TWI Summit

June 5-6, 2007

Bottom Line Impact of JI:

5-Year Case Study

June 6, 2007

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Session Outline

- Lean Activities before TWI
- ESCO Strategic Planning Process
- Strategy Map
- The Role of TWI JI Training
- ESCO Approach is The TOYOTA Way
- Results Achieved
- Standard Work Lessons from ESCO
- Questions

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ESCO®
Turbine Technologies

- ESCO is a network of companies and alliances specializing in challenging production that requires exotic alloys or complex geometries which are used in the aerospace and industrial gas turbine markets.
- Produce and source from global locations including the United States, Mexico, Western Europe, Eastern Europe, China and India.

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Investment Casting Business Climate

- Customers are very large i.e., General Electric, Siemens-Westinghouse, Solar Turbines, Rolls Royce, Pratt & Whitney.
- There is enormous price pressure. Some customers are demanding reductions in the price they pay for our products 6% to 12% immediately and 3% per year for the next 3 years.
- Customers looking to offshore / low cost poles to source product.

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Lean History of the Plant Before Strategic Planning

- Cellular Manufacturing
  - Remove the Departmental “Silos”.
- Kaizen
  - A Continuous Improvement philosophy of “change for the better”
- Synchronous Manufacturing
  - Constraint Management
- Six Sigma
  - Addressing inconsistencies in the process with improvements driven and supported by data.

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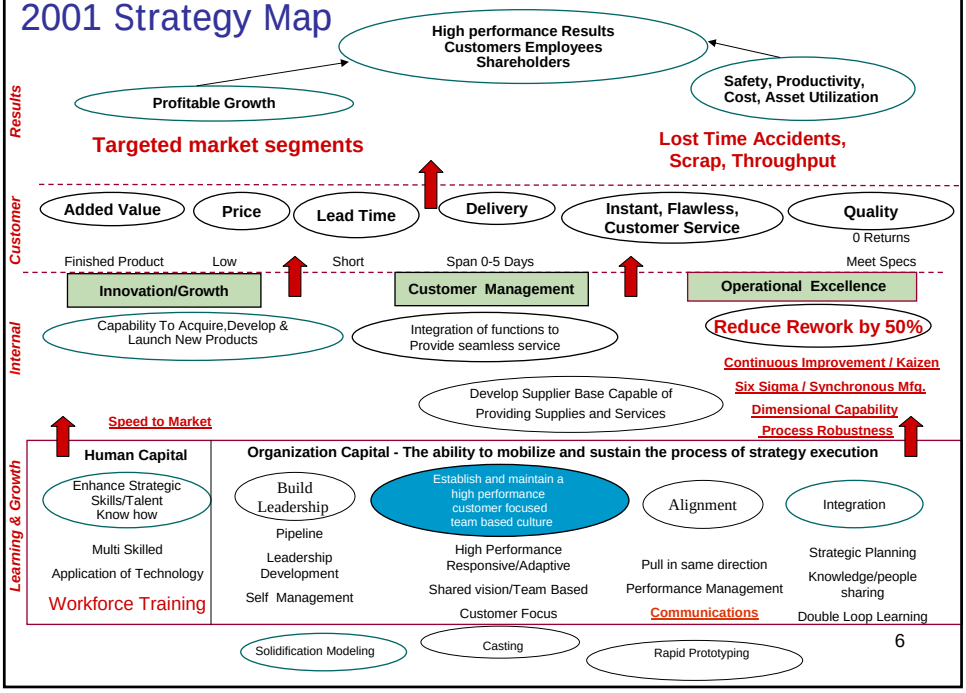
2001 Strategy Map



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Strategic Objectives

- Reduce inventory
- Increase speed of flow
- Decrease lead time for the customer
- Improve ability to take drop in orders for the replacement parts market

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Strategic Job Family: Wax Mold Assy.

Analysis:

> On-time release from Wax Dept. averaged 73% in 2002.
> Significant variability in techniques used by assemblers.
> Significant defects in the initial completed molds.
> Rework increased cost and slowed the flow of work.

Action:

Identify competency constraints *(combination of skills, know how, and process)* which were impacting on our ability to deliver our customer value proposition.

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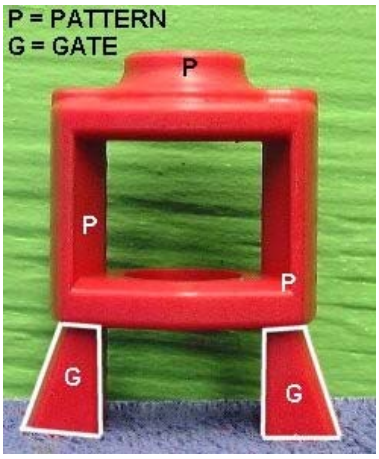
Quality Begins in the Wax Department



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Approach to Training Not Effective

Employees were either being trained

- Utilizing the buddy technique, or
- Assigning one of our best employees to train the new employee

The company searched for a repeatable and verifiable method for training and found what they had been looking for in the TWI Job Instruction (JI) Program.

