitments for open projects and projects that are running behind should be flagged and highlighted (perhaps on a whiteboard or bulletin board for this exercise, instead of an intranet application in actuality).
- In order to meet customer delivery requirements, the constraint must be considered and priorities through constraints must be determined.

## EXERCISE OVERVIEW

The overall simulation exercise consists of five parts:

I. Introduction - describing exercise and randomly determining roles of participants.
II. Simulation One – design process with traditional functional organization (~20 min).
III. Simulation One Analysis – a discussion session summarizing results, recording issues, planning process improvements (~45 min)
IV. Simulation Two - with improved process as determined by participants(~20 min)
V. Wrap-up session summarizing and comparing results, documenting any additional lessons learned (~30 min)

## EXERCISE OVERVIEW: PRODUCT DEVELOPMENT PROCESS

The product to be delivered to the customer is a design and prototypes for that design.
Account managers will get projects from various customers. These projects will be to provide a design (a drawing) of a farm animal with specific criteria from the customer, in a specified format, to be tested in a certain process, with a certain amount of prototypes that look like the drawing cut-out with scissors. To complete a project requires various functions such as account managers, engineers, CAD designers, manufacturing engineers and material logistics people.

## EXERCISE OVERVIEW: ROLES

Approximately twenty people will participate in the exercise. Each person will be given a role on a functional team with a complete description of that role.

Below are the general roles for each subgroup.

Customer Representative (4)

There will be four customer representatives with varying general requirements, varying degrees of maintenance, varying organizations.

- Customer F will give the supplier lots of business, mostly modifying current products.
- Customer G is a new customer that has similar needs to customer F.
- Customer T is a new customer with a different culture having a much higher demand for service.
- Customer P is a new customer with different culture than F, G, and T, with very different testing requirements.

Each customer will have a role description sheet identifying proprietary background information (what they can tell, what they can't, etc.). They must be in separate locations from each other (they cannot overhear the other customers). They will have a certain amount of projects that they want the supplier to accomplish (project deliverables and requirement dates). These project descriptions will also identify what they learn at a later (e.g. volume change, additional product requirements, additional test requirements, time required for customer to give the job to supplier).

Account Manager (4)

There is an account manager for each customer. They must sit with the customer and find out their needs, make a deal to complete a project and then communicate this information on to their organization (engineering). Account managers initiate a project tracking sheet for each job.

Design Engineer (3)

The role of the design engineer is to sketch up a drawing according to the customer requirements from the account managers in pencil. This information is then passed to CAD designers.

CAD Designer (2)

CAD designers must take a sketch from engineering and create another copy in pen. The drawing will also have a title block added (stamped area with signatures of engineer and CAD designer) and assign an internal part number. Each drawing that leaves the CAD department must be in a plastic sheet. The color that certain parts of the drawing must have must be documented on the sheet. This drawing is passed to the Test Engineers. Assign a drawing number.

Manufacturing Engineer (2)

Manufacturing Engineers build the prototypes for the customer to accompany the design. Build (cut out) the specified number of parts.

Test Engineer (2)
Test engineers will perform tests on the prototypes that Manufacturing Engineers produced. They will place the drawing in certain "test" vanilla envelopes for specified amount of time. They will also perform certain inspections on the drawing (e.g. must not be wrinkled in plastic sheet, specific standards, tests, no scribbled out lines). They must document each drawing that is tested and the start and stop time of the testing. The Test Engineers hand off the tested product and design to the Account Managers to deliver to the customer.

Material Logistics Manager (1)
The Material Logistics Manager sits at a separate table from everyone else. They hold the paper used for all the exercises. They are held responsible for material cost at the end of the day. They have regular typing paper, transparent paper (for easier tracing), overhead transparencies, and project tracking sheets (used by the account managers to initiate a job). Various costs are associated with each different material. Material logistics person must record each piece of material given out and who it was given to.

Monitors
A few people to monitor and insure no one is breaking the rules of the simulation should be observing.

