Value Stream Mapping

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IPFW

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Discussion Points

1. Introduction & Getting Started
2. The Current State Map
3. Lean Value Stream
4. The Future State Map
5. Achieving the Future State
6. Conclusion

The Goal is to develop your ability to “see the flow” and design a future state
Why Lean Manufacturing?

- **Past**
  - Profit
  - Cost
  - Price

- **Present**
  - Profit
  - Cost
  - Market Price

- **Future**
  - Profit
  - Cost
  - Market Price

Arguments for Lean Manufacturing:
- Lean manufacturing reduces waste, eschewing excess inventory and overproduction.
- It focuses on the elimination of waste in the production process to improve efficiency and reduce costs.
- Lean manufacturing is about using resources in an optimal way to produce what customers truly want.
Lean Manufacturing is a group of strategies for the identification and elimination of the waste inside the Value Stream.
Levels of a Value Stream

begin here

process level

single plant (door to door)

multiple plants

across companies
Value Stream Improvement & Process Improvement

VALUE STREAM

PROCESS
STAMPING

PROCESS
WELDING

PROCESS
ASSEMBLY CELL

CUSTOMER

Raw Material

Finished Product

Value Stream: All steps, both VA & NVA, required to bring the product from raw material to the customer.
Value Stream Mapping

A) Follow a product’s production path from beginning to end, and draw a visual representation of every process in the material & information flows.

B) Then draw (using icons) a “future state” map of how value should flow.
Using the Value Stream Mapping Tool

1. **product family**
2. **current state drawing**
   - 2 days
3. **future state drawing**
   - Understanding how the shop floor currently operates. The foundation for the future state.
   - Designing a lean flow.
4. **plan and implementation**
Focus on one product family

Determine Product Families via:
Similar downstream “assembly” steps and equipment

<table>
<thead>
<tr>
<th>PRODUCTS</th>
<th>Process Steps &amp; Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>LH Steering Bracket</td>
<td>X</td>
</tr>
<tr>
<td>RH Steering Bracket</td>
<td>X</td>
</tr>
<tr>
<td>Instrument Panel Brace</td>
<td></td>
</tr>
<tr>
<td>Seat Rail</td>
<td>X</td>
</tr>
<tr>
<td>Bumper Brackets</td>
<td>X</td>
</tr>
</tbody>
</table>
Value Stream Managers

Each Value Stream Needs a Value Stream Manager

For product ownership beyond functions

Assign responsibility for the future state mapping and implementing lean value streams to line managers with the capability to make change happen across functional and departmental boundaries.

Value Stream Managers should make their progress reports to the top manager on site.
What Have We learned so far...

• Value Stream mapping looks at the material and information flow in a value stream.

• A product family matrix is used to identify and group products into families based on whether they pass through similar steps in your downstream process.

• A Value Stream Manager is the lead person with the responsibility for understanding a product family’s value stream and improving it.

• The recommended level for beginning to map for a product family is door-to-door in an individual facility.
The Current State Map

Current State Drawing

Understanding how the shop floor currently operates.

- Material and Information flows
- Draw using icons
- Start with the “door to door” flow
- Have to walk the flow and get actuals
  - no standard times
  - draw by hand, with pencil
- Foundation for the Future State
“ACME Stamping” Data Set

Acme Stamping Company produces several components for vehicle assembly plants. This case concerns one product family: a steel instrument-panel bracket subassembly in two types: one each for left-hand and right-hand drive versions of the same automobile model. These components are sent to the State Street Vehicle Assembly Plant (the customer).

