

CREATING A WORLD CLASS SAFETY CULTURE

PART II: LESSONS LEARNED FROM INDUSTRIAL ACCIDENTS

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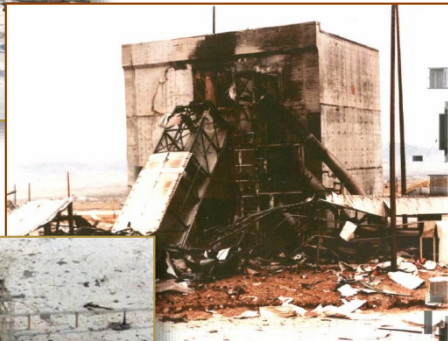
**Reference:*

**“Creating a World Class Safety Culture:
Lessons Learned from Launch Vehicle Failures
and Industrial Accidents”**

Stan Graves, Senior Director, Orbital ATK
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INDUSTRIAL MISHAPS: AN UNFORGIVING BUSINESS



Common Root Causes

- Inadequate process definition
- Inadequate physics-based understanding of hazardous processes
- Inadequate process control and change control
- Failure to communicate the engineering intent (what and why)
- Technical staff didn't really understand what was happening on the shop floor
- Failure to follow procedures
- Failure to stop work when an unusual condition is encountered
- Unauthorized work-arounds
- Lack of management involvement
- Inattention
- Lack of discipline

Draining the Swamps

After working failure investigations for several fires or explosions, *I became convinced that I could write the findings for all future accidents*

Causes of the accidents were readily apparent within 2 days of the accident

If these causes are apparent after the fact, what can we do to see the issues and take preventative measures before an accident occurs?

Error Management: Key Concepts*

- Unlike unsafe acts, whose specific forms are often hard to foresee, unsafe *latent conditions can be identified and remedied before an adverse event occurs*
- *Mishaps are like mosquitoes. It is pointless to deal with them one by one; others simply appear in their place. The *only long-term solution is to drain the swamps* in which they breed - that is to attack the latent unsafe conditions.*

*Source: James Reason, Managing the Risks of Organizational Accidents, 1997.

ELEMENTS OF SAFETY MANAGEMENT*

"Swamps"

1. Process definition and control
2. Change control
3. Procedural discipline
4. Culture to stop work when unusual conditions encountered
5. Innovation management
6. Leadership involvement
7. FOD control
8. Technical excellence and oversight
9. Schedule discipline

- ### Improvement Recipe:
1. Learn from incidents
 2. Shore up defenses
 3. Minimize hazards
 4. Train and motivate the work force
 5. Develop **proactive initiatives** to *"drain the swamps"*

"Swamps"
Systems and Culture Issues

Identify Initiatives

Measure and Control

Incidents

(Cause/Corrective Action)

Process Variation

Operator Error

Hazards

Minimize

Train and Motivate



Defenses

Our Traditional Safety Program

Learn From

*Adapted from James Reason, "Managing the Risks of Organizational Accidents", Ashgate, 1997.

IDENTIFYING THE SWAMPS

	Swamp	Best Practice
Innovation	Technicians use their expertise to “figure it out” and solve problems on their own	Technicians work literally to approved written instructions. Innovative changes are encouraged, but managed via formal change control.
Process Definition and Control	Processes are loosely defined, “being developed”, or tribal knowledge not captured. Process variables not monitored.	Processes are defined, process limits established, off-nominal conditions identified, contingency plans available for process upsets. Critical process variables are defined, measured.
Change Control	Changes are made to “make it better” or “NO” change. Decisions based on judgment and expert opinion.	Changes are reviewed and approved by responsible leadership. “KNOW” change: controlled continuous improvement based on engineering data and analysis.
FOD Control	FOD control means following procedures. FOD control zones and requirements poorly defined.	Work team is passionate about FOD control everyday. Parts, tools, and equipment are accounted for, housekeeping is immaculate and 5S is platinum standard.
Culture to “Stop” at Unusual Events	“Unusual” events are common. Culture is to solve problems, when to stop unclear.	Off-nominal or unusual conditions apparent. Requirement to stop as a condition of employment clearly understood.
Frequency of Operations	Infrequent. Once a year or every other year.	Daily