**EXERCISE OVERVIEW: MEASURABLES (TIME, LABOR COST, MATERIAL COST)**
Time will be measured during this exercise. When a person sends a job to another area the time is noted. In the center of the room there will be a large clock displaying current time (minutes and seconds) for all to read and record accurately.

Cost will also be calculated based on the amount of time each person spends on the job as well as the materials (paper) used to complete a job (variable cost only). Cost of one person (for any role) working a minute is $100 and the cost for other materials, such as paper, is also defined and tracked in the exercise (see attachment titled Material Logistics Manager Material Cost Tracking Sheet for detail on individual material costs).

**CONCLUSION**
The following attachments are the actual material for the simulation exercise described above, including instructions to the facilitator on how to perform the simulation exercise.

I hope this exercise communicates the principles stated earlier. Please submit feedback to Jonathan Hobgood (contact information is on front cover sheet). Thank you.

**ATTACHMENTS**
Attached in this Microsoft Word document:
- One page Introduction read to all participants.
- One page of background information for each company (companies V, F, G, P, and T).
- One page for each job function.
- Description of jobs for each customer that they desire to source to supplier Company V.
- Facilitator Instructions

Attached in a Microsoft Excel file:
- Project tracking sheet (template for every project started by account managers - Function, time in, total seconds for function)
- Customer tracking form to record how many designs were delivered on time.
- Material tracking sheet for Material Logistics Manager to track material usage.
- Total cost tracking sheet.

**Document Title: Facilitator Instructions (one page)**
**For: Facilitator Only**

Introduction

- Read Participant Introduction document (possibly have this posted on the wall as well).
- Randomly determine roles of participants (you can do this with attached Signup and Roles document if desired).
- Review the following rules:
  - You must not show other functions your role description sheet.
  - Roles are not interchangeable throughout exercise.
  - Don't tell others about the exercise – we will be rolling this out in our SBU.
  - Tables cannot be moved (like physical buildings or areas).
  - Only items at your table can be used to perform your function (e.g. you cannot go to another table and cut a part out) but must cut drawings out sitting at your table.
  - No papers can be thrown away. Place them in a bin at your table if you are done with them.
- Pass out Industry Overview documents (each Company has a separate document).
- Pass out the Role Description Documents.

Simulation One

Once all documents have been reviewed, start the "Master Time Clock" and let the participants begin the simulation exercise.

Simulation One Analysis

The facilitator should lead a discussion emphasizing the need for change in the principle areas identified previously on page two.

Some questions the facilitator should ask:

- How many jobs were completed on time?
- How many jobs were profitable?
- What problems did you find?
- What could you change to make the company perform more effectively?
- In your real company today, can you tell which jobs are more profitable than others?
- In your real company today, can you confidently determine if you should take on a specific job from a specific customer or not?
- Was bumping into each other in a flurry of activity remind you of a game of "phone tag"?
- Was the engineer's signature on the CAD designer's drawing "value-add"?
- Were there any problems communicating customer requirements to the whole team?
- How could you improve the capturing of customer requirements?
- How could you "bookshelf" designs to increase efficiency?
- Can you imagine the simulation if we added the realistic situation of the customer calling engineering and CAD designers directly?
- Should we take on all the potential business we can?
- What steps could be eliminated?
- Is there enough people? Would more people (resources) necessarily help get work done more efficiently?
- Were priorities set and queued properly?

The facilitator could also share statistics info from Quick Response Manufacturing: A Companywide Approach to Reducing Lead Times by Rajan Suri, 1998, to emphasize the amount of waste without organizing functions into lean design cells. Each principle on the page two list should be at least briefly discussed if not addressed by the above questions.

The participants can change anything except the customers, table locations, and general roles to make an improvement for Simulation Two.

Simulation Two

Start the “Master Time Clock” and let the participants begin the simulation exercise again with their process improvements in place that they determined in the Simulation One Analysis period.

Wrap-Up

Results should be compared with the results from session one. Efficiencies should have been gained after implementing the suggestions from the participants.