CUSTOMER REQUIREMENTS:

- 18,400 pieces per month
  - 12,000 per month of Type “LH”
  - 6,400 per month of Type “RH”
- Customer plant operates on two shifts
- Palletized returnable tray packaging with 20 brackets in a tray and up to 10 trays on a pallet. The customer orders in multiples of trays.
- One daily shipment to the assembly plant by truck

WORK TIME:

- 20 days in a month
- Two shift operation in all production departments
- Eight (8) hours every shift, with overtime if necessary
- Two 10-minute breaks during each shift
  Manual processes stop during breaks
  Unpaid lunch
State Street Assembly

- 18,400 pcs/mo
- 12,000 "L"
- 6,400 "R"

Tray = 20 pieces
2 Shifts

Ix Daily
“ACME Stamping” Data Set (continued)

PRODUCTION PROCESSES:

- Acme’s process for this product family involves **stamping** a metal part followed by **welding** and subsequent **assembly**. The components are then **staged & shipped** to the vehicle assembly plant on a daily basis.
- Switching between Type “LH” (left-hand drive) and Type “RH” (right-hand drive) brackets requires 1 hour changeover in stamping and 10-minute fixture change in the welding processes.
- **Steel coils are supplied by Michigan Steel Co.** Deliveries are made to Acme on Tuesdays and Thursdays.

ACME PRODUCTION CONTROL DEPARTMENT:

- Receives State Street’s 90/60/30-day forecasts and enters them to MRP
- Issues Acme 6-week forecast to Michigan Steel Co. via MRP
- Secures coil steel by weekly faxed order release to Michigan Steel Co.
- Receives daily firm order from State Street
- Generates MRP-based weekly departmental requirements based upon customer order, WIP inventory levels, F/G inventory levels, and anticipated scrap and downtime
- Issues weekly build schedules to Stamping, Welding, and Assembly processes
- Issues daily shipping schedule to Shipping Department
"ACME Stamping" Data Set (continued)

PROCESS INFORMATION:
All processes occur in the following order and each piece goes through all processes.

1) STAMPING
(The press makes parts for many Acme products)
- Automated 200 Ton press with coil (automatic material feed)
- Cycle Time: 1 second (60 pieces per minute)
- Changeover time: 1 hour (good piece to good piece)
- Machine reliability: 85%
- Observed Inventory:
  5 days of coils before stamping
  4,600 pieces of Type “LH” finished stampings
  2,400 pieces of Type “RH” finished stampings

2) SPOT-WELD WORKSTATION I
(dedicated to this product family)
- Manual process with one operator
- Cycle Time: 39 seconds
- Changeover time: 10 minutes (fixture change)
- Reliability: 100%
- Observed Inventory:
  1,100 pieces of Type “LH”
  600 pieces of Type “RH”

3) SPOT-WELD WORKSTATION II
(dedicated to this product family)
- Manual process with one operator
- Cycle Time: 46 seconds
- Changeover time: 10 minutes (fixture change)
- Reliability: 80%
- Observed Inventory:
  1,600 pieces of Type “LH”
  850 pieces of Type “RH”

4) ASSEMBLY WORKSTATION I
(dedicated to this product family)
- Manual process with one operator
- Cycle Time: 62 seconds
- Changeover time: none
- Reliability: 100%
- Observed Inventory:
  1,200 pieces of Type “LH”
  640 pieces of Type “RH”

5) ASSEMBLY WORKSTATION II
(dedicated to this product family)
- Manual process with one operator
- Cycle Time: 40 seconds
- Changeover time: none
- Reliability: 100%
- Observed Finished-Goods Inventory in Warehouse:
  2,700 pieces of Type “LH”
  1,440 pieces of Type “RH”

6) SHIPPING DEPARTMENT
Removes parts from finished goods warehouse and stages them for truck shipment to customer.
Acme Stamping
Steering Brackets
Current State

- State Street Assembly
  - 18,400 pcs/mo
  - 12,000 “L”
  - 6,400 “R”
  - Tray = 20 pieces
  - 2 Shifts

- Stamping
  - 200 T
  - 4600 L
  - 2400 R
  - 1
  - C/T = 1 second
  - C/O = 1 hour
  - Uptime = 85%

- S. Weld #1
  - 1100 L
  - 600 R
  - 1
  - C/T = 59 seconds
  - C/O = 10 minutes
  - Uptime = 100%

- S. Weld #2
  - 1800 L
  - 850 R
  - 1
  - C/T = 46 seconds
  - C/O = 10 minutes
  - Uptime = 80%

- Assembly #1
  - 1200 L
  - 640 R
  - 1
  - C/T = 62 seconds
  - C/O = 0
  - Uptime = 100%

- Assembly #2
  - 2700 L
  - 1440 R
  - 1
  - C/T = 40 seconds
  - C/O = 0
  - Uptime = 100%

- Shipping
  - Coils
  - 5 days
Points To Remember....

