

Applying STAMP/STPA to Human Safety System for Manufacturing Process

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Agenda

Current situation of safety management



Study about explosion inside factory (case1)



Study about machine equipment accident(case2)



Safety measures and problem of the production in LCCs



Conclusion

Current situation in human safety risk management

Increasing in industrial countries



Accidents **Still** happen in many industries.

WHY?

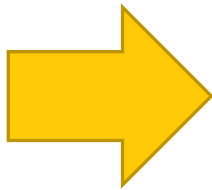
Let's examine 2 accidents

1: Explosion caused by detonation in heat treating furnaces

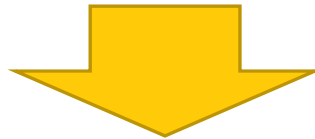
2: A human intervention accident case involving metal chips process

Process

- ▶ The front door of a heat-treating furnace blown off. (2013)



Destroyed heating pipe



Deformed equipment

Due to **abnormal heating** by cleaning solution attached to work-pieces

Background

- ▶ Components for transmissions were on production.

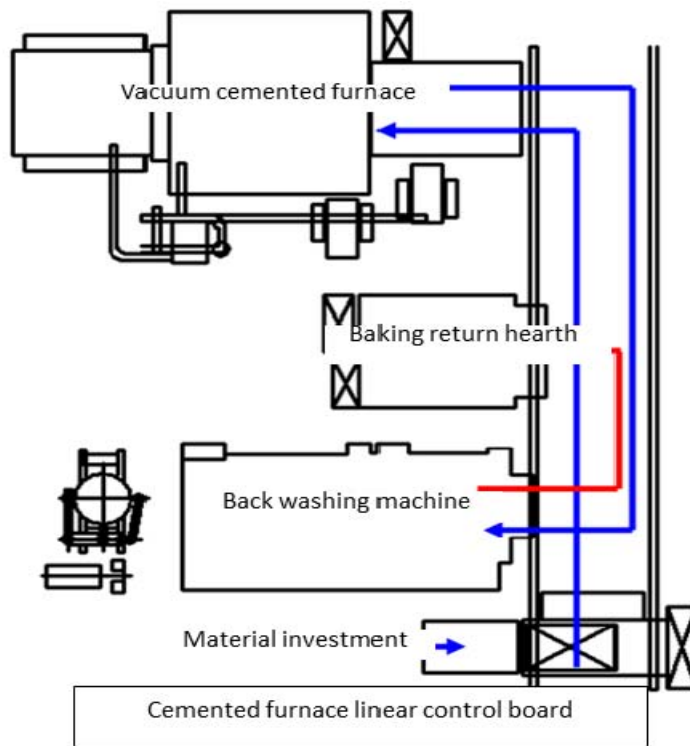
Heat treating furnaces

Back washing machine

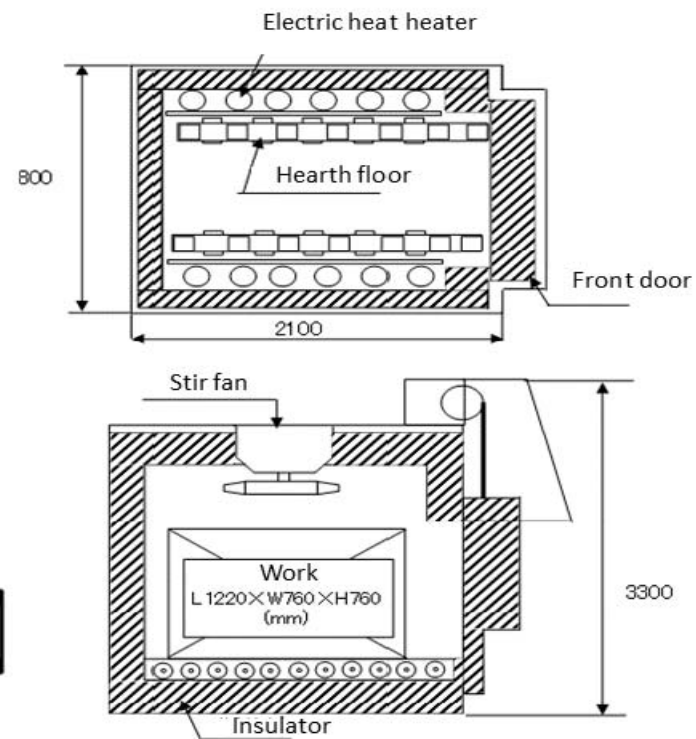


Internal movements are performed by conveyers.

