Managing Risk in the Innovation Process

W.P. Neumann

Human Factors Engineering Lab, Ryerson University,
Toronto, Canada

HFE Industrial Engineering R&D Human Factors Engineering Lab

RYERSON UNIVERSITY

Division of Labour

”The greatest improvement in the productive powers of labour… seem to have been the effects of the division of labour”

-ADAM SMITH (1776)

Chapter 1: *’The Wealth of Nations’*

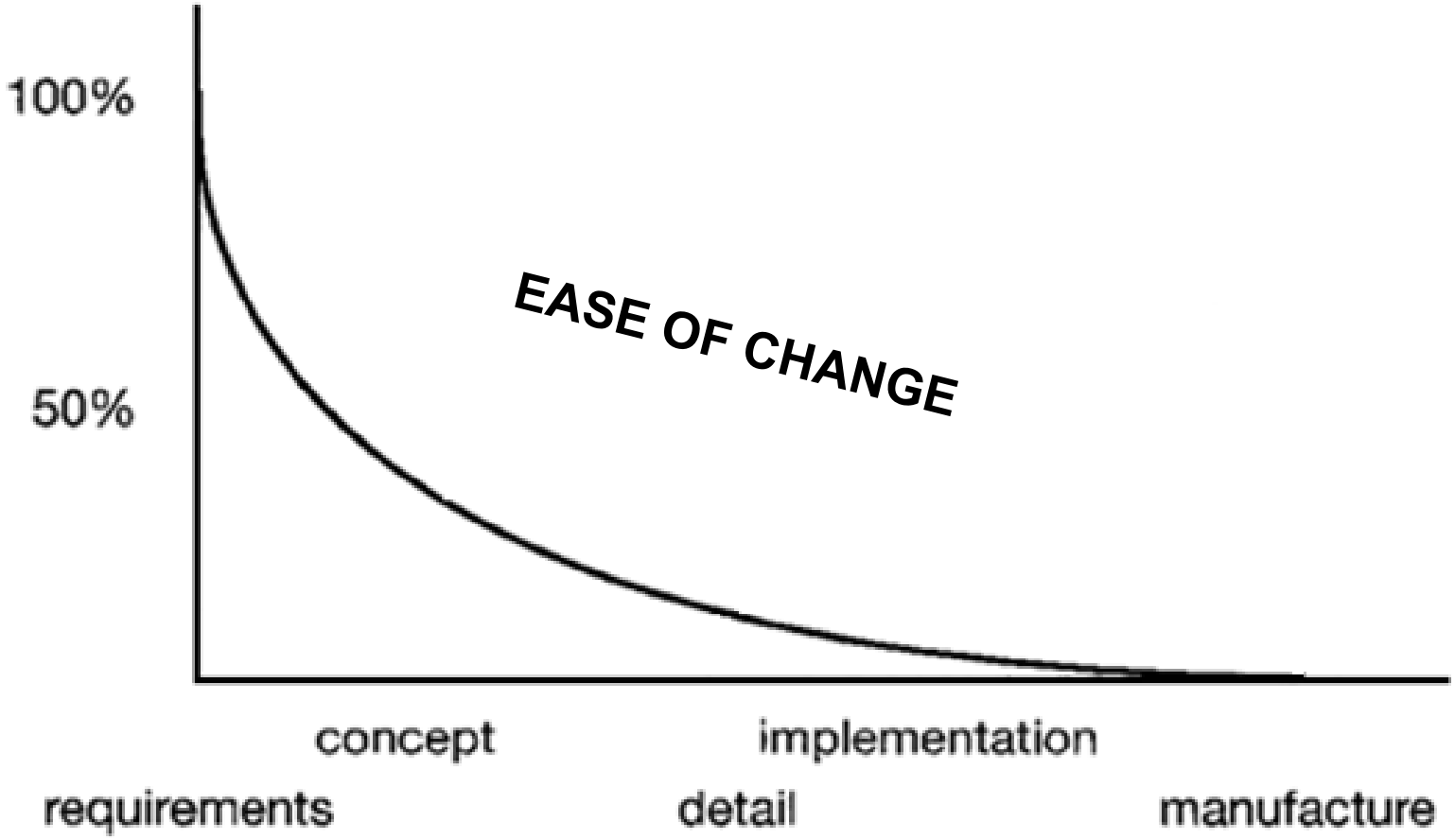
- ✓ **The Pin Factory Example**

And the race was on…

- Talyor (1911) – *Scientific management*
- FORD (1920's)
- Demming (1950s +) – *Continuous Improvement*
- TOYOTA (1970 +)
- Womack (1994) – *'Lean'*
- *2000+ "Lean Sigma": "Waste" Elimination*

Engineered systems are largely immune from change

Change gets harder throughout design



[Miles and Swift, 1998].

OLD

’DOCK’ Station

NEW

’LINE’ Station

(Neumann et al., 2006, IJOPM)

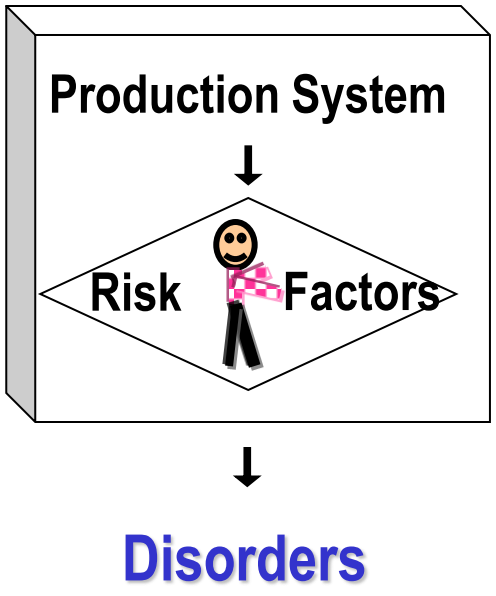
What is the problem?