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TWI
Training Within Industry

Job Instruction Training (JI)

How to teach people to quickly learn to do a job

correctly,

safely, and

conscientiously.

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Standard Training Format

No. _____

JOB INSTRUCTION BREAKDOWN SHEET

Operation: _____

Parts: _____

Tools & Materials: _____

IMPORTANT STEPS	KEY POINTS	REASONS
A logical segment of the operation when something happens to advance the work.	Anything in a step that might— 1.Make or break the job 2.Injure the worker 3.Make the work easier to do, i.e. "knack", "trick", special timing, bit of special information	Reasons for each key point

12

Repeatable Format

Important Steps

What

A logical segment of the operation when something happens to advance the work.

Putting a new blade in hack saw.

Key Points

How

Anything in a step that might—

- Make or break the job
- Injure the worker
- Make the work easier to do, i.e. “knack”, “trick”, special timing, bit of special information, etc.

That 5 or 10% of a the hard or tricky parts of a job.

Reasons

Why

The reason for each Key Point

People learn better when they know why they do things.

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Verifiable Element

Step 1 - Prepare the Worker

Step 2 - Present the Operation

Step 3 – Try out Performance

Step 4 - Follow-up

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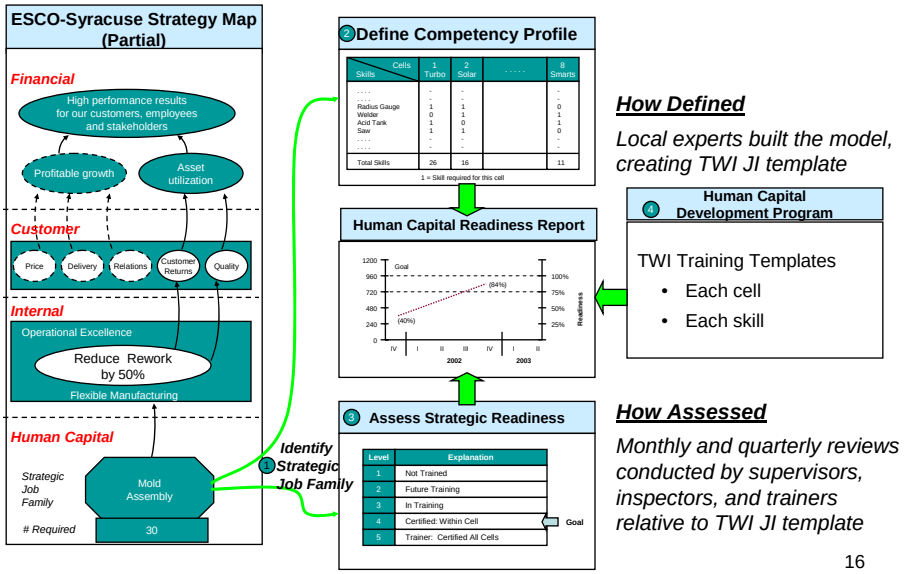
JI Training Timetable

Name: Jones Dept.: 2nd Electrical Dept. Date: (today's date)	Breakdown No.	Smith	Lark	Morse	Taylor	Massy	Peters	Baker		Changes In Production
Assembling Parts		✓	✓	✓	✓		✓	✓		
Wiring		✓	✓	✓	✓					
Combining		✓	✓	✓		✓	✓			
Knot tying	123	✓	✓	✓	✓	✓		X/X		Need 1 more worker at end of (month).
Clamping		✓	✓	✓	★ x/x	✓	✓			
Adjustment		✓	X/X	✓						
Turnover Work Performance				Scheduled to retire on xx/xx	Needs more training					

Human Capital Readiness Program



How Defined

Local experts built the model, creating TWI JI template

How Assessed

Monthly and quarterly reviews conducted by supervisors, inspectors, and trainers relative to TWI JI template

Competency Profiles for Mold Assembly

2 Define Competency Profile

Skills \ Cells	1 Turbo	2 Solar	. . . . .	8 Small Parts
. . . .	-	-		-
Radius Gauge	1	1		0
Welder	0	1		1
Acid Tank	1	0		1
Saw	1	1		0
. . . .	-	-		-
. . . .	-	-		-
Total Skills	26	16		11

1 = Skill required for this cell

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Record Progress

3 Assess Strategic Readiness

Level	Explanation
1	Not Trained
2	Future Training
3	In Training
4	Certified: Within Cell
5	Trainer: Certified All Cells

Goal

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Development a Plan to Close Gaps

Human Capital Development Program

4

TWI Training Templates

- Each Skill
- Each Cell
- Within Cells
- Within Departments

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Audit Process to Sustain Training

- Random audits using the JI breakdown once an employee has been trained on a job.
- Operators are qualified by element after passing six consecutive audits on that element.
- Goal is to qualify all employees in the elements common for all lines and then qualify people for jobs within a line.
- Once they are qualified within a line, training continues with the goal for all people in the department to become qualified in all lines.
- Cross functional training between departments.