• The best way to draw a value stream map is in pencil on the work floor, mapping the whole value stream yourself.

• Lead time is the time it takes one piece to move all the way through a process or a value stream from start to finish.

• Data boxes should contain information based on what you observe as you draw your map.

• The process of value stream mapping begins with the Supplier.
Team Tips
Current State Mapping

1. MAPPING THE CURRENT STATE:
   - Review the basic processing steps and calculate the assembly takt time in your team’s breakout room.
   - Everyone draw while on the shop floor. Be sure to draw both the material & information flows.
   - Always introduce yourself to operators and tell them what you are doing: “Drawing the total factory flow as part of a training session.” Show them your drawings.
   - Select a scribe and combine your drawings into one current state map (in team area).
   - Calculate total lead time versus processing time.

2. PRESENTING YOUR CURRENT STATE MAP:
   - All team members go up front with presenter. State the product family and takt.
   - Present from your current state map. (less than 5 minutes)
   - Start with the customer and information flow into the facility.
   - State the lead time vs. processing time.
   - What are the problems you see? Where did you find push and overproduction?
   - Share any future state thoughts you have so far.
Future State Drawing

Designing a Lean Flow

- The power behind Value Stream Mapping is you always need a future state!
- 70% & Keep Updating. Use pencil!
- Material & Information flows
- Basis for your Work Plan — like a “blueprint”
- Begin by drawing on Current State
- 1st iteration assumes existing steps & equipment
  Can move equipment, combine, take out conveyors, make minor purchases, etc.

But there is a Problem!
Mass Production
Large Lots, Pushed Ahead, "Island" Mentality

Value-Added Time: Minutes
Time in Plant: Weeks

Order
Cash

Goal: The MORE the FASTER the BETTER
Waste

- The elements of production that add no value to the product
- Waste only adds cost and time

Things to Remember about Waste

- Waste is really a symptom rather than a root cause of the problem
- Waste points to problems within the system (at both process and value stream levels)
- We need to find and address causes of waste
Overproduction

= Making more than is required by the next process
= Making earlier than is required by the next process
= Making faster than is required by the next process
Individual Efficiency vs. System Efficiency

How fast should we produce?
TAKT Time

Synchronizes pace of assembly to match pace of sales.
Rate for assembling a product based on sales rate.

\[
\text{Takt Time} = \frac{\text{Effective Working Time per Shift}}{\text{Customer Requirement per Shift}}
\]

\[
\frac{27,000 \text{ sec}}{460 \text{ pieces}} = 59 \text{ sec}
\]
Build to Supermarket or to Shipping?

To Shipping

To Supermarket
Continuous Flow Processing

Batch & Push Processing

Process A: 10 minutes

Process B: 10 minutes

Process C: 10 minutes

Lead Time: 30++ minutes for total order

Continuous Flow “make one, move one”

3 min
12 min
Problem Points in the Flow
Where One-Piece Flow Ends

How can we control production between flows?
MRP-based schedules?
Supermarket Pull System

1) Customer process goes to supermarket and withdraws what it needs when it needs it.

2) Supplying process produces to replenish what was withdrawn.

Purpose: A way to control production between flows. Controls production at supplying process without trying to schedule.
Try to Schedule Only 1 Point

- SUPERMARKET
- FIFO

schedule

FLOW

customer
Mixed Production at the Pacemaker
(Assembly)

No Good

Assembly Schedule

- Monday .......... 400 A
- Tuesday ........ 100 A, 300 B
- Wednesday ... 200 B, 200 C
- Thursday ..... 400 C
- Friday .......... 200 C, 200 A

Better: Every Part Every Day

- Monday: 140 A, 100 B, 160 C

Important:
Near-zero changeover time and frequent changeovers at the Pacemaker Process!

Even Better: Every Part Every Ship Window

- Monday
  - 50B  70A  80C
  - 50B  70A  80C
What Happens to a Lean Flow...