↓

Disorders

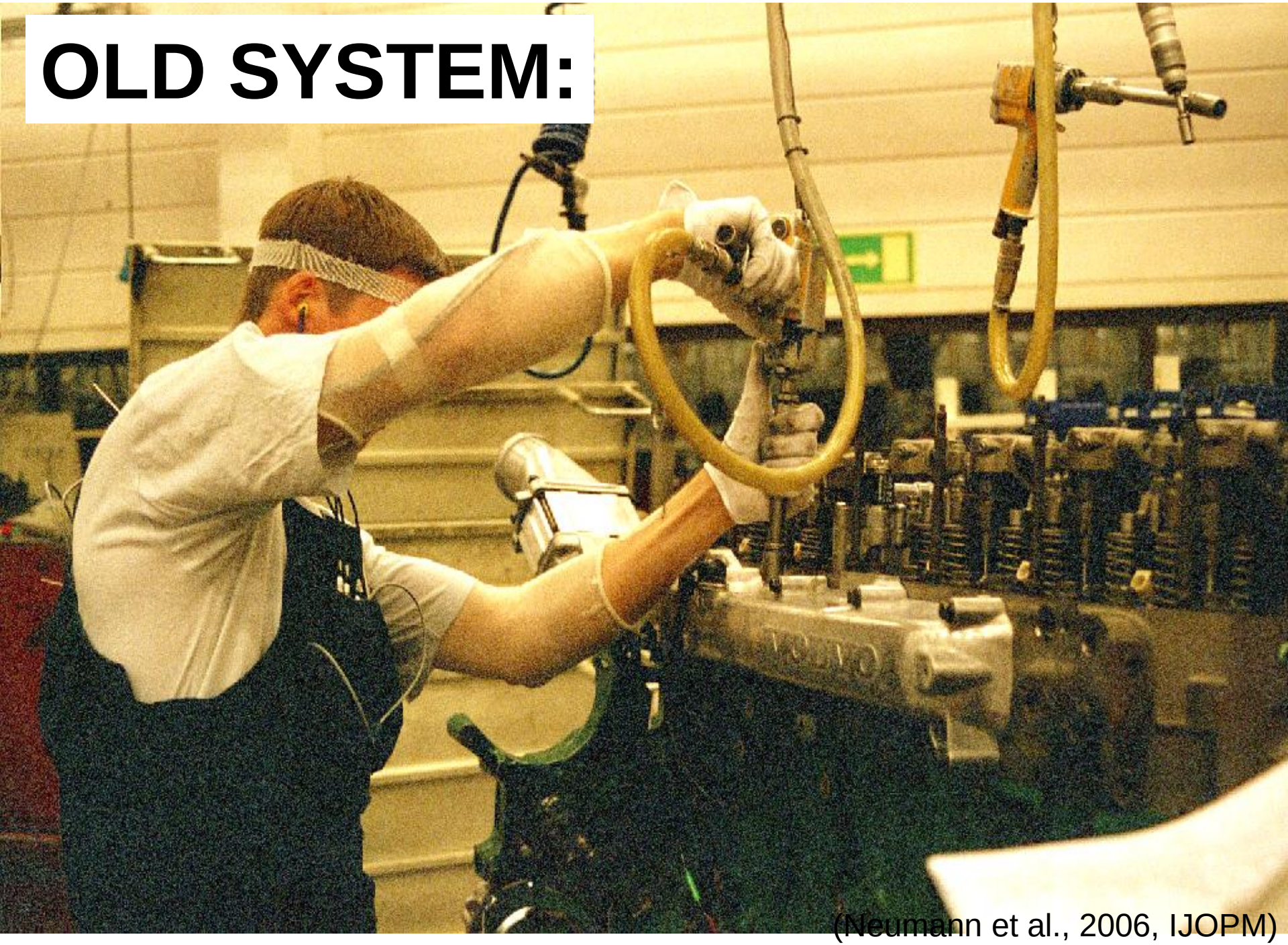
(Neumann et al., 2006, IJOPM)

What is the Problem?



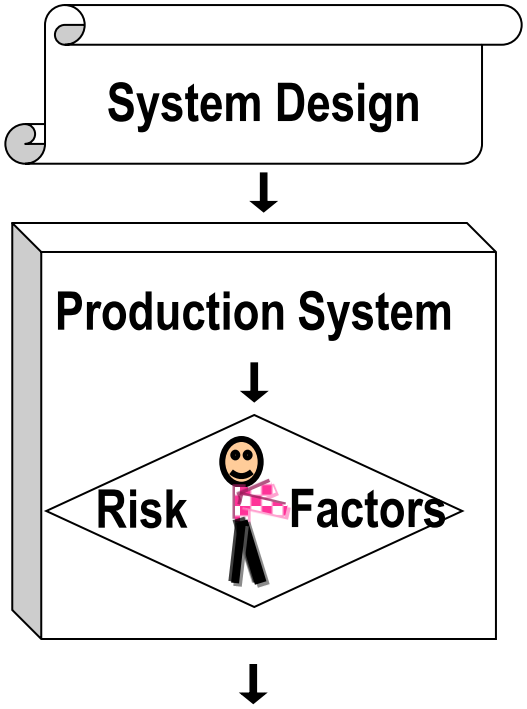
(Neumann et al., 2006, IJOPM)