Benefit: Maximum flexibility for production to move employees as required by customer demand.

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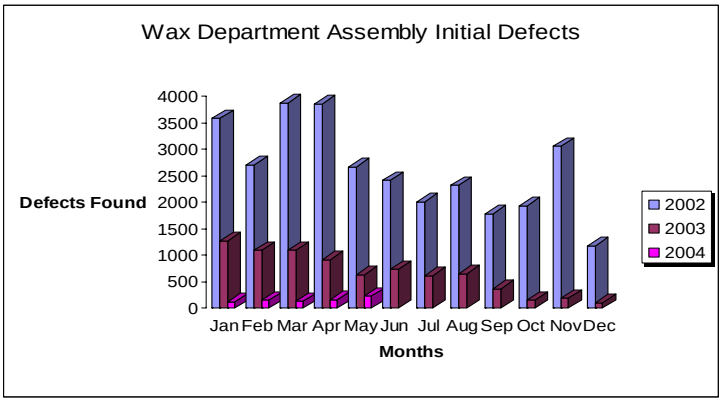
Impact on Bottom Line: Reduced Rework



2003 vs. 2002	75% reduction
2004 vs. 2003	83% reduction
2004 vs. 2002	96% reduction

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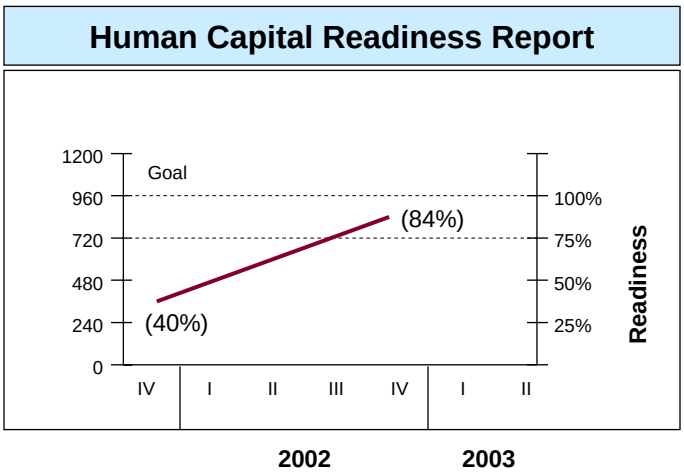
Increased Readiness



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Improved Mold Release Time

Average On-Time Release Shot Up

2002 - 73.0%
2003 - 89.5%
2004 - 98.6%

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Other Outcomes

Training Time went from	2 mos. to 2 weeks
Cycle time reduction	64%
Inventory reduction	50%
On time delivery improvement	80%

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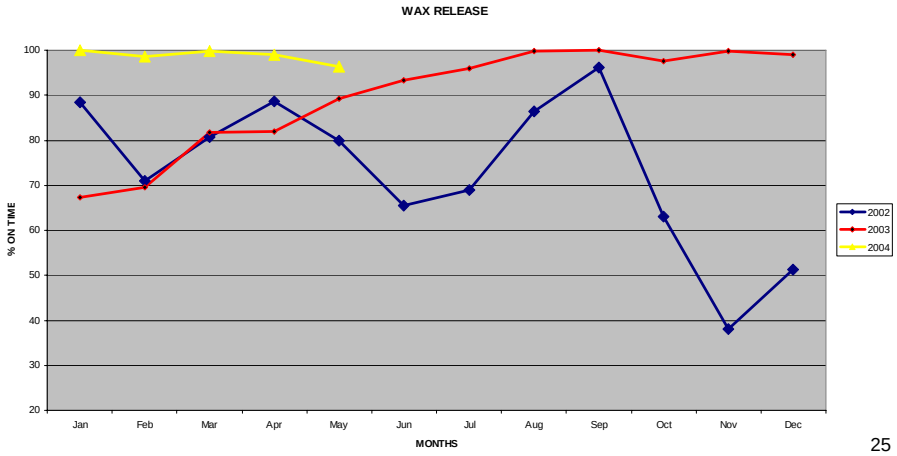
Stabilized the Wax Process

