The Lean 3P Advantage

A Practitioner’s Experience with the Production, Preparation, Process
This is a story of a process that helps us avoid bad designs, takes us past average designs and to the place where good designs can become GREAT.
We all recognize faulty design...
Tacoma Narrows Bridge
Why apply 3P?

Production, Preparation, Process

An event-driven process for developing a new product concurrently with the operation (process) that will produce it, by the people who will interact with it.

Breakthrough Results

Lowest Initial Capital Costs

Lowest Ongoing Cost Basis
Where did 3P come from?

Lean 3P is a systematic process for innovation in design based on Toyota’s Set Based Concurrent Engineering methodology.

3P was developed by Mr. Chihiro Nakao, a former Senior Manager at Toyota and founder of Shingijutsu.
3P enables development of GREAT products

The Right Features
The Right Price Point
The Lowest Manufacturing Cost
The Highest Customer Satisfaction

“Good is the Enemy of Great”
- Jim Collins
More and more companies are adopting Lean 3P

Two Examples
General Electric

2012 Superbowl Commercial
- GE Appliance Park, Lexington, KY

and now . . . the rest of the story . . .
Danaher

An umbrella corporation encompassing many successful companies including: Beckman Coulter, Molecular Devices, Fluke, Dexis, Dover, Eagle-Signal, Qualitrol, Tektronix, Arbor Networks . . .

“The general rule of thumb for leadership is that with 3P, you can normally get a given increment of capacity at one-quarter the capital cost of traditional approaches, and you can normally get a fourfold productivity gain” *

- George Koenigsaecker
  Former President of Danaher and Developer of the Danaher Business System

What about other companies who make GREAT products, but don’t use 3P?
“We wanted to get rid of anything other than what was absolutely essential. To do so required **total collaboration** between the designers, the product developers, the engineers, and the manufacturing team. We kept going back to the beginning, again and again. Do we need that part? Can we get it to perform the function of the other four parts?”

- Steve Jobs

“Much of the design process is a conversation, a back-and-forth as we walk around the tables and play with the models. He doesn’t like to read complex drawings. He wants to see and feel a model. He’s right. I get surprised when we make a model and then realize it’s rubbish, even though based on the CAD renderings it looked great.”

- Jony Ive

Sr. VP of Industrial Design, Apple
Where is 3P applied?

- Designing a new product
- Increasing Plant capacity to meet customer demand
- Relocating factory operations
- During process quality improvement efforts
- Purchase of capital equipment
New Products

AME 3P WORKSHOP
Squeeze machine redesign at Therafin Corporation
June 2012 – Chicago, IL
Natural Alternatives

Evaluating Alternatives

Prototype

Final Concept
Plant Layouts

Alternatives

Criteria Defined

Scale Model Prototypes
New Operations

Combined Prototype

Completed Operation
The Problem With Typical Product & Process Development
Typical Product Development Approach

- Over the Wall
- Late to Market
- Rework pre-launch and post-launch
- High development costs

The Shape of Reliable Innovation is . . .

Iterative . . .

- Generate Product Concept
- Repeat
- Expose Customer to Product
- Conversation with Customer About Product

Not Sequential

- Concept Generation
- Product Planning
- Product Engineering
- Process Engineering
- Production Process

Product

Why does 3P work?

- Intense cross-functional collaboration
- Product Development concurrently with Process
- Rapid learning and Try-storming
- A process that moves quickly through a series of steps that activate our thinking and help us gain understanding as we evaluate and converge upon optimum solutions.
Lean 3P Event Flow

- Information
  - Knowledge Gathering
- Innovation
  - Develop Alternatives
- Prototyping & Redesign
  - Prototyping & Convergence
- Optimization
  - Evaluation & Detailed Planning

The Lean 3P Process
Who needs to be included?

Collaboration during development of *both* the *product* and the *process*
## Sources of Cross-functional Input

<table>
<thead>
<tr>
<th>Research &amp; Development</th>
<th>Quality Assurance</th>
<th>Process Engineering</th>
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<tbody>
<tr>
<td>Design Engineering</td>
<td>Health, Safety, Environmental</td>
<td>Supply Chain / Logistics</td>
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<tr>
<td>Operations Management</td>
<td>Material Handling</td>
<td>Finance</td>
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<tr>
<td>Technical</td>
<td>Maintenance</td>
<td>Equipment Vendors</td>
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<tr>
<td>Production Operators</td>
<td>Customers</td>
<td>Sales / Marketing</td>
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<tr>
<td>Raw Material Suppliers</td>
<td>Regulatory / Compliance</td>
<td>External Experts</td>
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# Goals and Boundaries

## The 3P Event Charter

<table>
<thead>
<tr>
<th>Process Name</th>
<th>Start Date</th>
<th>End Date</th>
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<tbody>
<tr>
<td>The No-Diesel Diesel Engine Project</td>
<td>May 5, 2014</td>
<td>May 9, 2014</td>
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### Process Boundaries

<table>
<thead>
<tr>
<th>Start Time</th>
<th>End Time</th>
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<tr>
<td>7:30 AM</td>
<td>4:30 PM</td>
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</tbody>
</table>

### Event Meeting Location

- South Factory

### Process Owners

- VP Operations - Ron M
- VP Marketing - Hal M

### Why Do We Need This Event?

Existing product lines plateau. Cost of oil is skyrocketing. Hybrids and electric causing market erosion at 5% per year.

