

A photograph of two men in industrial safety gear. The man on the left wears a blue hard hat, safety glasses, and a high-visibility yellow vest over a dark blue jacket. He is pointing his right index finger towards the upper left. The man on the right wears a yellow hard hat with a communication device, safety glasses, and a high-visibility yellow vest over a dark blue shirt. He is looking in the same direction as the first man. Both are holding black folders. The background is a blurred construction site with a large yellow crane arm visible.

## ***LEARNING FACTORIES....***

The Atlas Copco Group, Thomas Dahlgren  
IVA, May 28, 2014



## ***COMMITTED TO SUSTAINABLE PRODUCTIVITY***

We stand by our responsibilities towards our customers,  
towards the environment and the people around us.  
We make performance stand the test of time. This is what  
we call – Sustainable Productivity.

## FACTS IN BRIEF

<b>Established</b>	1873 in Stockholm, Sweden
<b>Four focused business areas</b>	<ul style="list-style-type: none"><li>■ Compressor Technique</li><li>■ Industrial Technique</li><li>■ Mining and Rock Excavation Technique</li><li>■ Construction Technique</li></ul>
<b>Global presence</b>	Customers in more than 180 countries
<b>Employees</b>	40 200 in 90 countries
<b>Annual revenues 2013</b>	BSEK 84 (BEUR 9.7)



# ATLAS COPCO SWEDEN

4 000

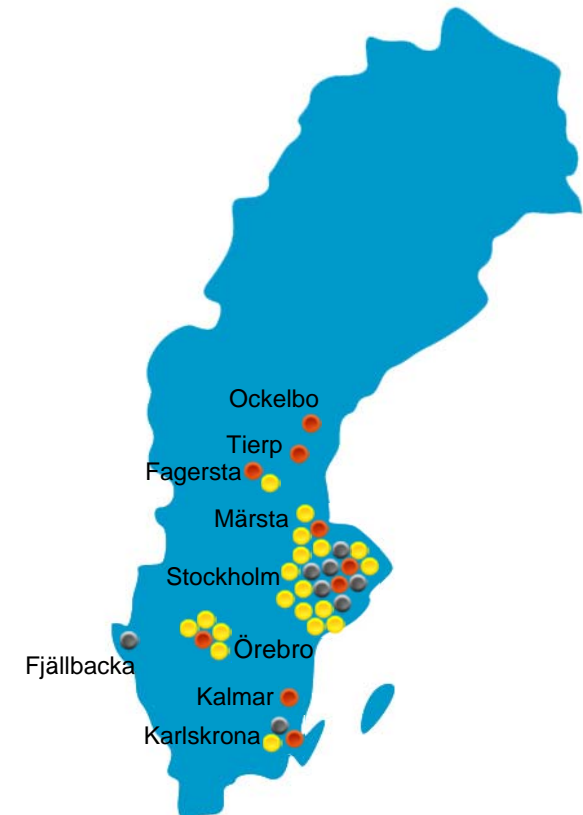
Employees



## ● Others

1. Atlas Copco Geotechnical Drilling and Exploration division
2. Atlas Copco AB
3. Atlas Copco AB GROUP CENTER
4. Atlas Copco Customer Finance AB
5. Atlas Copco Group Standards
6. Industria Insurance Company Ltd
7. Atlas Copco Business Services Örebro
8. Atlas Copco Business Services Sweden
9. Atlas Copco Industrial Technique Service
10. Atlas Copco Tools and Assembly Systems Business Line Accessories