Significant leveling of month to month
Variability of On-Time Release of Molds



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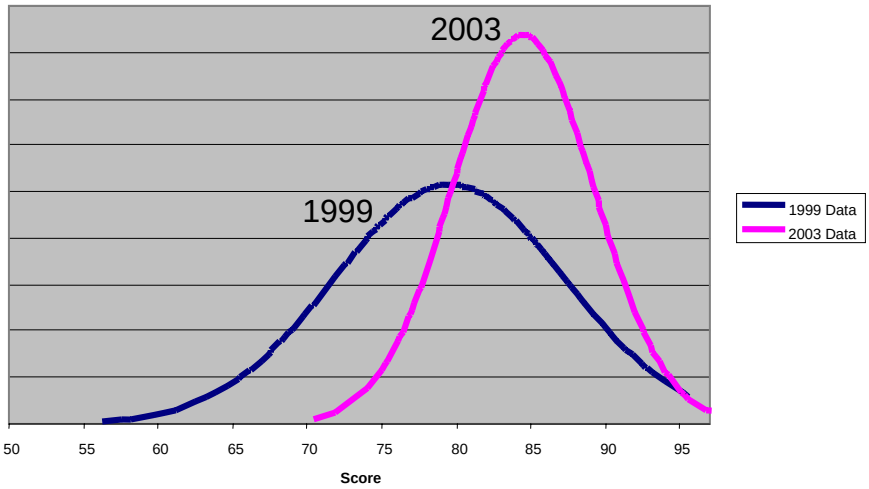
Surprising Outcome

Significant Improvement in Performance Reviews



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Dedicated Wax Training Area Today

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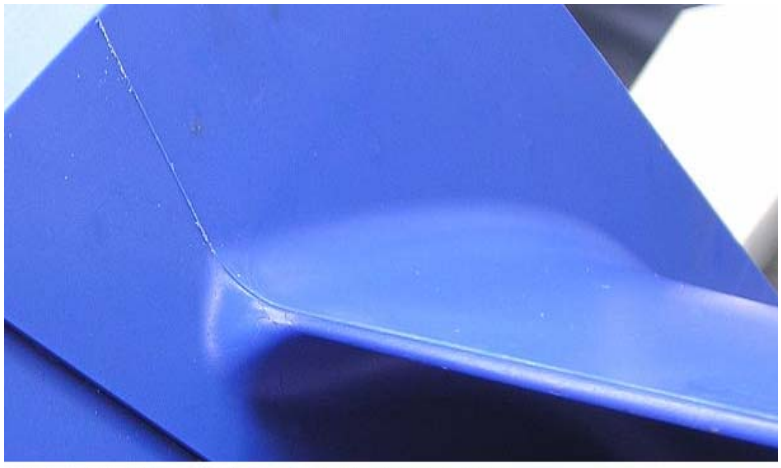
Wax Defect - Parting Line



Wax Parting Line - A positive, seam like in appearance.

Cause - Seperation of the pattern die.

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Wax Department Tools

Waxroom Trim and Assembly Tools

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Relationship Between Internal Method Sheet (IMS) and Job Instruction Training (JI)

The IMS - provides the customer specification

Does not specify the techniques for using the tools.

The JI Breakdown

Is used to teach the safe and proper use of the tools and the techniques to meet customer specifications.

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Wax Trim Internal Method Sheet (IMS)

ALLOWABLE:

POSITIVES: ___NONE ALLOWED_____
NEGATIVES: ___NONE ALLOWED_____
MISMATCH: ___NONE ALLOWED_____
FLOW LINES: ___NONE ALLOWED_____
PARTING LINES: ___NONE ALLOWED_____
INJECTION FEED HEIGHT:_____

NOTE: PATTERNS MUST BE X-RAYED 100% BEFORE ASSEMBLY - Do not set patterns up unless X-ray is complete and results are in!

TRIMMING COMPONENTS:

1. Injected patterns 10
2. S-355 (GATE) 10

TRIMMING:

1. No nicks, cracks, through defects, flash, air bubbles, or non-fill allowed, unless otherwise
   specified. (CAUTION: Scotch bright lines must be filled in)
2. Shellac core,**(3) heavy coats**, trim after tabs and fill in holes.
3. Fill in (5) chaplet holes and slot with hot wax and trim flush.

(Be sure holes are not negative).

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Wax Trim Job Instruction Sheet (JI)

No. ASSM -15
Rev.1

Job Instruction Breakdown Sheet (JI)

Title: trim flash and parting lines

Part: all

Tools and Materials: pattern, pick, air hose, paper towel

STEP NO.	IMPORTANT STEPS	KEY POINTS	REASONS
1	remove flash/parting line	1.lightly with flat side of pick 2.one direction starting and stopping in the same spot 3.away from you 4.over paper towel	1.prevent gouging pattern 2.prevent over trimming 3.Safety 4.keep flash off piece
2	blow off pattern	1.air hose 2.one piece at a time	1.free of debris 2.prevent damage of pattern
3	inspect	1.visually	1.Scratching 2.Negatives
			3.radius
4	place pattern back on tray	1.same way you took it off	1.dimensional

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JI Expands from Wax

Metal End, Coating, and Foundry

- TWI incorporated into new employee training
- Competency profiles are maintained for all employees within flow lines.
- Cross-functional training between lines
- Cross-functional training between departments.
- Training maintains a plant wide training matrix.
- TWI Trainers audit, train and retrain on a continuing basis through the Team Leaders.