### Event Experts

- Product Mgr - John W
- Design Engr - Kay M
- Regulatory Mgr - Stan G
- Director HSE - Jim E
- Director Operations - Alex K
- Supply Chain - Paula E
- Production Super - Joyce W
- Technical Mgr - Kim G
- Procurement - George M
- Quality Supr - Narda M
- Finance - Pam M
- Operators - Megan B
- Facilities - Glenn S

### Event Judges

- Chief Engr - Ron M
- Research - Maria S
- COO - Ken R
- Dir. Lean Sigma - Drew L

### Event Targets

- Final product cost under $1,500 USD at rate of 30,000 units per year.
- Capital cost limited to $1.2 MM USD.
- Time to market launch 14 months or less.

### Process Outsiders

- Acme Machine Tool Co - Andrew J

### Facilitators

- The Sensei Co. - Kit E
- MEP - Kim K

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Choosing Design Criteria

Select strong Design Evaluation Criteria

These Design Criterion will be used to evaluate all alternatives and prototypes during the event.

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>MUST</th>
<th>SHOULD</th>
<th>COULD</th>
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<tbody>
<tr>
<td>1 Takt Time</td>
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<td>2 One-Piece Flow</td>
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<td>3 Pull System</td>
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<td>4 People Involvement</td>
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<td>5 Automatic Unloading</td>
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<td>6 Load-Load Operations</td>
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<td>7 Low Cost Automation</td>
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<td>8 Mistake-Proof (Poka Yoke)</td>
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<td>9 Minimal Capital</td>
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<td>10 Minimal Space Required</td>
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<td>11 Low Motion Waste</td>
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<td>12 100% Gauging</td>
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<td>13 Maximum Operator Value-Add</td>
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<td>14 Changeover Time</td>
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<td>15 Tool Room Maintenance</td>
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<td>16 Tooling Quality or Tooling Cost</td>
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<td>17 Safety, Ergonomics, and Health</td>
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<td>18 Environmental Impact</td>
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<td>19 Internal Waste Collection</td>
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<tr>
<td>20 Simple as Possible</td>
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<tr>
<td>21 Standard or Off-the-Shelf Equipment</td>
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<td>22 Process capability (Cp)</td>
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<td>23 Known Process</td>
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<tr>
<td>24 Future Challenge</td>
<td></td>
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<td></td>
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<td>25 Maintenance Free</td>
<td></td>
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<tr>
<td>26 Technical Advantage</td>
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<tr>
<td>27 Autonomation</td>
<td></td>
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<tr>
<td>28 Development Time or In-House Development</td>
<td></td>
<td></td>
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<tr>
<td>29 Scalability</td>
<td></td>
<td></td>
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<tr>
<td>30 Flexibility</td>
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</tr>
</tbody>
</table>

# Takt Time

Takt time equals the available time per day, divided by the daily customer demand, often expressed as seconds per piece.

<table>
<thead>
<tr>
<th>BAKED APPLE Sales Per Quarter</th>
<th>1&lt;sup&gt;st&lt;/sup&gt; Quarter</th>
<th>2&lt;sup&gt;nd&lt;/sup&gt; Quarter</th>
<th>3&lt;sup&gt;rd&lt;/sup&gt; Quarter</th>
<th>4&lt;sup&gt;th&lt;/sup&gt; Quarter</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 day wk / 8 hrs - Apples per Minute</td>
<td>1,350,000</td>
<td>750,000</td>
<td>350,000</td>
<td>1,100,000</td>
</tr>
<tr>
<td>seconds per apple</td>
<td>72</td>
<td>40</td>
<td>19</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>0.8</td>
<td>1.5</td>
<td>3.2</td>
<td>1.0</td>
</tr>
<tr>
<td>6 day wk / 8 hrs - Apples per Minute</td>
<td>1,350,000</td>
<td>750,000</td>
<td>350,000</td>
<td>1,100,000</td>
</tr>
<tr>
<td>seconds per apple</td>
<td>60</td>
<td>33</td>
<td>16</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>1.0</td>
<td>1.8</td>
<td>3.9</td>
<td>1.2</td>
</tr>
<tr>
<td>5 day wk / 16 hrs - Apples per Minute</td>
<td>1,350,000</td>
<td>750,000</td>
<td>350,000</td>
<td>1,100,000</td>
</tr>
<tr>
<td>seconds per apple</td>
<td>31</td>
<td>17</td>
<td>8</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>1.9</td>
<td>3.5</td>
<td>7.5</td>
<td>2.4</td>
</tr>
</tbody>
</table>