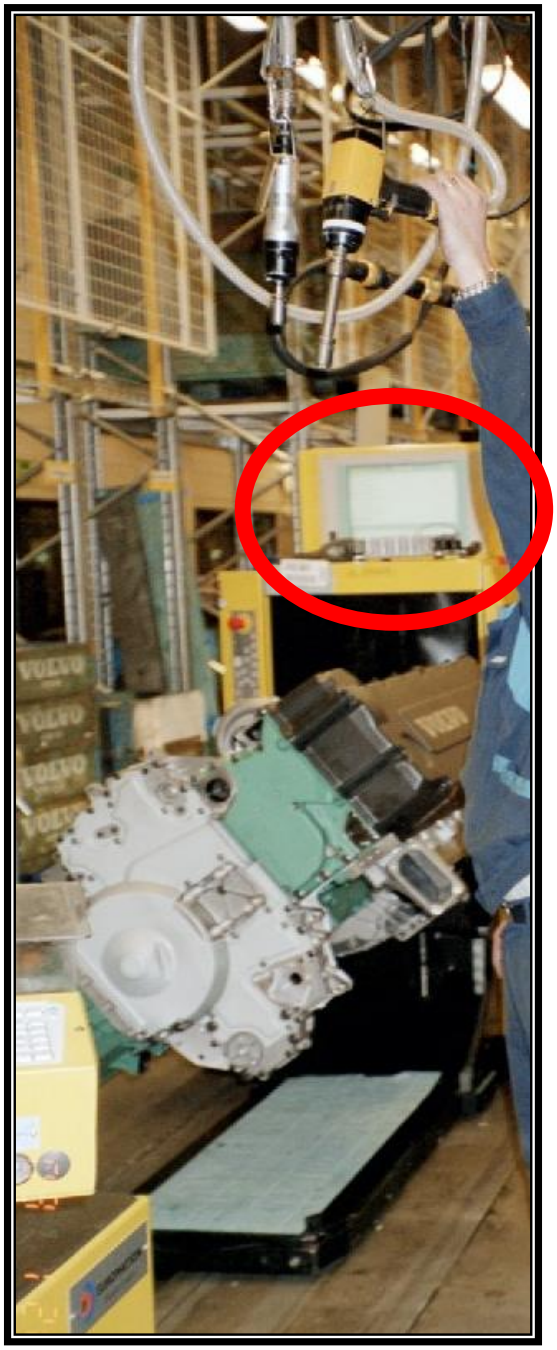
OLD SYSTEM:



(Neumann et al., 2006, IJOPM)

What is the source of the problem?





(Neumann et al., 2006, IJOPM)

WHO IS RESPONSIBLE?

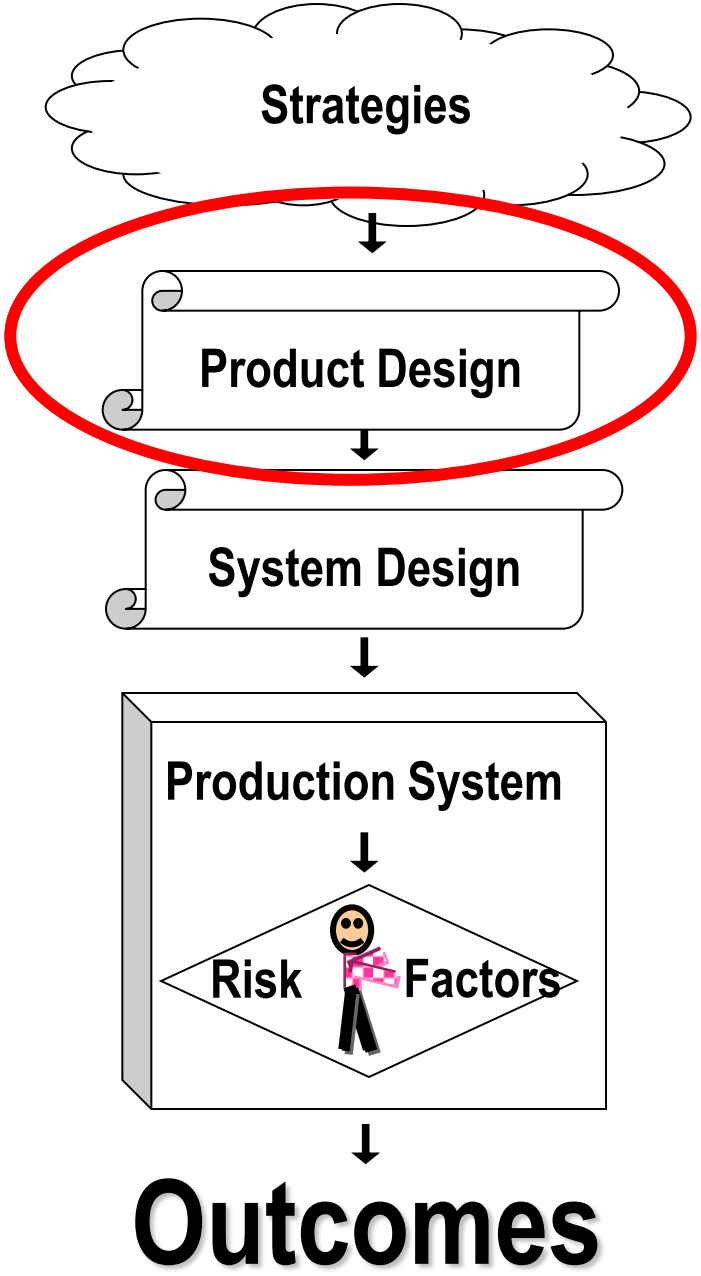
NO ONE!