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Different Skills for Metal End Repair

Basic Visual Categories:

Blending Discrete Negatives

Blending Positives

Blending Trailing and Leading Edge

Identifying Stones, Belts, Discs

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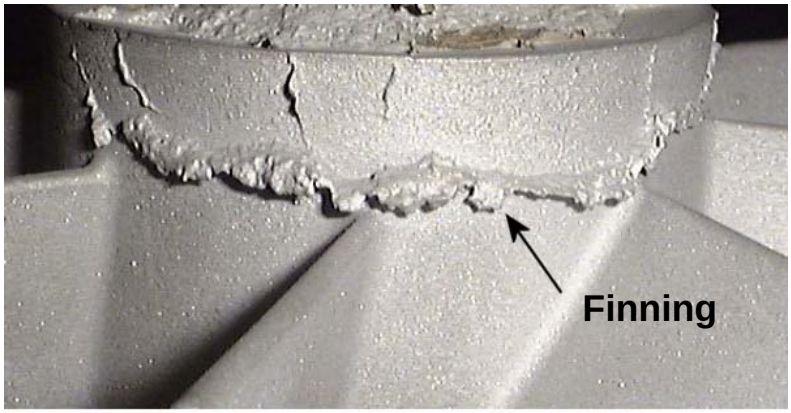
Metal End Defect



Finning - A thin positive line of metal

Cause - Formed as a result of shell splitting.

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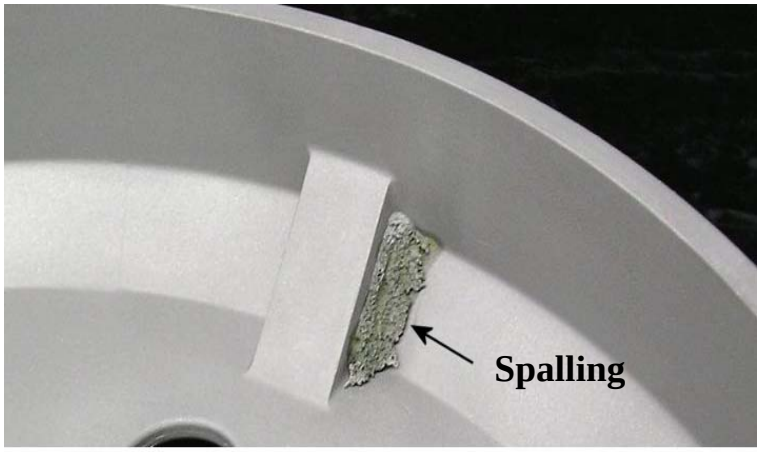
Metal End Defect



Spalling - Appears as a positive, often in a corner or slot.

Cause - Lack of inner coat adhesion during shelling allowing chips to break off and redeposited in another location on the casting.

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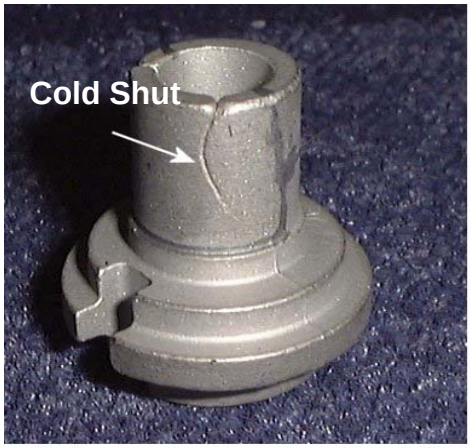
Metal End Defect



Cold Shut - Intermittent or continuous linear indication formed where two streams of metal meet and do not fuse.

Cause - Oxide films or dirt on the surface of the metal streams during solidification (low mold, metal temperatures, slow pour).