...if a machine breaks down?
...if a defective part is included with good parts?
Paced Withdrawal at the Pacemaker

- What amount of work do you schedule and take away at the pacemaker?
- This amount = your management time frame.
  (How often do you know your performance to customer demand?)
- Are you providing takt image?

```
1 Week
1 Day
1 Shift
1 Hour
1 Pitch = Takt x (packout)
1 Takt
```
More Points Learned…

• Takt time is the customer demand rate

• A supermarket is used where continuous flow is not possible due to distance, unreliability, or where processes serve multiple product families

• A pacemaker process responds to the external customer, and is usually the point at which production is scheduled in the door-to-door value stream.

• Overproduction is usually the most significant source of waste in a value stream.
Future State Questions

- What is the takt time?
- Will we build to shipping or to a supermarket?
- Where can we use continuous flow?
- Where do we have to use supermarket pull systems?
- At what single point in the production chain do we trigger production?
- How do we level the production mix at the pacemaker process?
- What increment of work will we release and take away at the pacemaker process? (Leveling the volume) Pitch

SUPPORTING IMPROVEMENTS

- What process improvements will be necessary? (e.g. uptime, changeover, training)
Future State Icons

- **Supermarket**
- **Production Kanban**
- **Withdrawal Kanban**
- **Signal Kanban**
- **Kanban Path**
- **Kanban Arriving in Batches**
- **Withdrawal**
- **Leveling Mix and/or Volume**
- **FIFO**
- **Max 50 pcs**
- **First-In First-Out Flow**
- **Kaizen Lightning Burst**
- **Changeover**
Why Not Flow From Weld - Assembly

• No Reason!!
• The lean approach is to place these four processes immediately adjacent to one another (cellular)
• Have the operators pass parts from one process to another.
• Keep operator’s work content just below the takt time.
Cycling Faster than Takt Time
(Operator Balance Chart)

Takt = 60 sec

Current Process Takt

After Kaizen Takt
Acme Stamping
Steering Brackets
Future State

Michigan Steel Co.
500 ft coils

6-week Forecast
weekly fax

PRODUCTION CONTROL
MRP

State Street Assembly
18,400 pcs/mo
-12,000 “L” 18,400 “R”
1x Daily

Daily Order
920 pcs/day

Takt = \frac{460 \text{ minutes}}{460 \text{ pieces}} = 60 \text{ sec}

Pitch = 60 \text{ sec} \times 20 \text{ pcs} = 20 \text{ min.}

Daily Ship Schedule

STAMPING

200 T

C/T = 1 second
C/O = 1 hour
Uptime = 85%

1

WELD & ASSY.

TT = 60 sec
C/T = 55 sec

3

1x Daily

SHIPPING

2 days

\text{Work Content} \leq 165 \text{ sec.}

SW II uptime

SW C/O = 0
Whiteboard 4-8

**Michigan Steel Co.**
- 500 ft coils

**State Street Assembly**
- 18,400 pcs/mo
- 12,000 “L”
- 6,400 “R”
- Tray = 20 pieces
- 2 Shiftings

**Takt Calculation**
- \[ \text{Takt} = \frac{460 \text{ minutes}}{460 \text{ pieces}} = 60 \text{ sec/piece} \]

**Pitch Calculation**
- \[ \text{Pitch} = 60 \text{ sec} \times 20 \text{ pcs} = 20 \text{ min} \]

**Daily Ship Schedule**
- 920 pcs/day

**Stamping**
- 200 T
- C/T = 1 second
- C/O = 1 hour
- Uptime = 85%
- 1 W

**Weld & Assy.**
- TT = 60 sec
- C/T = 55 sec
- 3 W

**Acme Stamping**
- Steering Brackets
- Future State
Acme Stamping
Steering Brackets
Future State
Acme Stamping
Steering Brackets
Future State
Whiteboard 4-14

Michigan Steel Co.
- 500 ft coils

Daily Forecast

6-week Forecast

Production Control

Daily Order

Daily Ship Schedule

80/80/120 day Forecast

State Street Assembly
- 18,400 pcs/mo
- 12,000 "L"
- 6,400 "R"
- Tray = 20 pieces
- 2 Shifts

Takt = \[
\frac{460 \text{ minutes}}{460 \text{ pieces}} = 60 \text{ sec}
\]

Pitch = 60 sec x 20 pcs = 20 min.