Understanding Product Assembly and Features

Develop Knowledge of Product Attributes, Features and Alternatives

Value-Adding Process Flow

Simple Flow Diagram

<table>
<thead>
<tr>
<th>Accumulate</th>
<th>Separate</th>
<th>Remove Contam.</th>
<th>Dry</th>
<th>Remove Matl.</th>
<th>Fill</th>
<th>Heat</th>
<th>Cool</th>
<th>Protect</th>
<th>ID</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
</tr>
</tbody>
</table>

Make Flow as Visual as Possible

# Value-Adding Functions

<table>
<thead>
<tr>
<th>Traditional Process Step</th>
<th>Description of Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Load Apples</td>
<td>Accumulate</td>
</tr>
<tr>
<td>2 Sort Apples</td>
<td>Separate</td>
</tr>
<tr>
<td>3 Spray Apples</td>
<td>Remove Contaminates</td>
</tr>
<tr>
<td>4 Blow Off Water</td>
<td>Dry</td>
</tr>
<tr>
<td>5 Core Apple</td>
<td>Remove Material</td>
</tr>
<tr>
<td>6 Insert Sugar &amp; Butter Mix</td>
<td>Fill Hole</td>
</tr>
<tr>
<td>7 Bake</td>
<td>Heat</td>
</tr>
<tr>
<td>8 Flash Cool</td>
<td>Cool</td>
</tr>
<tr>
<td>9 Package in Clamshell &amp; Weld</td>
<td>Protect</td>
</tr>
<tr>
<td>10 Label</td>
<td>Identify</td>
</tr>
<tr>
<td>11 Package</td>
<td>Group</td>
</tr>
</tbody>
</table>

Develop 7 Natural Alternatives
Select the 3 Most Viable

## 7 Alternatives From Nature

<table>
<thead>
<tr>
<th>HEAT</th>
<th>1. Electricity</th>
<th>2. Rub Hands Friction</th>
<th>3. Lava Conducts</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Apple Fire" /></td>
<td><img src="image" alt="Electricity" /></td>
<td><img src="image" alt="Rub Hands" /></td>
<td><img src="image" alt="Lava" /></td>
</tr>
<tr>
<td><img src="image" alt="Sun" /></td>
<td><img src="image" alt="Lightning Bug" /></td>
<td><img src="image" alt="Fire" /></td>
<td><img src="image" alt="Wind" /></td>
</tr>
</tbody>
</table>

*Used with permission: Coletta, Allan. *The Lean 3P Advantage*. Boca Raton: CRC, 2012*
### Finding Industrial Alternatives

#### 7 PROCESS OPTIONS FOR: HEAT

<table>
<thead>
<tr>
<th>Material</th>
<th>High Voltage Electricity</th>
<th>Microwave Heat</th>
<th>Conduction Heat</th>
<th>Radiant Heat</th>
<th>Exothermic Chemical Reaction</th>
<th>Fire</th>
<th>Convection Heat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>Arc Welder</td>
<td>Microwave Oven</td>
<td>Deep Fryer with Butter</td>
<td>Infrared Oven</td>
<td>???</td>
<td>Pizza Oven or Broiler</td>
<td>Convection Oven</td>
</tr>
</tbody>
</table>

Assigning Alternatives to the 3 Different Prototypes

Distributing Alternatives to the 3 Teams

Value-Adding Functions

Sketching Ideas

Prototypes and Try-Storming

Simple Solutions
“Creativity Before Capital”

Researching Ideas & Physical Modeling:
“Fail Fast, Fail Cheap”

* Used with permission: Coletta, Allan. The Lean 3P Advantage. Boca Raton: CRC, 2012
Three Different Prototypes Built

For Every Value-Adding Step: A Different Alternative in Each Model

Different Functions Working Together, Collaborating & Learning to Gain Understanding

Best Alternatives Combined into One Final Prototype

Rapid PDCA to Learn, Evaluate and Refine

Stakeholders Add Detail and Error Proofing

Simulate Actual Operation

To Develop Standard Work

To Practice, Refine and Prepare for Vertical Launch

Final Report-Out Session

- Process at a Glance
- Estimated performance versus evaluation criterion
- Prototype walk-through, highlighting people involvement
- Financial plan and estimates versus target costing
- Project timeline and risks
- Open actions and opportunities
- Summary of accomplishments

## Process at a Glance

<table>
<thead>
<tr>
<th>PROCESS AT A GLANCE</th>
<th>1</th>
<th>2</th>
<th>3</th>
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<th>Complete Process</th>
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<td>Process Step</td>
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</table>

1. Minimal Capital
2. Changeover Time
3. Low Motion Waste
4. Pull System
5. Autonotation
6. Off the Shelf Equipment
7. High Process Capability
8. Internal Waste Collection
9. Simple as Possible
10. Maintenance Free
11. Scalability

TOTAL +
TOTAL -
RATING TOTAL

Process at a Glance

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Potholes and Stumbling Blocks

• Choose optimists versus pessimists
• Judges: influential “critical evaluators”
• Let the process breathe . . .
• Time management - keep things moving
• Leadership through the highs and lows
• Believe in and trust the 3P process
• Stakeholders involved from event(s) through to Launch

Questions?
Presenters

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