SWEDEN



Atlas Copco

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4 000

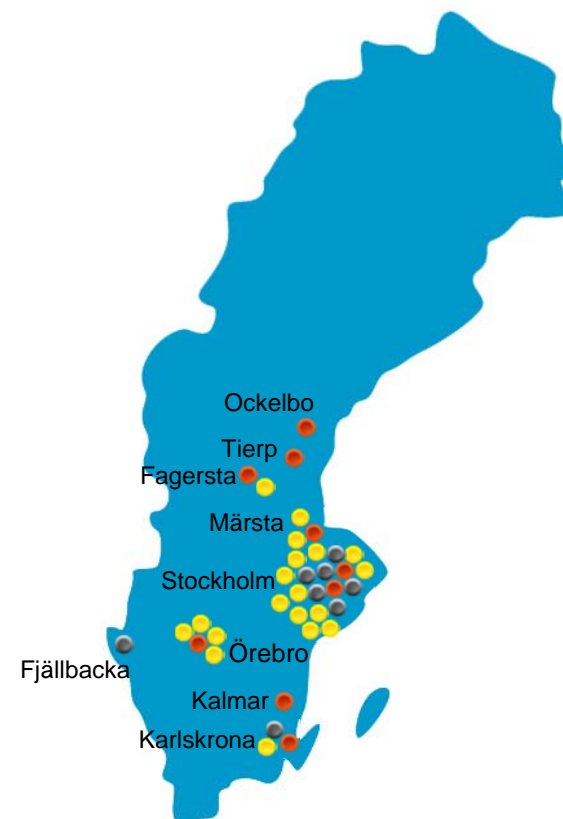
Employees



## ● Others

- 11. Atlas Copco Tools and Assembly Systems Motor Vehicle Industry division
- 12. Atlas Copco Tools and Assembly Systems General Industry division
- 13. Atlas Copco Rocktec division
- 14. Atlas Copco Underground Rock Excavation division
- 15. Atlas Copco Surface Drilling division
- 16. Atlas Copco Mining and Rock Excavation Service division
- 17. Atlas Copco Secoroc division
- 18. Dynapac AB
- 19. Atlas Copco Construction Tools division

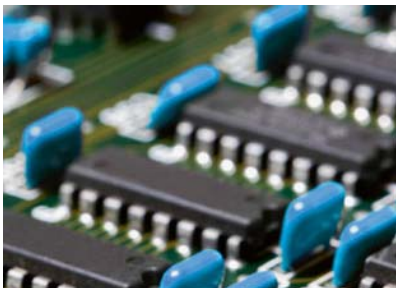
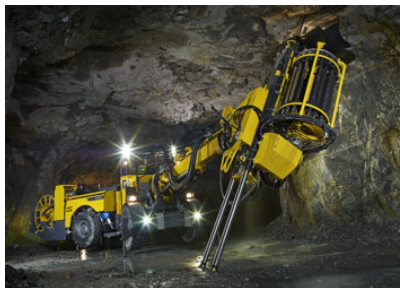
SWEDEN