A: Composition of entire system



B: Details of baking return hearth



Analysis

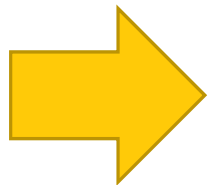
- ▶ Sensors and program to confirm whether cleaning solution and work-pieces had been removed were not installed. (washing machine)

Lack of knowledge

Risk assessment including STAMP/STPA is performed

Process

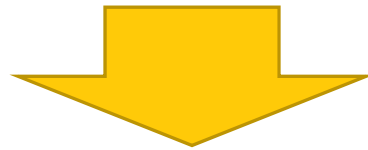
Tried to eliminate metal chips with a hook following instructions in the manual.



Finger injured by slipping chips

Analysis

This accident happened even though worker confirmed **safety and used safety tools.**



strong possibility not only the unskilled worker but

STAMP/STPA with human mental model used to prevent accident

How to Educate?

Training before Working



Training with material

Safety Sensory training

On the job training

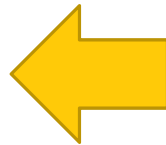
Process During Working in the Factory



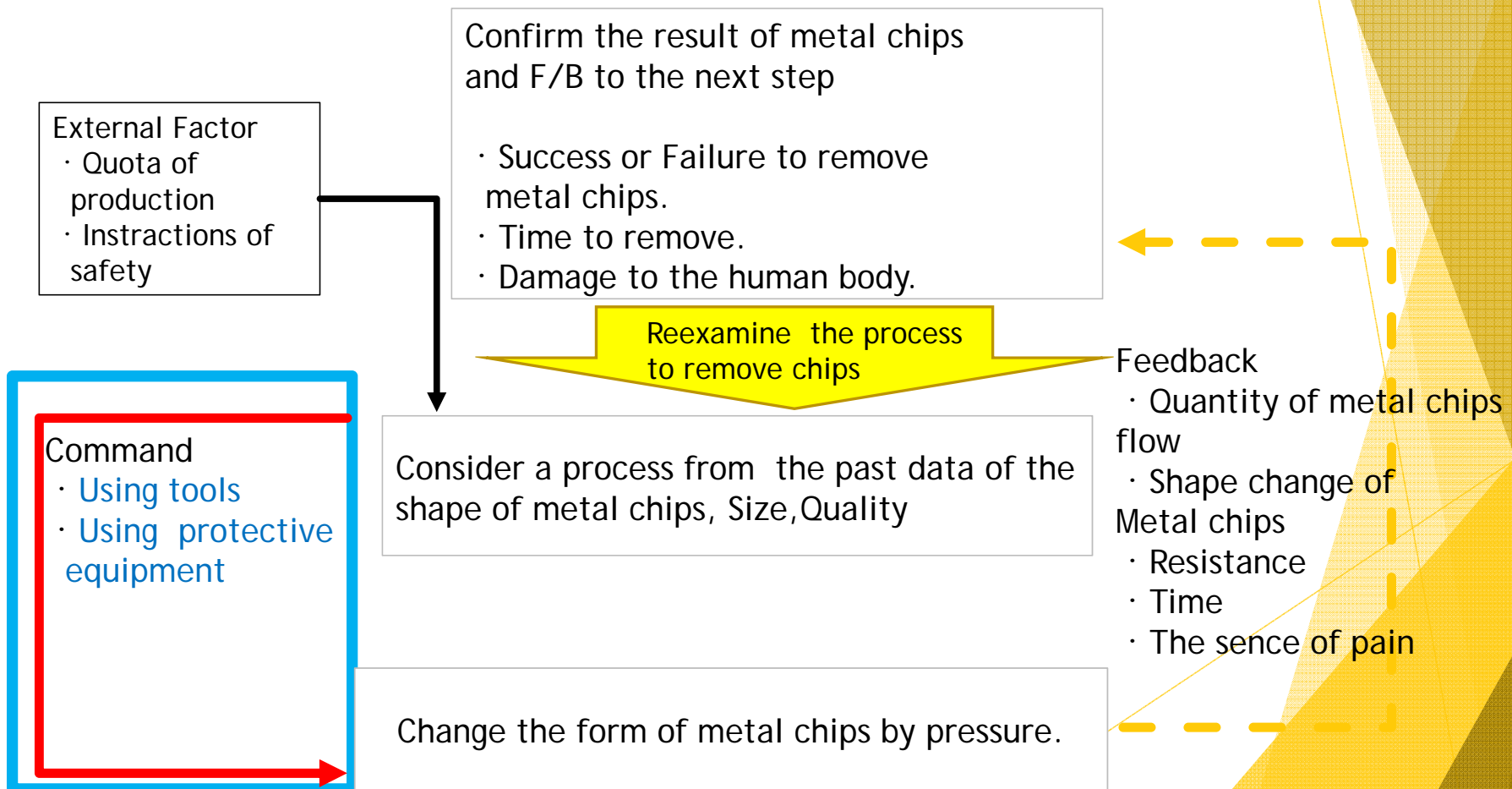
Remove metal chips with a hook



Remove remaining metal chips using a tool



Routine of the Chip Removal Operation



Hazard scenario analysis

No	Command	No Command	Incorrect Command	Incorrect Timing	Command Stopped Too Soon
1	Using tools	In case of not using tools, Worker will cut their body , protective equipment by touching metal chips directly. (UCA1-1)	If the wrong tools are used, Worker may cut themselves (UCA1-2)	In case of Early Timing, there is no problem since metal chips are not produced. In case of Slow Timing, there is no problem since chips have no change if the command is not input.	When workers stop using tools and begin to remove metal chips with their hands, they may cut their fingers. (UCA1-3)
2	Using protective equipment	Without protective equipment, workers may cut themselves or injure their eyes when they touch the metal chips. (UCA2-1)	Without sufficiently durable protective equipment, workers may cut or injure their eyes (UCA2-2)		When workers stop using protective equipment, they may cut or injure their eyes (UCA2-3)

Control loop of UCA 1 - 2

· **Misunderstanding how to use the**
 { **external**
 indication

No appropriate tool in hand

Metal Chips

- Shape change