IDENTIFYING THE SWAMPS

	Swamp	Best Practice
Technical Excellence and Oversight	Requirements are “tossed over the wall”. Engineers only come around after there is a problem.	Technical requirements are defined, translated in shop planning, and executed concurrently. Table Top reviews are the norm. Operators understand “what and why”, engineers <i>know</i> how requirements are met and verified.
Leadership Involvement	Leadership is on the road, in the office, or otherwise disengaged. Leaders not aware of what their people are doing or not available to help when needed.	Leadership has a floor presence. Standard work for leaders in place. Leaders are passionate about execution, excellence, and improvement.
Corrective Action	Program has no corrective action board, or board is focused on correcting individual defects.	Program has a formal corrective action board resolving repeat offenders and looking for systemic reforms.
Work Environment and Schedule Compliance	Panics, behind schedule, overtime, backlog. Late engineering. Late planning. Materials unavailable. Stuff happens.	“Cadence”. Takt Time. Flow. On schedule. Work planned and executed. Engineering, planning, materials, tooling, people ready when needed. PES embraced and implemented.
Discipline	Get the job done mentality, no matter what. Rules don’t apply in this situation. A short cut will save time and no one will know. No one listens to my needs.	Standards (planning, safety rules) are in place and followed. Risks understood. Operator concerns are addressed. Initiatives are in place to prevent and identify process creep.

IDENTIFYING THE SWAMPS

	Swamp	Best Practice
Application of “Rules in Use”	<p>Systems are complex</p> <p>Roles and responsibilities unclear</p> <p>Work is chaotic</p> <p>Backlogs are large</p> <p>Overtime is high</p>	<p>Work of each person is highly defined</p> <p>Defined process with no forks/loops</p> <p>Customer/supplier communications simple and visual</p> <p>Continuously improved to eliminate waste: help chain is poised to pounce</p>
Implementation of “Pull” system working to Takt	<p>Product produced in batches</p> <p>Materials are purchased to meet sales goals</p> <p>Problems age and are complex</p>	<p>Products produced 1 x 1 as needed by the customer</p> <p>Materials arrive just in time</p> <p>Problems are visible and solved at low levels</p>
Implementation of Standard Work	<p>Everyone does it different</p> <p>Problems are hard to recognize</p>	<p>Work is standardized to the best practice for Takt time, sequence, content, and expected outcome</p>
Organization and Orderliness	<p>Work place is cluttered with stuff you might need someday</p>	<p>Stuff is sorted, set to order, shined, and standardized to the 5S Platinum Standard</p>
Multi-skilled Workers	<p>Everyone is specialized. Things sit if key people are absent.</p>	<p>People are interchangeable. Products and services continue when team members are absent.</p>
Passion for Eliminating Waste	<p>Defects are common. Things and people are waiting in queue.</p>	<p>Defects are an abomination. Self-tests and error-proofing make defects impossible. Things and people are engaged in value added activities.</p>

“NORMAL ACCIDENTS”

Charles Perrow studied Three Mile Island. He was surprised to find that *the disaster resulted from a string of rather trivial things that had gone wrong; stuck valves, a balky pump, an obscured gauge, and an inaccurate sensor.*

All had gone wrong before with no ill effect

This time they occurred in just the right sequence to cause a nuclear disaster

When little things go wrong, people discover how to contain the problem using a variety of work-arounds, often showing great creativity

Perrow termed this a **Normal Accident** – so called because they arise in situations that seemed perfectly normal right up to the moment of failure

Core Melt Down March 28, 1979



1. **Blocked water filter** (common)
2. Standard repair – vacuum out blockage – failed. **Operators decided** to blow out debris with compressed air. (uncontrolled innovation)
3. Water got past a **stuck-open check valve** and into an instrument air line
4. Water caused **inaccurate sensor reading**, which caused primary **feed water pumps to stop**
5. A **stuck-open valve** allowed large amounts of nuclear reactor coolant to escape
6. A **hidden indicator light** led an operator to manually override the automatic emergency cooling system of the reactor
7. Three **auxiliary** pumps activated automatically. However, because the **valves** had been **closed for routine maintenance**, the system was unable to pump any water.