Atlas Copco

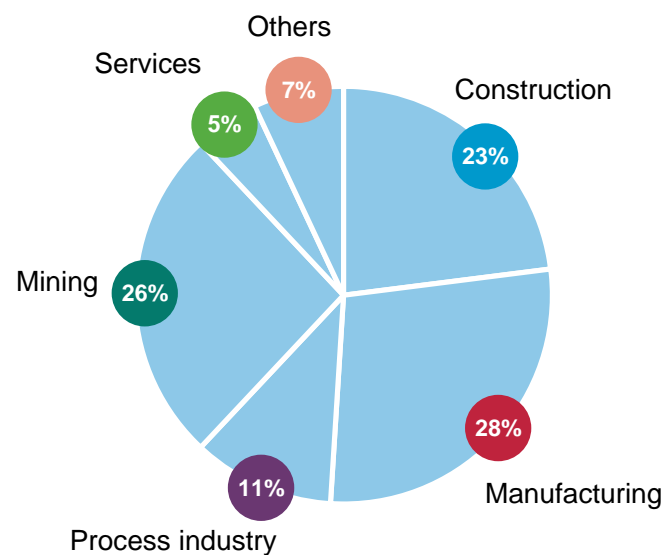


# CUSTOMERS IN ALL INDUSTRIES

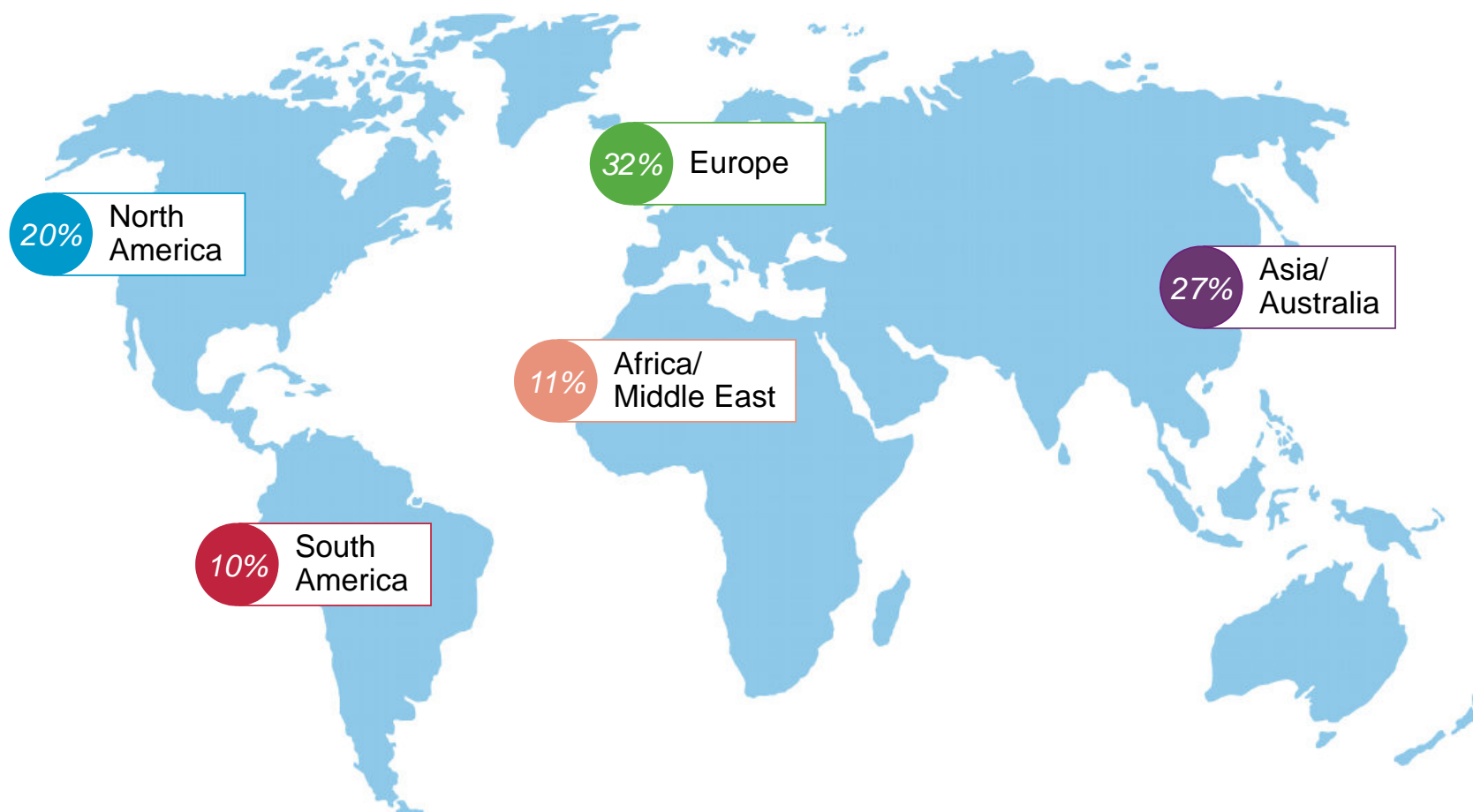


# A LEADING INDUSTRIAL PROVIDER

*Sales per customer category*



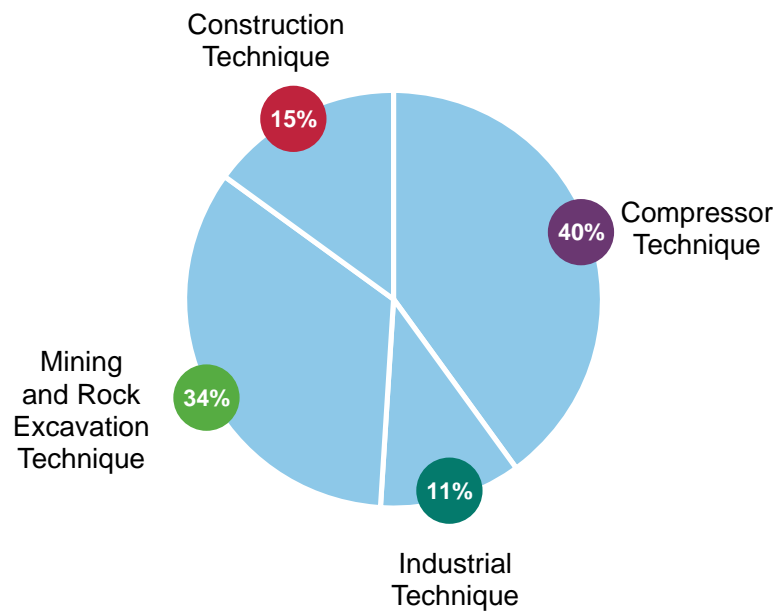
## CUSTOMERS EVERYWHERE





# SUPPORTING A WIDE VARIETY OF INDUSTRIES

*Revenues per business area*



# VISION AND STRATEGY

## Vision

- An Atlas Copco Organisation, offering Lean solutions for process improvement along the complete value chain.