- Temperature characteristics
- Move

Misunderstanding

- { the Form of metal chips
- { that metal chips have been removed

Lack of Information for process

Human mental model analysis(Until chip removal)

Layer	Process			
	①Detection	②Identification	③Decision	④Action
(I)SKILL-BASED BEHAVIOR (Expert)	Find the rest of Metal chips in the machine.	Recognize the risk of injury by pulling Metal chips	Decide to use a hook.	Cut their hands by touching machine when removing dusts.
(II)RULE-BASED BEHAVIOR (Generalworker)	↑	↑	↑	↑
(III)KNOWLEDGE- BASED BEHAVIOR (Newcomer)	↑	↑	↑	↑

Human mental model matrix(UCA1-2:When an proper tool not be chosen)

Layer	Process			
	①Detection	②Identification	③Decision	④Action
(I)SKILL-BASED BEHAVIOR (Expert)	Find out that can't remove machining dust by hook	Recognize the risk of injury by pulling Metal chips	Use the safety tool, just try to remove Metal chips by hook.	Cut their finger by touching machining dust.
(II)RULE-BASED BEHAVIOR (Generalworker)	↑	↑	Decide to just remove machining dust by hook.	↑
(III)KNOWLEDGE- BASED BEHAVIOR	↑	→	Decide to remove Metal chips t by	↑

Not occurring a judgment to choose a another tool.

Problems of manufacturers in LCC

- ① Most workers **not accustomed to the job**
- ② **Low-understanding** of the facility or safety risk
- ③ Understanding of the job is depends on education
- ④ Not understood about relations between **Quality the Safety risk.**
- ⑤ Not understood about an influence of production after accident

As a result...

- Considering to establish an automated process
- Making a policy to never cause an accident of the manufacturing plant

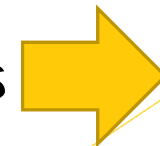
Protection by
government

Our Proposal...



① Protective gloves

② Metal gloves



Conclusion

From our presentation...

- **Human error** and **lack of understanding** of process in manufacturing led to accidents.
- Need not only to set up manual reflecting the status of worker and process in manufacturing, but also to invent new

Human can be involved in the hazard situation.



Thank You for Listening to Our Presentation!

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