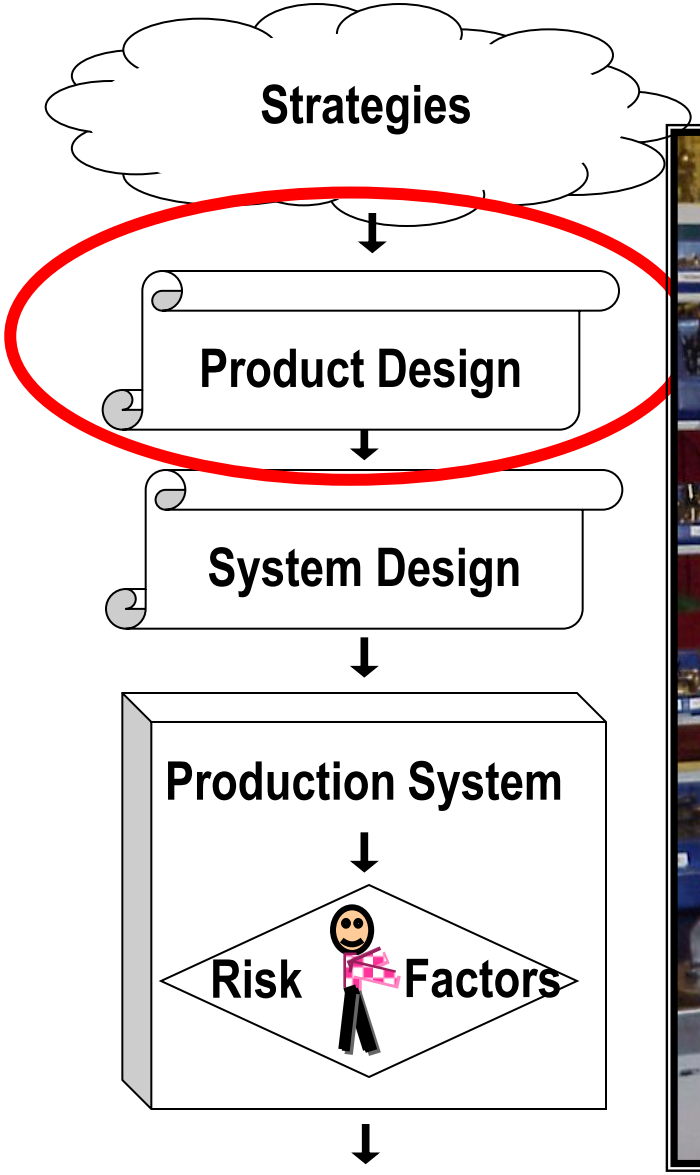
Workplace is an EMREGENT Characteristic of design

(Neumann et al., 2006, IJOPM)

PRODUCT DESIGN EXAMPLES

Product Design Can Define Postures


Strategies
Product Design
System Design
Production System
Risk
Factors
Outcomes



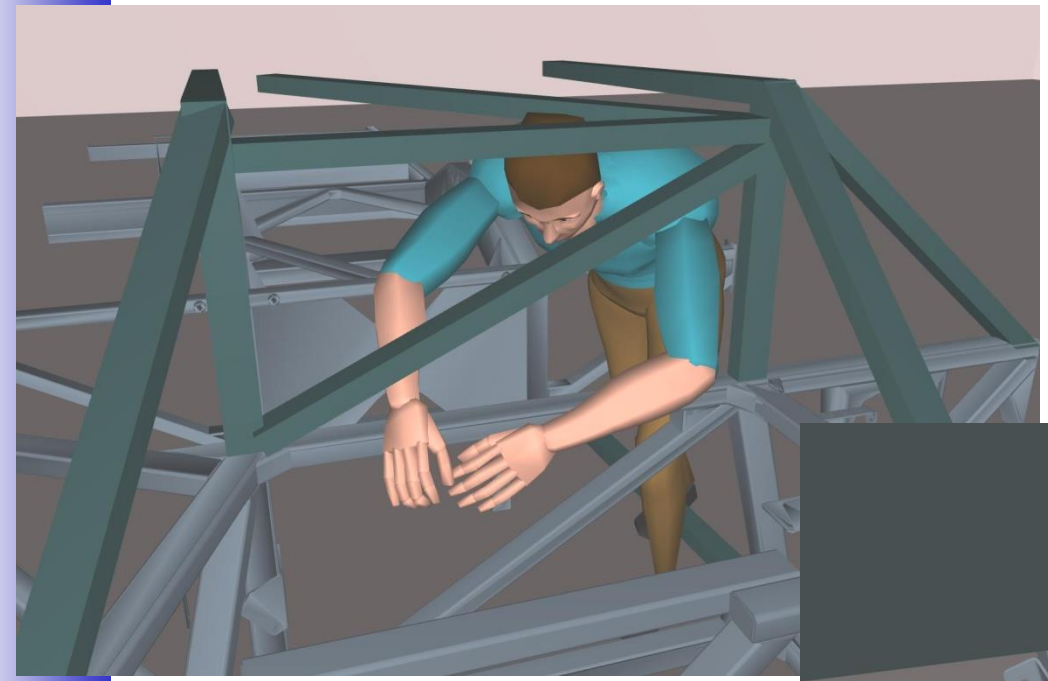
(Neumann et al., 2006, IJOPM)