MIX BOWL CLEANING FIRE

Description of Event

- The fire occurred during the unattended removal of residual propellant from mix bowl
- “Doing the dishes” after the process is finished

Direct Cause

- Facility and process design allowed stainless steel galling of the bowl wall resulting in initiation of the propellant due to metal-to-metal contact



The mix bowl cleaning process had been routinely accomplished **without incident for well over 20 years**

- **Everything was perfectly “normal” right up to the moment of the fire**
 - Key personnel off to training class
 - Inexperienced team left to perform the process
 - Unclear work instructions
 - Work instructions on the shelf (GOP)
 - Process creep away from safety “goodness” (less solvent)
 - Process interruption
 - Poor machine design and safety controls
 - Poor physics-based understanding of process margins

How can we “see” these deficiencies before a mishap occurs?

Applying “Lean Principles” to Safety Mishaps

Lean Principles 101

<p>If I <u><i>correctly</i></u> do my:</p>	<p>Activity +</p>	<p><i>Content</i> <i>Sequence</i> <i>Timing</i> <i>Location</i></p>	<p>Then my <u><i>Outcome will</i></u> <u><i>be right.</i></u></p>
	<p>Connection +</p>	<p><i>Binary Request</i> <i>Binary Response</i></p>	
	<p>Pathway</p>	<p><i>Pre-specified</i> <i>Simple</i> <i>No intertwining</i> <i>No loops</i></p>	

Rules in Use*

- Work of each person is highly defined
- Specified processes with no forks/loops
- Customer/supplier communications simple and visual
- Continuously improved under the eye of an expert

*Steven Spear. *Decoding the DNA of the Toyota Production System*. Harvard Business Review, 1999

“When I learn that an **injury** has occurred, I “see” it through our *Rules in Use** -- using them as “*lenses*” to search for breaches in the system that could have contributed to the injury.”

“*The Alcoa Business System: Pathway to Performance*” G. Keith Turnbull. 2003.

Using the Rules-In-Use to Bring Focus to our Chaotic World



Ideal State Out of Focus

Normal Accidents:
 Everything was perfectly **“normal”** right up to the moment of the fire

- Key personnel off to training class
- Inexperienced team left to perform the process
- Unclear work instructions
- Work instructions on the shelf
- Process creep away from safety “goodness” (less solvent)
- Process interruption
- Poor machine design and safety controls
- Poor physics-based understanding of process margins
- Error prone

Use the “*Rules in Use*” as a *lens* to see clearly

- *Is the activity pre-defined in terms of content, sequence, and timing?*
- *Is the process pre-specified and simple?*
- *Are the outcomes pre-specified?*
- *Do we have built-in tests to assure the work is occurring as specified?*
- *Is the proper response to unexpected outcomes specified?*
- *Are the person-to-person or person-to-machine or person-to-processes clear in their requests and clear in their responses?*
- *If we encounter a problem, do we know when to stop?*
- *When problem solving, do we get help from an expert?*
- *Do we develop a hypothesis for our improvements and design a test to validate the changes?*

Ideal State Focused

Mix bowl fire corrective actions

(Easy to see after the fact.)

By using the *Rules-In-Use* as a lens, we could have taken these actions proactively:

- Process standardized and simplified
- Outcomes predefined
- Built-in tests to detect off-nominal conditions
- Process hazards defined based on physics
- Process controls defined and error proofed
 - Safety interlocks
 - Automated process
 - Electronic Shop Instruction controls
- Work crew and crew proficiency defined

LEAN PRINCIPLES FOR SAFETY AND LEARNING*

Every safety mishap has an opportunity to learn and improve.

No team can design a perfect system in advance, *but people can discover great systems and keep discovering how to make them better. Here's how:*

**“Chasing the Rabbit”*. Steven Spear. McGraw Hill. 2008

1. Capture existing best practices. No ambiguity.

- Make explicit the most effective approach that is currently known
 - Who does what work in what order
 - How products and information will flow from the person performing one step to the person performing the next step
 - What methods will be used to accomplish each piece of work

2. Specify in advance what outcomes are expected

- Makes it far easier to recognize when something unexpected has happened

3. Build in a test to detect failures when and where they occur

- Test failures illuminate gaps in our collective knowledge about how to succeed
- With pockets of ignorance identified, we know where to invest to get better