RLLRL... pitch = 20 min.

Stamping
- 200 T
- C/T = 1 second
- C/O = 1 hour
- Uptime = 85%

Weld & Ass'y.
- TT = 60 sec
- C/T = 55 sec

Shipping
- Stage

Acme Stamping
- Steering Brackets
- Future State

1 sec.

1.5 days

1.5 days

165 sec.

2 days

166 seconds

5 days

46 Trays

1x Daily

Work content ≤ 165 sec.
## Lead Time Improvements

<table>
<thead>
<tr>
<th></th>
<th>Coils</th>
<th>Stamped Parts</th>
<th>Weld/Assy WIP</th>
<th>Finished Goods</th>
<th>Production Lead time</th>
<th>Total Inventory Turns</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Before</strong></td>
<td>5 days</td>
<td>7.6 Days</td>
<td>6.5 Days</td>
<td>4.5 Days</td>
<td>23.6 Days</td>
<td>10</td>
</tr>
<tr>
<td><strong>Cont Flow &amp; Pull</strong></td>
<td>2 days</td>
<td>1.5 days</td>
<td>0</td>
<td>4.5 days</td>
<td>8 days</td>
<td>30</td>
</tr>
<tr>
<td><strong>With Leveling</strong></td>
<td>1.5 days</td>
<td>1 day</td>
<td>0</td>
<td>2 days</td>
<td>4.5 days</td>
<td>53</td>
</tr>
</tbody>
</table>
Recap

• Kanban cards are used to provide an instruction that regulates the sequence and timing of production.

• When calculating takt time do not include lunches, breaks, machine downtime, and any other unavailable production time.

• Pitch is a consistent increment of schedule used to level production volume and help detect production abnormalities at a pacemaker process

• Finished goods supermarket can be utilized to help maintain a level volume of pacemaker work even when customer demand rises and falls.
Team Tips

Future State Mapping

1. MAPPING THE FUTURE STATE:
   - Use the list of future state questions.
   - Begin by drawing on copies of your current state map.
   - Then draw a future state map.

2. PRESENTING YOUR FUTURE STATE MAP:
   - Present from your future state map
   - Explain the following, including your rationale:
     - Takt?
     - Build to order or supermarket?
     - Where will you flow, where do you need to pull?
     - What is the pacemaker process?
     - What is the schedule point and pitch?
     - Will you level the assembly mix?
     - Are supporting improvements necessary?
     - Resulting lead time improvement
Think Good Flow (5S)

• Small
  – Keep equipment footprint small
  – Don’t overbuild equipment, keep to the basics

• Simple
  – Standard method must be easily understood
  – Equipment setup and operation is easily maintained

• Smooth
  – Don’t design in unnecessary WIP
  – Manage to the takt time
  – Target one piece being processed

• Short
  – Maximize Manufacturing Cycle Time, reduce lead-time
  – Eliminate Non-valued added operations

• Stabile
  – Implement operator training, simple instructions
  – Utilize Total Productive Maintenance
  – Insist on Quality at the Source
Manufacturing Cycle Efficiency

Cycle Efficiency is measured as the amount of value added time in a process divided by the total lead time. It can be used to gauge the potential for cost reductions.

\[
\text{Manufacturing Cycle Efficiency} = \frac{\text{Value-Added Time}}{\text{Total Lead Time}}
\]

**Stretch Objective:** A Lean process is one in which the value-added time in the process is more than 25% of the total lead time of that process. Improvements in Cycle Efficiency will result in:

- Reduction in quality costs
- Shorter lead times increasing process flexibility
- Less inventory, reducing storage cost and increasing inventory turns
- Elimination of wastes due to scrap and repair resulting in improved manufacturing overhead cost

**Where:** Cycle Efficiency should be collected at the end of the process.

**When:** Cycle Efficiency should be collected and used, at minimum, semi-annually. When a project or kaizen has been implemented to set a new baseline, or when projects are being evaluated for cost reduction potential.
Manufacturing Cycle Efficiency Calculation