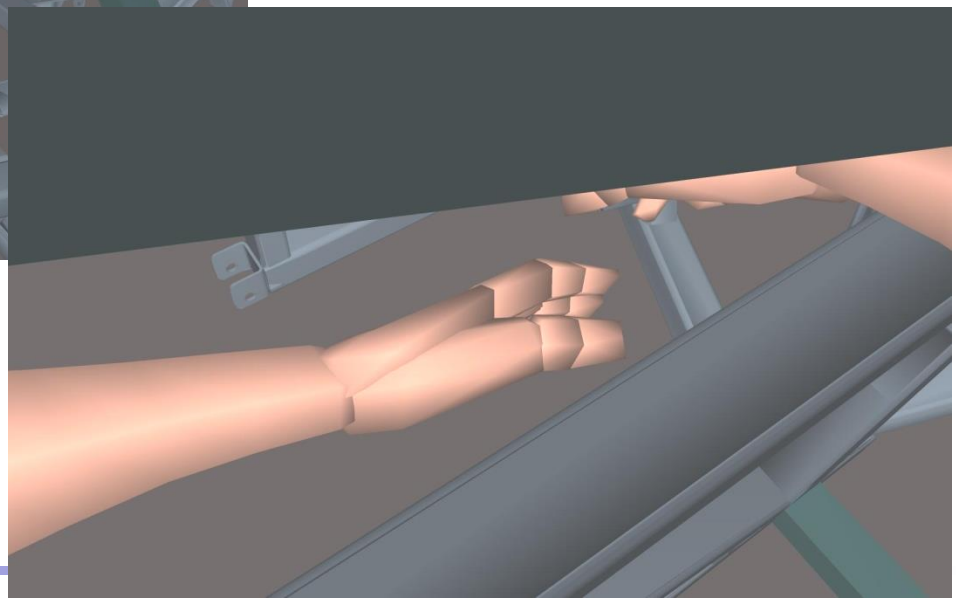
Product Design + Logistic s system Design

Ergonomics is an "emergent" characteristics (Neumann et al., 2006, IJOPM)