4. Swarm Problems to Build New Knowledge

- Detect problems in our systems at the time and place of their occurrence
 - Contain the problems before they have a chance to spread
 - Diagnose and treat their causes so the problems cannot recur
- Many problems occur because of some unexpected interaction of people, processes, products, places, and circumstances
- Swarming problems allows gathering of information that would otherwise be lost to fading memory and changing circumstances

5. Problems are solved using the scientific method in a disciplined fashion

- Hypothesis: What actions are expected to have what outcomes?
- Experimentation: Was I right or wrong?
- Method results in deeper knowledge of how our processes work (or don't work)

WHY THINGS THAT USED TO WORK DON'T

1. Program *assumes* it has mature and *stable* processes. **WRONG**

- *Stability is not a natural state: it has to be achieved and maintained*
- *A system will only remain stable by virtue of people's vigilance, knowledge, and effort*
- A few sources of instability:
 - Much of our process knowledge lies in the eyes, ears, hands, and minds of experienced operators, maintenance workers, and inspectors – tribal knowledge
 - Operators don't always understand the “why” of the design, and engineers don't always understand the “what” and “how” aspects of the process
 - Materials and processes creep
 - Our technical and program folks are distracted by customer needs

2. Planning is complex, cluttered, and does not follow actual process logically or sequentially

- Can't really read the planning word for word
- Procedures allow out of sequence processing

3. Complex, onerous change process

- *Operator*: “I need help.”
- *Engineer*: “We have a no change policy.” or “Change is hard.”
- *Operator*: “I'll figure something out.”

4. Late engineering and evolving requirements

- Insufficient time to “do it right”

5. Culture accepts errors

- Acceptable practice to have errors
- Errors happen: Just fix them

RISKS WITH OUR CHANGING WORK ENVIRONMENT

Our work is changing

- Commercial competition (good)
- Fewer people doing more and different things on a less frequent basis
- Senior people leaving the work force

Worries:

- Lots of new, inexperienced people
- Work team members may be inadequately trained for the new tasks or lack tribal knowledge of inherent process risks
- Work instructions may be incomplete or unclear
- Fewer independent eyes – inspectors, safety engineers, quality engineers, assessors, auditors

Risk Mitigation:

- Heavy emphasis on **process control** and **process readiness reviews**
- **Clearly defined process instructions: both *what* and *why***
- **Clearly defined critical process variables and with strong controls**
- ***Treat each process as if it were being conducted for the first time.***
- **Assure we can execute perfectly every time by having the**
 - ***Right people***
 - ***Right tooling***
 - ***Right process instructions***
 - ***Right materials***

SIX INITIATIVES TO CHANGE THE WORLD (A LITTLE)

Remember: *Mishaps are like mosquitoes.* It is pointless to deal with them one by one. Others simply appear in their place. The *only long term solution is to drain the swamps* in which they breed.

Translation. To improve safety performance and eliminate mishaps, **we have to change the current work environment.**

- Change how *people do their work*
- **Change how people think about their work**
- Create a stable, predictable factory
- ***Develop a learning culture*** that continually identifies problems and ***gets them fixed***

The following are examples of initiatives we have taken that fundamentally change the work environment

1. Product-focused engineering teams
2. Process system design
3. Clean slate planning
4. Critical process variable case studies
5. Ready now!
6. Challenge – response check lists

I. Product-Focused IPT

- Engineering and program technical resources focused on the factory floor
 - **Robust designs**
 - *Design for manufacturing and producibility*
 - *Critical design characteristics*
 - **Robust processes and process control**
 - *Process variables linked to key design characteristics with strong process controls*
 - *SPC, Cpk, DFMEA, PFMEA*
 - **Excellence in execution**
 - *Process stability, Lean Principles, error proofing, process readiness reviews*
 - *Requirements management: Communication from the design desk to the shop floor*
 - *Knowledge capture and management*