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Training Delivery Approach

- Team leaders deliver training in Wax area

  These people also have an assigned job in the Wax area

- Dedicated TWI trainers deliver training for the team leaders in the Metal end

  These people never worked in the Metal End

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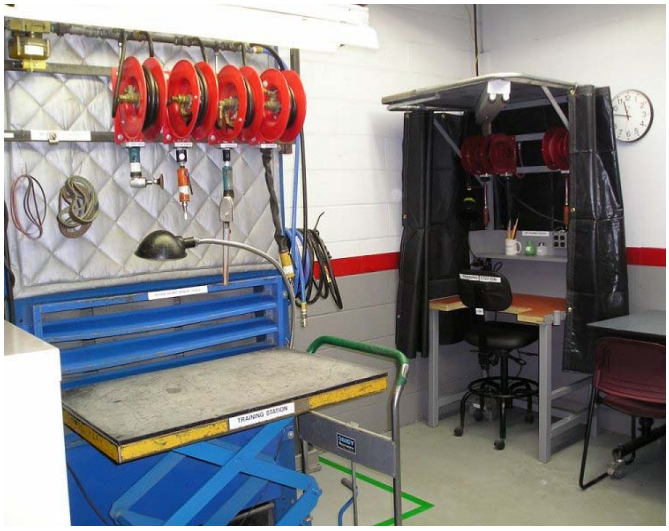
Dedicated Metal End Training Area

Blending Stations



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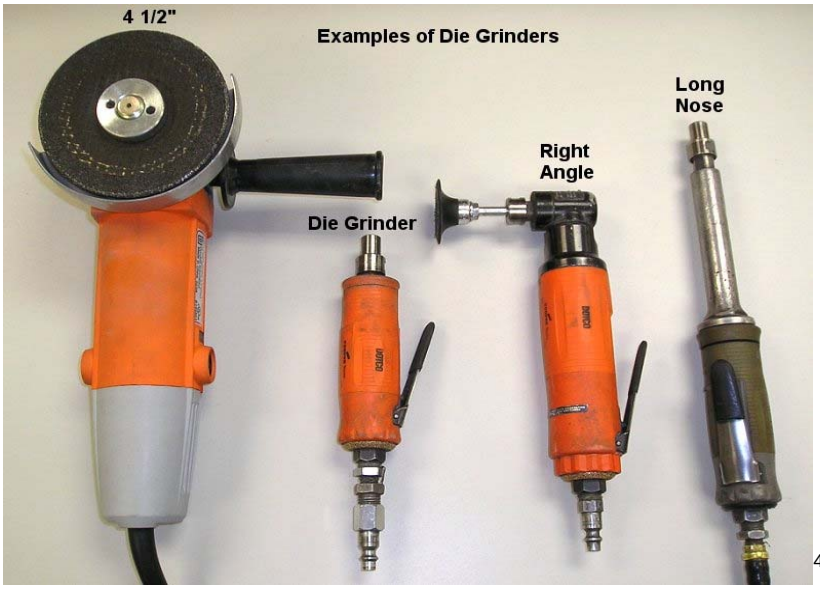
Metal End Visual Tools



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Die Grinder Accessories

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Metal End Visual IMS

VISUAL INSPECTION (rough before hip)
Perform complete visual inspection in accordance with requirements listed below.
All castings shall be sent to HIP.

SPECIFICATIONS:
1) No cracks, cold shuts, porosity, or linear defects permitted.

2) Positives:
a.) Any positives up to .005 high are permitted.
b.) Between .005 and .032 high, maximum of five (5) & in a two (2) inch square (4 square inches) area.
c.) Parting lines and gates: .015 max.
d.) Local positive material a max. of .060 high is permitted in areas to be machined (reference sketch). Except for core flash at throat area, flash must be .020 max. high.
e.) Positive metal up to .020 high (due to core chaplets) permitted where shown on sketch. If it is necessary to blend these areas, then a soft stone must be used. Do Not Over Blend!

3) Negatives:
a.) Negatives less than .015 long permitted with a minimum separation of 3X the maximum indication.
b.) Negatives up to .032 long permitted with a minimum separation of .096.
c.) Any negative which will be completely removed by machining is permitted. (reference machine stock sketch or machined part)

4) No welding in throat area.

5) Do not over blend throat area. .060 minimum wall thickness must be maintained. Measure all castings (reference sketch).

6) Use boroscope to inspect core passage 100% for broken cores and any core residue.
REFERENCE WELD TECHNIQUE AS REQUIRED.
NOTE: All welded/blended areas must be verified to ensure dimensions are within B/P limits.

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No. Blend-1 (Sm. I & II)

JOB BREAKDOWN SHEET

Operation: BLENDING DISCRETE POSITIVES
Parts:
Tools & Materials: Die Grinder/White stone, Dynabrade 80 Grit, Casting, IMS

IMPORTANT STEPS	KEY POINTS	REASONS
A logical segment of the operation when something happens to advance the work.	Anything in a step that might— 1. Make or break the job 2. Injure the worker 3. Make the work easier to do, i.e. "knack", "trick", special timing, bit of special information	Reasons for the key points
1. Position Casting	1. Defect visible	1. Avoid overwork
2. Select Tool For Area	1. Die grinder/white stone 2. Dynabrade/80 grit	1. Minimizes to acceptable defect 2. Minimizes to acceptable defect
3. Blend	1. On top of defect 2. Constant back & forth motion 3. To acceptable limit	1. Proper starting point 2. Smooth transition 3. Dimensional quality