- Make and maintain Atlas Copco a Partner, who secures and accelerates the business of our customers.
- Introduce new manufacturing technologies

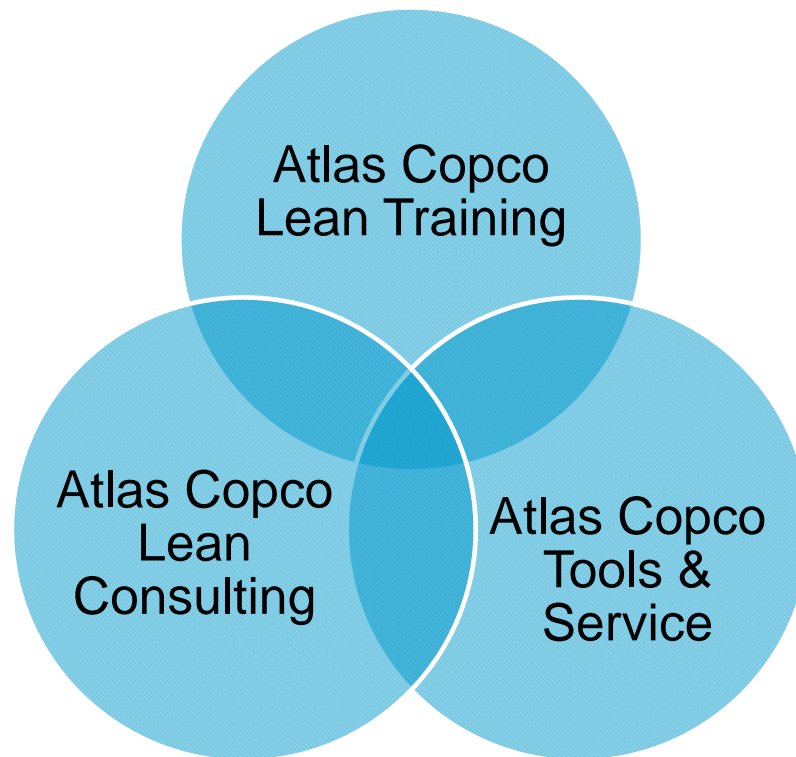


## Strategy

- Recruit and establish expert Lean knowledge
- “AC Lean Academy” - run Atlas Copco Lean preparation trainings
- “Atlas Copco Lean Consulting” - Lean expert support
- Market Lean Services under Atlas Copco Service
- Use the Lean Teams to prepare customer processes for new comprehensive production technology.