Manufacturing Cycle Efficiency = \frac{\text{Value-Added Time}}{\text{Total Lead Time}}

Value added time = 3 hours
Total lead time = 96 hours (12, 8 hour days)

Manufacturing Cycle Efficiency = \frac{3}{96} = 3.125 %

Process Cycle Efficiency = 3.125 %
Process Lead Time can be estimated by:

Process Lead Time = \frac{\text{Number of “Things” in Process (WIP)}}{\text{Completions per Hour}}

Typical and world-class cycle efficiencies

<table>
<thead>
<tr>
<th>Application</th>
<th>Typical</th>
<th>World-Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machining</td>
<td>1%</td>
<td>20%</td>
</tr>
<tr>
<td>Fabrication</td>
<td>10%</td>
<td>25%</td>
</tr>
<tr>
<td>Assembly</td>
<td>15%</td>
<td>35%</td>
</tr>
<tr>
<td>Continuous Manufacturing</td>
<td>30%</td>
<td>80%</td>
</tr>
<tr>
<td>Business Process - Transactional</td>
<td>10%</td>
<td>50%</td>
</tr>
<tr>
<td>Business Process- Creative/Cognitive</td>
<td>5%</td>
<td>25%</td>
</tr>
</tbody>
</table>
A Plan to Get There

- *Don’t Wait!*

- *To “manage the exceptions” you need a plan!*
  1. Tie it to business objectives.
  2. Break your future state into “loops”.
  4. Now relate the FS Map to your layout.
  5. VS Manager completes VS Review form in advance.
  6. Conduct VS Reviews walking the flow.
## Yearly Value Stream Plan

### Product Family Business Objective

**Improving profitability in steering brackets**

### Value Stream Loop 1: Production

<table>
<thead>
<tr>
<th>Objective</th>
<th>Goal (measurable)</th>
<th>2000 Monthly Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>continuous flow from weld-assembly</em></td>
<td>zero wip</td>
<td>12</td>
</tr>
<tr>
<td><em>kalzen to 165 sec.</em></td>
<td>≤ 165 sec</td>
<td>11</td>
</tr>
<tr>
<td><em>eliminate weld o/c</em></td>
<td>&lt; 80° c/o</td>
<td>10</td>
</tr>
<tr>
<td><em>uptime welder #2</em></td>
<td>100%</td>
<td>9</td>
</tr>
<tr>
<td><em>finished goodie pull</em></td>
<td>2 days FG + pull schedule</td>
<td>8</td>
</tr>
<tr>
<td><em>material handler route</em></td>
<td></td>
<td>7</td>
</tr>
</tbody>
</table>

### Value Stream Loop 2: Stamping

<table>
<thead>
<tr>
<th>Objective</th>
<th>Goal (measurable)</th>
<th>2000 Monthly Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>stamping pull</em></td>
<td>1 day inventory + pull schedule</td>
<td>12</td>
</tr>
<tr>
<td><em>stamping changeover</em></td>
<td>batch size</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>300/160 pcs</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>o/c &lt; 10 min</td>
<td>9</td>
</tr>
</tbody>
</table>

### Value Stream Loop 3: Supplier

<table>
<thead>
<tr>
<th>Objective</th>
<th>Goal (measurable)</th>
<th>2000 Monthly Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>pull for coils with daily delivery</em></td>
<td>daily delivery &amp; ≤ 1.5 days of coils at press</td>
<td>12</td>
</tr>
</tbody>
</table>

**Product Family:** Steering Brackets
Implementation via Point Kaizen

Future State Map

Value Stream Manager

Point Kaizen
Value Stream Mapping

- Helps you visualize more than the single process level
- Links the material and information flows
- Provides a common language
- Provides a blueprint for implementation
- More useful than quantitative tools
- Ties together lean concepts and techniques

Stamping .......... welding .......... assembly .........
Seeing The Whole
(mapping the extended value stream)

When you have learned to see value streams in individual facilities, it’s time to see and then to optimize entire value streams, from raw materials to customer.
Acknowledgements

• Lean Enterprise Institute (LEI)
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  – Mike Rother
  – John Shook
Questions?

NISCO
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Thanks For Your Attendance