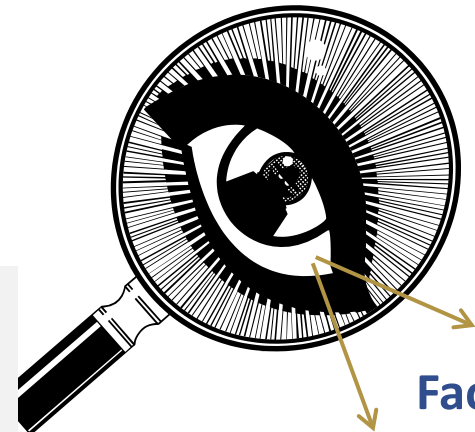
Customer



Only somewhat distracted by day-to-day customer demands

Product-Focused IPT

- Design Engineer
- Process Engineer
- Quality Engineer
- Supply Chain
- Operations



Factory & Suppliers

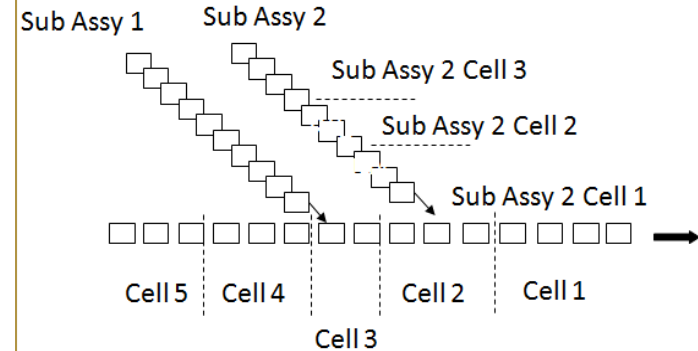
	Swamp	Best Practice
Technical Excellence and Oversight	Requirements are "tossed over the wall". Engineers only come around after there is a problem.	Technical requirements are defined, translated in shop planning, and executed concurrently. Table Top reviews are the norm. Operators understand "what and why", engineers <i>know</i> how requirements are met and verified.

2. Process System Design (PSD)

Key principle: *Disciplined* adherence to Standard Work (*processes accomplished within Takt time, without standard repairs or parallel work or multiple work paths*) reveals problems and **requires the technical help chain to engage** and *solve the problems* real time.

Benefits:

- Improved safety--- **handling incidents went down by 70%**
- Improved quality--- **75% reduction in defects**
- *Increased stability* in the whole organization
- Focuses on *solving problems* and continuous improvement



- *Process discipline* creates a sense of urgency and adds **energy** to the system
- *Process cadence* requires team to be “*ready to execute*”
 - Engineering, tools, people, planning, materials, etc. ready when needed

Work Environment and Schedule Compliance

Panics, behind schedule, overtime, backlog. Late engineering. Late planning. Materials unavailable. Stuff happens.

“Cadence”. Takt Time. Flow. On schedule. Work planned and executed. Engineering, planning, materials, tooling, people ready when needed. PES embraced and implemented.

Examples.
Boeing 767 production line.
RSRM production cadence.

3. CLEAN SLATE PLANNING

Requirements-based planning system with four elements

1. **Process maps**
2. **Why?** Engineering requirements and inspection index
3. **What?** Shop planning contains only requirements, buy-offs, and data recording
4. **How?** Standard Work instructions containing explicit craft details (*written by Operations with the technician in mind*)

Benefits realized

- Cleaner, more readable format fosters successful execution
- Clearly defined process flows yield processing repeatability
- Use of Standard Work facilitates continuous improvement and process consistency with a smaller, less specialized, work force
- Data entry and transfer errors minimized



Technical Excellence and Oversight

Requirements are "tossed over the wall". Engineers only come around after there is a problem.

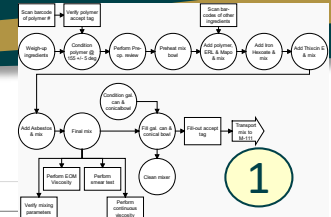
Technical requirements are defined, translated in shop planning, and executed concurrently. Table Top reviews are the norm. Operators understand "what and why", engineers *know* how requirements are met and verified.

4. Critical Process Variable Case Studies

Process Variable Mapping Creates a Recipe for Success!