## ***TODAYS' OFFERING***



# LEAN ACADEMY

Set up today



## ***...BUT WE SAW MORE OPPORTUNITIES...***

- Increased awareness of continuous improvement with university students
- Employer Branding
- Brand building in general

## ***...WHICH LED TO CONTACTS WITH KTH...***



***COMMITTED TO  
SUSTAINABLE PRODUCTIVITY.***



*Atlas Copco*



# *Impacts of Learning Factories over Perception of Lean Philosophy*

Hakan Akillioglu

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# INTRODUCTION

Manufacturing is a subject that cannot be tackled inside a classroom alone from all aspects.

Main objective of the learning factories in engineering education is the integration of the theoretical knowledge learned in the class room into real life applications within an environment similar to industrial settings.

According to previous experience and research the major contribution of learning factories are

- Hands-on experience
- Action-oriented learning
- Providing effective team activities
- Motivating the learner

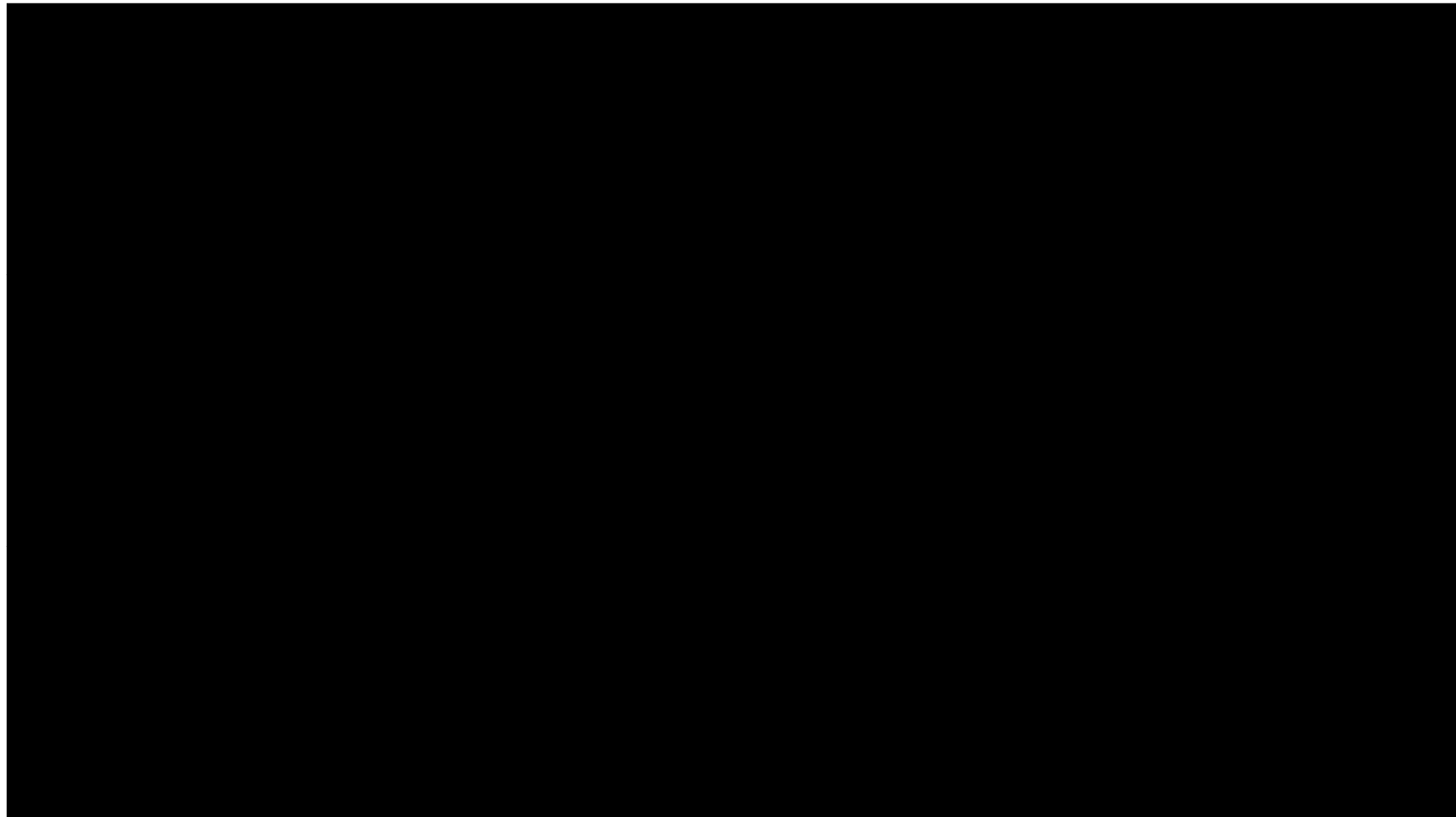


# OUTLINE

- Learning factory setup in Atlas Copco
- Research base
- Results and conclusion



# *LEARNING FACTORY IN ATLAS COPCO*



# LEARNING FACTORY SETUP

- U-shaped assembly line with 6 workstations
- Final product is a lean temple, composed of several blocks and layers
- 12 students participate to each session

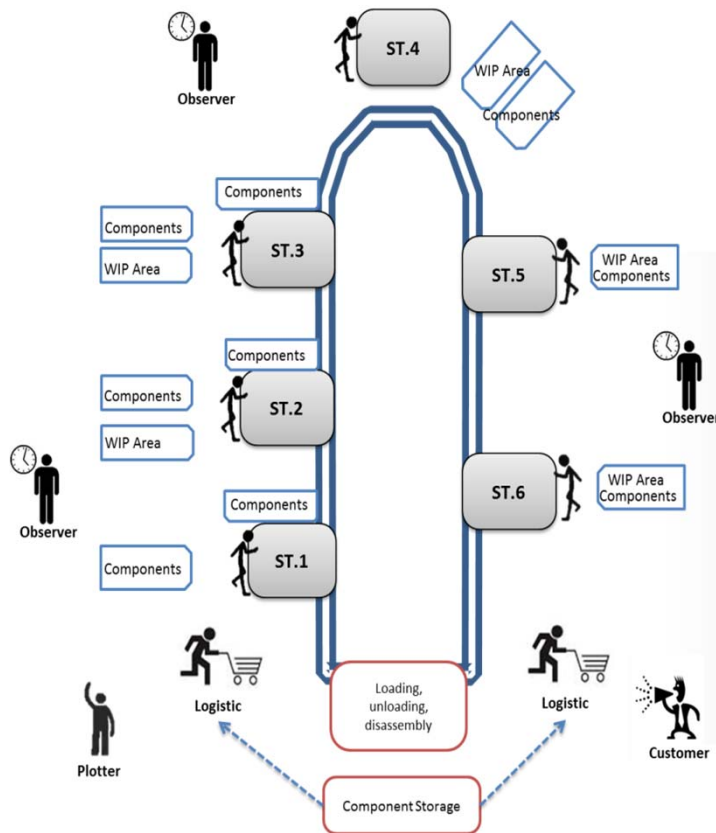


Function	Responsibility	Position	Number
Operator	Performing the tasks at specified stations	Stations	6
Logistics	Performing the transportation between the stations and also between the storage and material supply desks.	At each side of assembly line	2
Plotter	Sketching the spaghetti diagram of the logistics.		1
Observers	Recording the completion time of every single component. Each observer is responsible for taking the records of two stations.	At related stations	3
		TOTAL:	12