Examples of analysis situations - Buss

50%ile male mounting air pipe under crossbeam



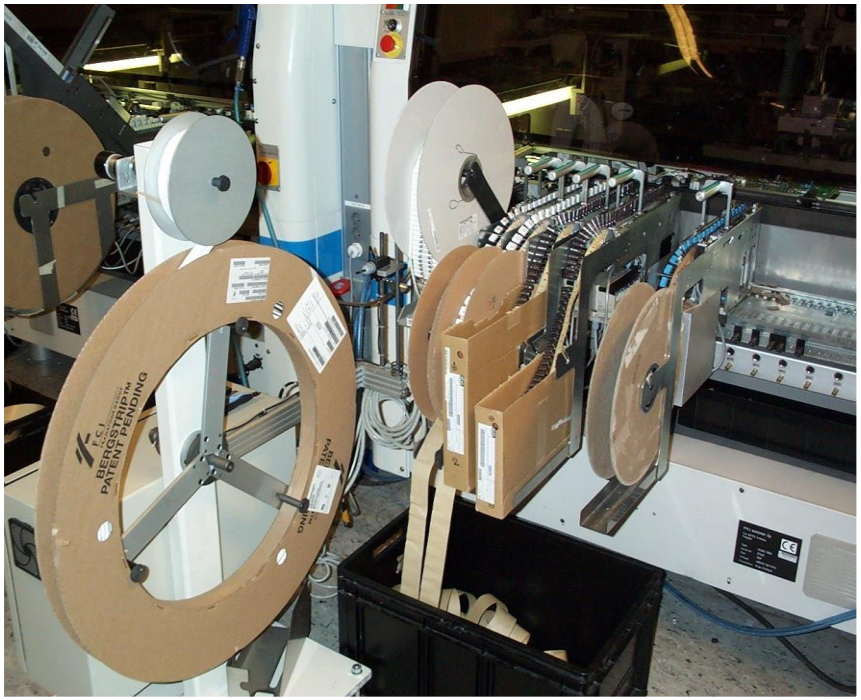


Eye view

Sundin 2000, IEA

AUTOMATION EXAMPLE

Automation of Assembly



Less manual work
save 2.6 min / board
++ machine supervision
++ Workstation cost

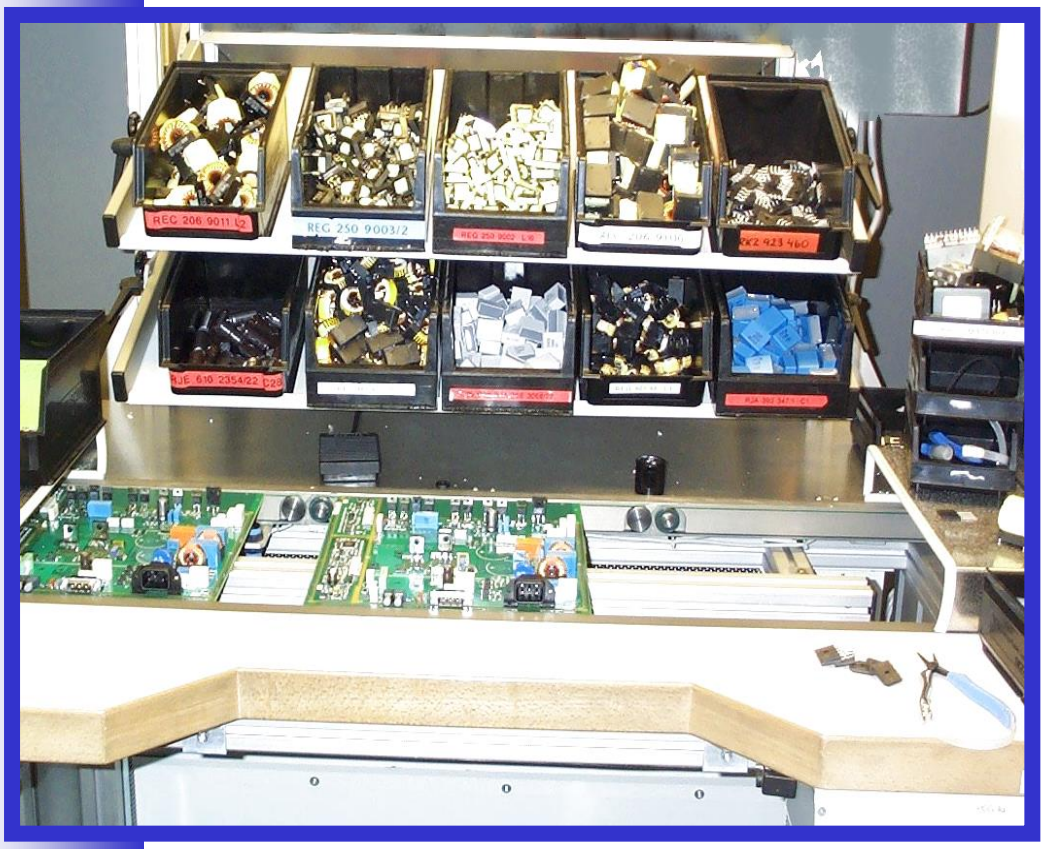
ERGONOMICS

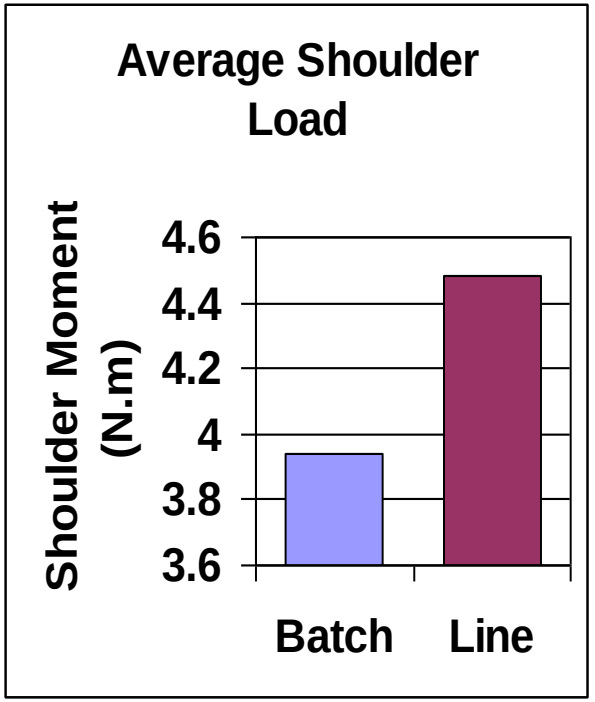
- **less total operator time in stereotyped tasks**
- **more variable**
- **Some awkward postures**

(Neumann et. al, 2006, IJPR)

HFE Industrial Engineering R&D
Human Factors Engineering Lab

Automation Failure -> machine paced manual work



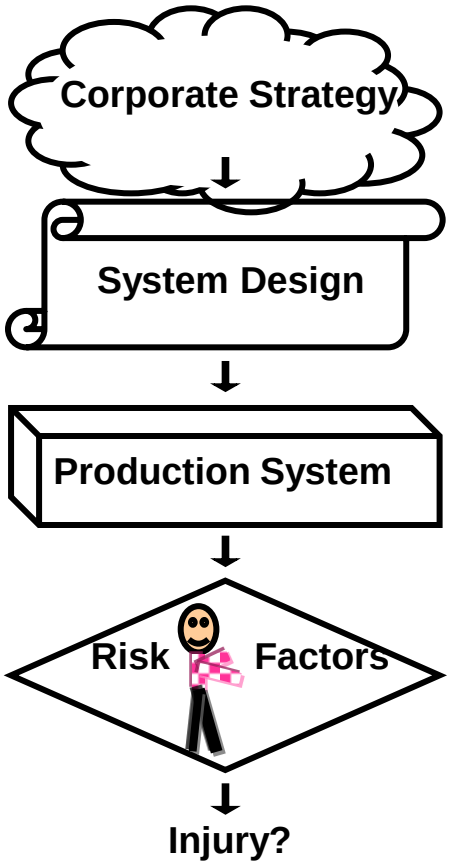


- **repetition + 38%**
- **Arm elevation + 26%**

- Adjustable ‘Ergonomic’ workstation (sit-stand capability):

(Neumann et. al, 2006, IJPR)

The Sources of Risk Run Deep…



Comment

1) Improve Performance with Automation
2) Consider Ergonomics separately

1) Technology choices for line system
2) Workstation design constrained by tech.

1) Increased rate, machine pacing elements
2) Fewer tasks, less interaction potential

1) Reduced Work Variability (↑ intensity)
2) Increased shoulder loading

59% report neck/shoulder pain or stress

(Neumann et. al, 2006, IJPR)