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Metal End Trainee

Technique and Tool Use Training for Blending a Positive

Job Instruction Audit Sheet

ESCO Turbine Technologies – Syracuse

Employee Name: Date:

JI: Quick Check Basics

( ) Not Acceptable ( ) Acceptable

Comments Identified :

Employee Signature:

Trainer Signature :

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Auditing A Trainee

Identifying Defects

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Defect Identification Survey

Defect Identification Survey

Employee:_____
Date:_____

____Pre-Survey ____Post-Survey

Spaces are provided below for identification of 10 different defects. The defect number of the casting is shown in the left column. Enter your determination of what the defect is in the adjacent column.

Pre & Post Training is Part of the Audit

Defect No.	In the space provided below, write what you would call this condition.
#6	
#8	
#9	
#10	
#13	
#14	
#15	
#16	
#19	
#30	

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Defect Identification Questionnaire

DEFECT TRAINING QUESTIONNAIRE

Name_____ Shift_____

Directions: Circle correct answer

1. Removal of positives or negatives within customer specification or blueprint limits is called?
   A. Benching
   B. Blending
   C. Dressing
   D. All of the above

2. What is a surface depression that is created in wax that normally has rounded edges, corners and bottom?
   A. Blowhole
   B. Cluster
   C. Discernible
   D. Wax Wall Check Marks

3. What is metal removed below the surface at the cut-off operation?
   A. Defect
   B. Fillet
   C. Cut Off Damage
   D. None of the above

4. What is a thin positive line of metal formed as a result of shell splitting?
   A. Metal Fin
   B. Parting Line
   C. Imperfection
   D. Mismatch

5. What is a crack-like indication at least 3:1. (3 times longer than it is wide)?
   A. Cold Shut
   B. Linear Defect
   C. Gas Hole
   D. Piping

6. What is a positive but, can be a negative seam line, caused by separation of wax die cavity inserts?
   A. Parting Line
   B. Indication
   C. Thru Porosity
   D. All of the above

7. What is raised metal on the surface?
   A. Pitting
   B. Cavitiy
   C. Flow Line
   D. Positives

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Results of Defect Audits & Training

Categories	Improvement
– Casting Configuration	**44%**
– Defect Identification	**67%**
– Quick Check Basics	**79%**
– Quick Check Advanced	**25%**

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JI Training = Win/Win

Productivity

Although the tools and skills for these areas are dramatically different, cross-trained employees are now assigned based on the production schedule for a given day.

Employee Satisfaction

Employees voluntarily move between departments just for a change of pace and to maintain their overall skills.

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JM Improvement Proposal Sheet

Submitted to: Fred Hanba
Made by: Vicki Holdridge & Colleen Mills
Department: Wax
Product/Part: **Date**: 1/4/07
Operations: Applying Alloy Code to gates

Proposed Improvement: Have alloy code injected onto gates.

Before Improvement: One person 240 seconds (4 min.) per mold
After Improvement: One person 10 seconds per mold

Content:

Employees will no longer have to walk to embosser, print cards, cut up alloy codes, use welder and inspect. Also avoids defects from wrong alloy codes being applied.

Savings: 230 seconds per mold (3.83 min.)
230 x annual run = annual savings

Special thanks to Fred Hanba for his assistance.

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TWI
Training Within Industry

The three TWI programs work together like a three-legged stool — take one leg away and the stool falls down.

- JR – Positive Environment
- JI – Stable Processes
- JM – Continuous Improvement

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A Review of the ESCO/TWI Timeline

August 2001	Balanced Scorecard Strategy Mapping identifies need for employee training
September 2001	ESCO people attend TWI JM pilot
March 2002	ESCO people attend JI and JR pilots
July 2002	TDO/Patrick Graupp trains 3 ESCO trainers on how to deliver TWI programs to train people in the Wax Department in order to meet strategic objectives to reduce inventory, increase speed of flow, and decrease lead time necessary to compete in replacements market.
April 2005	Initial goals are met. Implement Lean.
May 2006	Implement JI training plant wide.
2007	JM is introduced.

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2001 – Lean Reveals Opportunities

In order to take maximum advantage of the flexible synchronous management principles that were already in use in the back end of the production process, the company reorganized the wax area into the same flow lines as in the finishing area.

This revealed a significant opportunity to reduce initial wax defects.

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2002 - Strategic Planning Reveals a Need

It would be necessary for the Wax Department to reduce Rework by at least 50% to eliminate the bottleneck at the front end of the investment casting process.

Utilizing the buddy technique, or assigning best employees to train the new employees was not working.