## LEARNING FACTORY SETUP

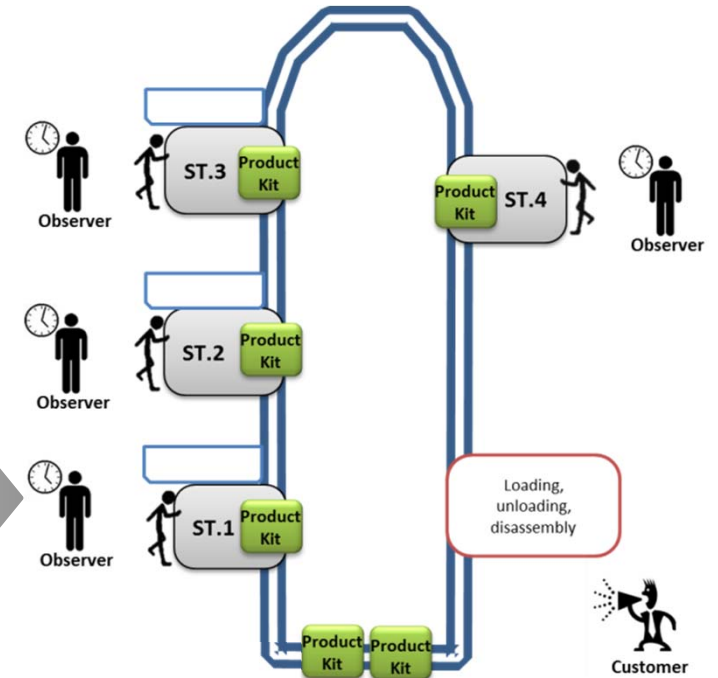
	Intended Learning Content
ROUND 1	<ul style="list-style-type: none"><li>* Standardized working methods</li><li>* 7+1 types of wastes</li><li>* Push production</li></ul>
ROUND 2	<ul style="list-style-type: none"><li>* 5S</li><li>* Elimination of wastes</li><li>* Pull production control</li><li>* One piece flow</li></ul>
ROUND 3	<ul style="list-style-type: none"><li>* Line balancing</li><li>* Built in quality</li><li>* Takt time</li><li>* One piece flow</li><li>* SMED</li></ul>

# LEARNING FACTORY SETUP



Round 1

- Highly automated production line
- Product kits
- Balanced station times
- Reduced number of stations
- Built-in quality with advanced tools
- Pull production control
- One piece flow
- Less inventory
- Elimination of wastes
- Improved operator utilisation
- Less defects
- ...



Round 3

# RESEARCH BASE

Research question

“ What is the impact of learning factories as a teaching approach over students’ learning experience in the context of lean production? ”

Experimented hypothesis:

*“Learning factories facilitate students to overcome the threshold concepts in lean production.  
Hence it helps students to reach a deeper level of understanding.”*





# THRESHOLD CONCEPT AND CHARACTERISTICS

## Definition

- a threshold concept represents a transformed way of grasping, perceiving or interpreting something, without which the individual in question cannot achieve a higher level of understanding of the topic.

## Characteristics

The threshold concept is likely to be:

- Transformative in the sense that the learner perspective of the topic changes. It might be just a change of mind set that reshapes the individual understanding of the whole or it can be a much more fundamental transformation that might result in the reconstruction of the personal identity and subjectivity.
- Probably irreversible. Once the change occurs, it is unlikely to be forgotten or reverse to the previous state.
- Integrative, since it exposes the synergies and correlation between things.



Jan Meyer and Ray Land. *Threshold concepts and troublesome knowledge: linkages to ways of thinking and practising within the disciplines*. University of Edinburgh UK, 2003.



## RESEARCH METHOD

- The lab is performed in the course of “Production Planning and Control” with 122 students at Atlas Copco facility, Stockholm.
- Interviews are conducted in a group of 4 students with the following questions

Q1. What is your overall impression about the learning factory?

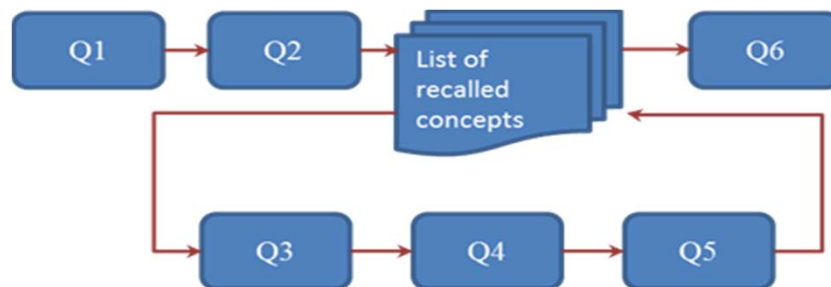
Q2. What are the main concepts that you recall from participating in the lab work?