Process Flow

1. Map the process in detail
2. Create detailed process descriptions
3. List process variables and define relationships to key design characteristics
4. List process controls, determine if weak or strong
5. Target opportunities to strengthen controls



Step	Process Description	Mts	Target	Max	Units	Controls	Process Variables
1	Weighing operations						
2	Set oven temperature	100	100	100	deg F		
3	Recall conditioning time						
4	Not enough cook time remaining?		45		min		
5	Verify conditioning	100	100	100	deg F		
6	Use Troy mixer						
7	Use Troy mixer						

Least Important Most

Control	200-lb Liner Mix		Strong		Weak		Comments
	Material	Process	Material	Process	Material	Process	
Material lot numbers	X		X	X	X	X	Field limit/barcode, accept tag, buy-off, 1-can ERL in room
Mix/mtrl aging			X	X	X	X	Field limit/barcode, clock, accept/envir. tag, record time, buy-off, OJT
Material amounts	X		X	X	X	X	Field limit/barcode, clock, tool condition, buy-off, record time, OJT
Mix/mtrl temperature		0	X	X	X	X	Calibration/setpoint, radiant heaters, buy-off, OJT
Asbestos moisture		0	X	X	X	X	Buy-off, engr judgement
Buy-off geometry		0	X	X	X	X	One Troy mixer, verify proper mix bowl
Mix speed		0	X	X	X	X	Tool condition, clock, buy-off, record time, OJT
Scrape-down technique		0	X	X	X	X	Clock, record time, OJT
Material addition rate		0	X	X	X	X	Clock, tool condition, record time, OJT
Viscosity measurement		0	X	X	X	X	Calibration, field limit, buy-off, record time, OJT
Formulation measurement		0	X	X	X	X	Buy-off
Dispersion measurement		0	X	X	X	X	Buy-off
Equipment cleanliness		0	X	X	X	X	FOD procedure, buy-off
Liner container cleanliness		0	X	X	X	X	Buy-off
Ingredient cleanliness		0	X	X	X	X	OJT
Backup system		0	X	X	X	X	Buy-off
Kanban pulled		0	X	X	X	X	Buy-off
Planning limit		0	X	X	X	X	Tool condition, clock, buy-off, record time, engr judgement, OJT
Preparedness		0	X	X	X	X	Accept/Haz tag

Control	200-lb Liner Mix		Strong		Weak		Comments
	Material	Process	Material	Process	Material	Process	
Material lot numbers	X		X	X	X	X	Field limit/barcode, accept tag, buy-off, 1-can ERL in room
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Asbestos moisture		0	X	X	X	X	Buy-off, engr judgement
Bowl & blade geometry		0	X	X	X	X	One Troy mixer, verify proper mix bowl
Mix speed		0	X	X	X	X	Tool condition, clock, buy-off, record time, OJT
Scrape-down technique		0	X	X	X	X	Clock, record time, OJT
Material addition rate		0	X	X	X	X	Clock, tool condition, record time, OJT
Viscosity measurement		0	X	X	X	X	Calibration, field limit, buy-off, record time, OJT
Formulation measurement		0	X	X	X	X	Buy-off
Dispersion measurement		0	X	X	X	X	Buy-off
Equipment cleanliness		0	X	X	X	X	FOD procedure, buy-off
Liner container cleanliness		0	X	X	X	X	Buy-off
Ingredient cleanliness		0	X	X	X	X	OJT
Backup system		0	X	X	X	X	Buy-off
Kanban pulled		0	X	X	X	X	Buy-off
Planning limit		0	X	X	X	X	Tool condition, clock, buy-off, record time, engr judgement, OJT
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Process Definition and Control	Processes are loosely defined, "being developed", or tribal knowledge not captured. Process variables not monitored.	Processes are defined, process limits established, off-nominal conditions identified, contingency plans available for process upsets. Critical process variables are defined, measured.
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I found cases where the most critical process variables had no controls at all. And, inspections or tests done on non-critical variables that could be eliminated and save \$.

5. READY NOW REVIEW

Four near fatalities in our machine shops and maintenance areas

- Machinists and maintenance technicians traditionally used their “expertise” to *figure it out*

Use of the **Ready Now** card has *significantly* improved both safety and quality, and changed the local safety culture

Ready Now ?

Work Order: _____

Process Safety Review

Cut Small Mill Large Mill
 Weld Fl/Fnl/Insp
 Lathe

Six Hat Thinking Process

White Hat Thinking: Facts, data, information known or needed.
 Red Hat Thinking: Difficulties, potential problems, who something may not work.
 Black Hat Thinking: Feelings, reactions, gut instincts, and intuitions.
 Green Hat Thinking: Creativity, possibilities, alternatives, solutions, new ideas.
 Yellow Hat Thinking: Values and benefits, why something may work.
 Blue Hat Thinking: Manage the thinking process, focus, next steps, action plans.