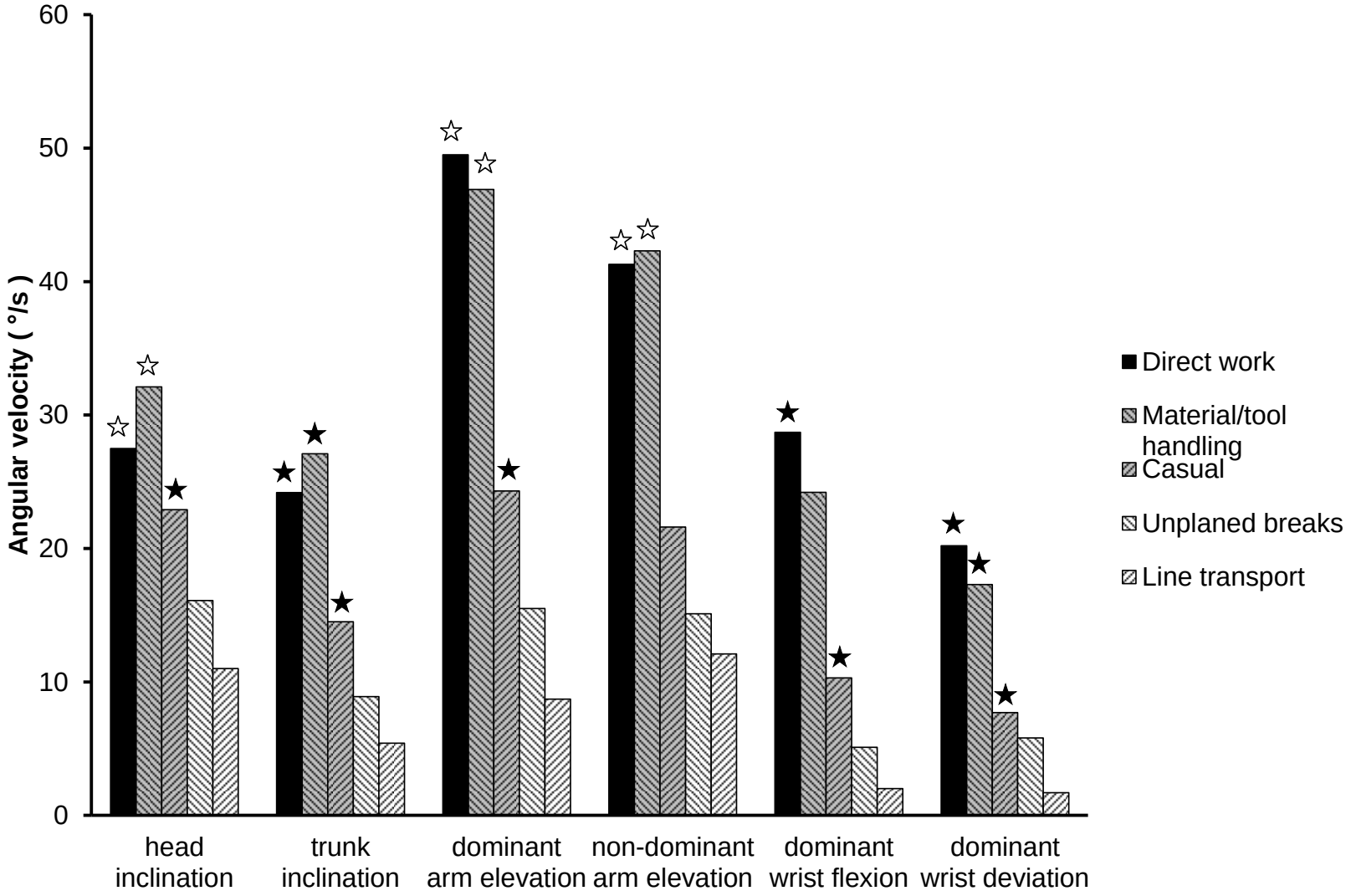
PROCESS INNOVATION EXAMPLE

(“Lean” and waste elimination)