Q3. Why do you remember that/those particular concept/s?

Q4. What was the most important factor during the AC lab that contributed to overcome/grasp that particular concept?

Q5. Did you understand the concept differently after the AC lab?

Q6. Do you think you can apply this concepts/knowledge today in another situation?



# CONTRIBUTION OF QUESTIONS TO EVALUATION OF STUDIED PEDAGOGICAL NOTIONS

	Deep learning achievement	Threshold concept		
		Transformative	Irreversible	Integrative
Question 1	✓			
Question 2	✓		✓	
Question 3	✓	✓	✓	✓
Question 4	✓	✓	✓	✓
Question 5	✓	✓		
Question 6	✓		✓	

# ACHIEVEMENTS FOR THE LEAN CONCEPTS

	Deep learning achievement	Threshold concept		
		Transformative	Irreversible	Integrative
Pull production	Yes	Yes & No	Yes	Yes
5S	Yes	No	Yes	No
One piece flow	Yes	Yes	Yes	Yes
Line balancing	Yes	No	Yes	Yes
Takt time	Yes	Yes	Yes	Yes
Built in quality	Yes	Yes & No	Yes	No
SMED	Yes	Yes	Yes	No

# ***PULL PRODUCTION***

Triggering activities;

- The effect of customer (both internal and external),
- Kanban application in round 2 and 3,
- Automated conveyor system.

Why transformative?

- The impact became perceptible on a much wider scope,
- The students' opinion that “as long as production system keeps producing, it performs well” has changed and the importance of efficient production was realized.

## **5S**

Triggering activities;

- Experiencing improved workplace design in round 2,

Student's theoretical understanding did not change. However, their perspective of the potential impacts of the concept has changed considerably.



## ONE PIECE FLOW

Triggering activities;

- Single kanban cards
- One piece flow ends up with idle stations in round 2 (Integrative),
- Understanding of the concepts became clearer and sound (Transformative).

## LINE BALANCING

Triggering activities;

- Smoothed workload over the stations in the last round,
- Experiencing the problems arising from unbalanced line.

Since the line balancing concept does not embrace complexity in itself, students' perception did not change therefore transformative characteristic cannot be mentioned

## TAKT TIME

### Triggering activities;

- takt time application in the last round,
  - the concept was relatively harder to grasp, however experiencing a real example on a production line enabled students to achieve a solid understanding
- 
- It is concluded from the interviews that students' understanding of four lean concepts of *pull production*, *one piece flow*, *line balancing* and *takt time*, shifted considerably through the realization of their relation and dependence in each other. Hence the LFA had a considerably important role in strengthening an integrated perspective of these concepts, in the students.

## CONCLUSION

- The learning factory is a compact activity in terms of its step wise approach which allows students to see the whole transition from an unstructured and problematic environment to a systematically working production line with implemented lean methods,
- The learning factory provides the environment where the students have the opportunity to achieve a sound understanding of the concepts through hands on experience. Besides they are able to visualize the practical consequences of their theoretical knowledge,
- The learning factory handles many lean concepts which facilitate establishing the links between them. This originates knowledge creation and irreversibility,
- It is explicitly highlights that big impacts can be achieved with simple lean applications.

## A QUOTE FROM THE INTERVIEW

- A student with 2 years of industrial experience stated;

*“I was seeing everywhere in the company lean related applications and visuals. I thought it was mostly for moral issues in order to emphasize their environmental friendly side. I was even thinking that they just want to seem following the trend. LFA made me realize what they were after. I recognized how small steps end up such huge improvements. Besides when I joined the company, I have not seen the previous problematic states which prevented me to see the real benefit of the lean tools. In the LFA, the step wise improvements starting from the problematic environment and ending up with a highly efficient line made me realize a lot.”*