Risk Assessment

5	5	5	5	5
4	4	4	4	4
3	3	3	3	3
2	2	2	2	2
1	1	1	1	1
Consequence				
1	2	3	4	5

Tooling Program Handling General Safety
Equipment Complexity Certifications Clamping Adequacy
Drawing Criticality Training Other
Op. No. Op. No. Op. No. Op. No.

1 _____ 5 _____ 9 _____ 13 _____
 2 _____ 6 _____ 10 _____ 14 _____
 3 _____ 7 _____ 11 _____ 15 _____
 4 _____ 8 _____ 12 _____ 16 _____

Risk Assessment Level

O.T.S. O.T.S & Next Level Management Machine Review Board

Ready Now Review (5 to 10 minutes)

1. Define process steps in detail
2. Assess risk of each step. Plot on 5X5.
 - Identify potential difficulties and dangers
 - “Is there a better way?” Creative solutions?
 - Alter the plan or prepare contingencies
 - “Do I know without a doubt it will work?”
3. Share with shop floor supervisor
4. Get managers approval for high risk operations.

Pre-Operations Review

1. Clarify work instructions
2. Establish help chain
3. Help people remember critical steps
4. Safeguard against interruptions
5. Help teams co-ordinate
6. Make everyone’s actions predictable
7. Define actions to take during a crisis

Innovation	Technicians use their expertise to “figure it out” and solve problems on their own.	Technicians work literally to approved written instructions. Innovative changes are encouraged, but managed via formal change control.
Discipline	Get the job done mentality, no matter what. Rules don't apply in this situation. A short cut will save time and no one will know. No one listens to my needs.	Standards (planning, safety rules) are in place and followed. Risks understood. Operator concerns are addressed. Initiatives are in place to prevent and identify process creep.

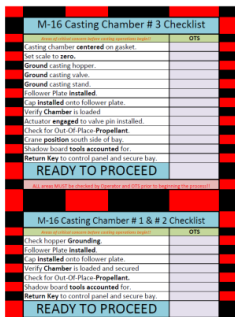
6. THE POWER OF CHECKLISTS

Standardize what you need to do, create a checklist, and follow it with a helper

- Checklists are a powerful tool:
 1. Help people remember critical steps
 2. Safeguard against interruptions
 3. Help teams co-ordinate
 4. Make everyone’s actions predictable
 5. Define actions to take during a crisis
- For critical tasks, a checklist should include ***“challenge and response”*** protocol
 - A second person verifies that each item has been completed

How to Create a Great Checklist

1. Seek out relevant guidelines – if one does not exist, tap into the “wisdom of crowds” by canvassing views from diverse sources
2. Compile a list of potential actions
3. Select those with the strongest impact and the lowest barriers to use
4. Translate each into an explicit, concise and unambiguous language
5. Insert a “challenge and response” if a second person needs to verify that each item has been completed
6. Keep it short – if necessary, separate the process into sub-steps and create a checklist for each one
7. Review it often – checklists must be dynamic and evolve in the light of new evidence



Laminated card filled in with a grease pencil, and reused. Created by the operators.

Implementation of Standard Work

Everyone does it different. Problems are hard to recognize.

Work is standardized to the best practice for Takt time, sequence, content and expected outcome

Something Else to Worry About

Risks

1. Routine-ization: The mark of a craftsman whereby the individual becomes so expert at exercising a particular skill that he no longer consciously thinks about it allowing the mind to wander and the unexpected to happen
2. Normalization: *The process of forgetting to be afraid*
3. Intrinsic hazard: No matter how well you defend yourself, the dangers out there never go away. Move outside your protective bubble and something or someone will get you.
4. Creeping entropy: Systems, policies, and procedures grow old and fail to adjust to changing external factors thus increasing the propensity for accidents to happen. People leave, retire, leadership changes.
5. Murphy's law: If it can happen it will happen. There is also Schultz' law: *Murphy was an optimist.*

Questions or Comments?