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2002 – Introduced JI in Wax

Identified skills requirements for each cell.

The simplest cell in Wax required 11 different activities, while the most complex cell required 27.

- Determine which jobs were common to all cells.
- Define a competency profile for each job in each cell.
- Create JI Breakdowns for all jobs within cells jobs.
- Assess levels of competency for each person in performing all jobs within their cell.
- Implemented training plan.

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2005 – Impact of JI at ESCO

The TWI Job Instruction program was recognized by management for its contribution to this plant becoming the first and only recipient to date of the prestigious Platinum Supplier Award from the Dallas, Texas based Lockheed Martin Missiles and Fire Control division at a public award ceremony in Chittenango, NY on June 21, 2005.

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The TOYOTA WAY/TWI Connection

"The Toyota Way of going to the source, observing in detail, and learning by doing were all very much influenced by TWI and became the backbone of Toyota's standardization philosophy…..

the belief that the way to learn about industrial engineering methods was through application on the shop floor and that standardized work should be a cooperative effort between the foreman and the worker." *

The Toyota Way, Jeffrey K. Liker 2004, pg. 141

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The TOYOTA Fieldbook/TWI Connection

- Standard work is lacking when “the amount of time it takes to perform a given process varies tremendously from person to person, across shifts, or over time.”
- “The first step in creating lean processes is to achieve a basic level of process stability.”
- “The initial level of stability is generally defined as the capability to produce consistent results some minimum percentage of the time.”
- “A simpler indicator *(of process stability)* would be the ability to meet customer requirements with quality products the first time through on time (again, 80 percent or better)”. *

* *The TOYOTA WAY Fieldbook*, Jeffrey Liker and David Meier, 2006, pg. 56

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The TOYOTA Way Fieldbook (2006)

Standard work is lacking when “the amount of time it takes to perform a given process varies tremendously from person to person, across shifts, or over time.” pg56

ESCO (2002 - 2005)

- Significant variability in techniques used by assemblers.
- On-time release from Wax Dept. averaged 73% in 2002.
- Significant defects in the initial completed molds.
- Rework increased cost and slowed the flow of work.

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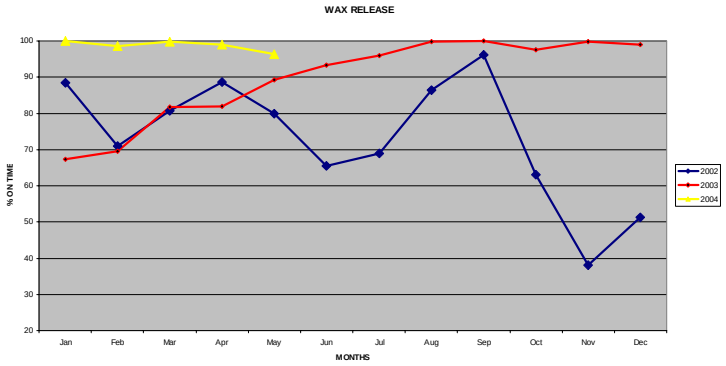
The TOYOTA Way Fieldbook (2006)

"The first step in creating lean processes is to achieve a basic level of process stability." pg 56

ESCO (2002 - 2004)

Significant leveling of month to month on-time release of wax molds



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The TOYOTA Way Fieldbook (2006)

"The initial level of stability is generally defined as the capability to produce consistent results some minimum percentage of the time." pg 56

ESCO (2002 - 2007)

Average On-Time Release of Molds from Wax

2002 - 2004 from 73% to 98.6%

2005 - 2007 98 - 99% maintained

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The TOYOTA Way Fieldbook (2006)

"A simpler indicator *(of process stability)* would be the ability to meet customer requirements with quality products the first time through on time (again, 80 percent or better)". pg 56

ESCO (2002 - 2005)

- Reduced Rework by 96%
- Shipped 25% more product with the same number of people.
- Customer on time delivery improved 80%

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ESCO and TOYOTA TALENT

Jeffrey K. Liker and David Meier, 2007

- "The three steps of the talent development process—determine what is important to teach, teach it, and then verify that learning occurred—will be repeated continually as new work methods are developed or as new processes are introduced." Pg 60
- "You must understand the organization. Develop an organization structure for training, develop plans for who will be trained and developed, and select and develop the trainers themselves." pg 54
- "Don't make the mistake of developing a Job Instruction course, sending people to it, and then expecting them to be 'trainers'. In the Job Instruction method the follow-up phase of the training is crucial to the overall success." pg 43
- "By focusing efforts where they yield the greatest benefit and adhering tightly to the most important aspects of the work, Toyota is able to consistently produce great results." pg 114
- "…it is not possible to operate a lean system without highly capable people, and without a lean system it is not mandatory to develop highly capable people who can continuously improve the system." pg 21

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Questions

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