Lean in DISSASEMBLY

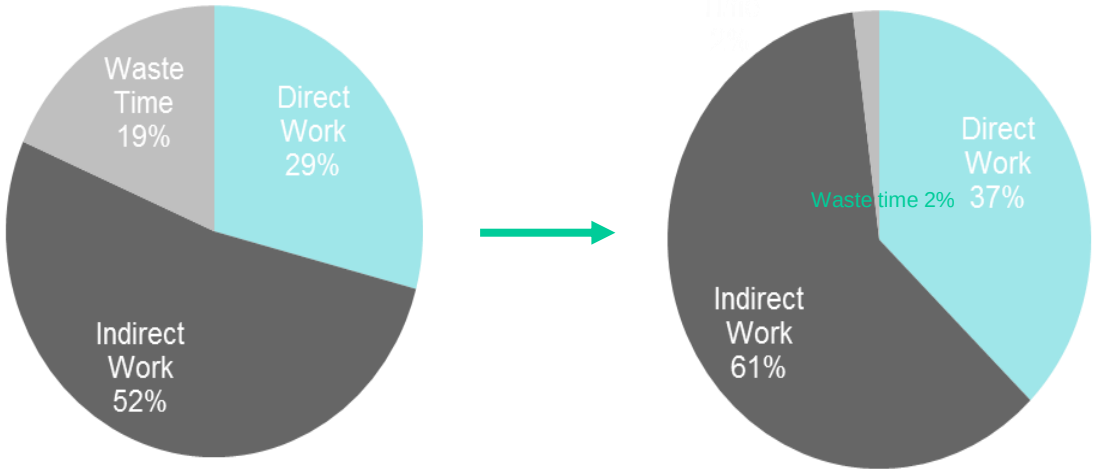
Measured Movement velocity

50th percentile

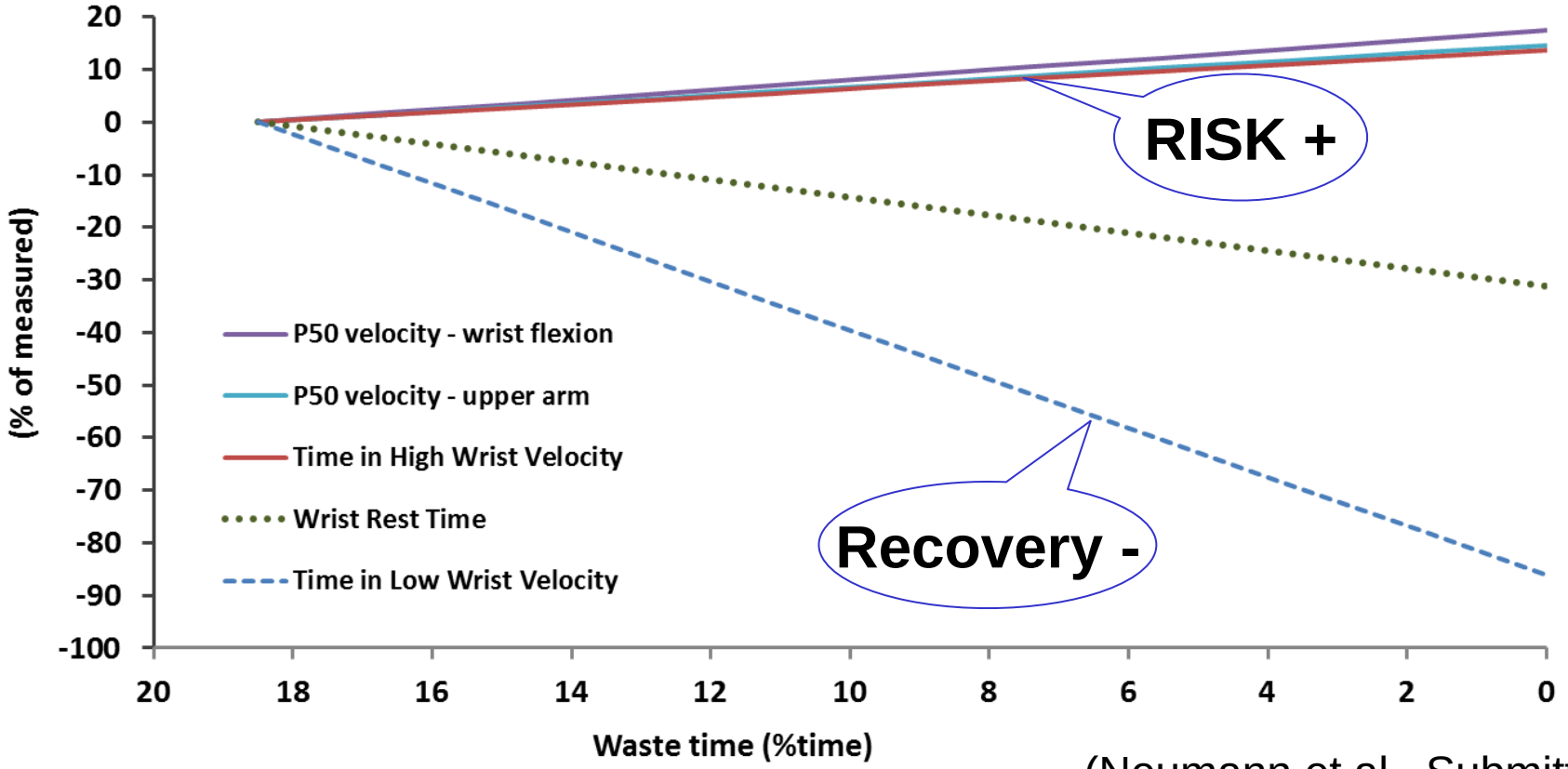


(Neumann et al., Submitted)

How "Lean" increases employee risk

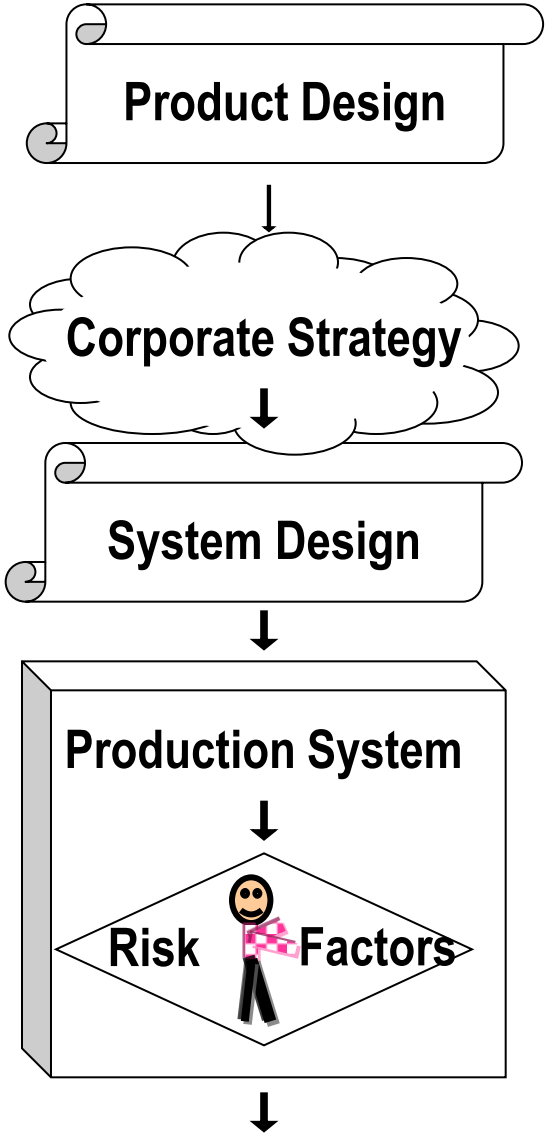


Car disassembly

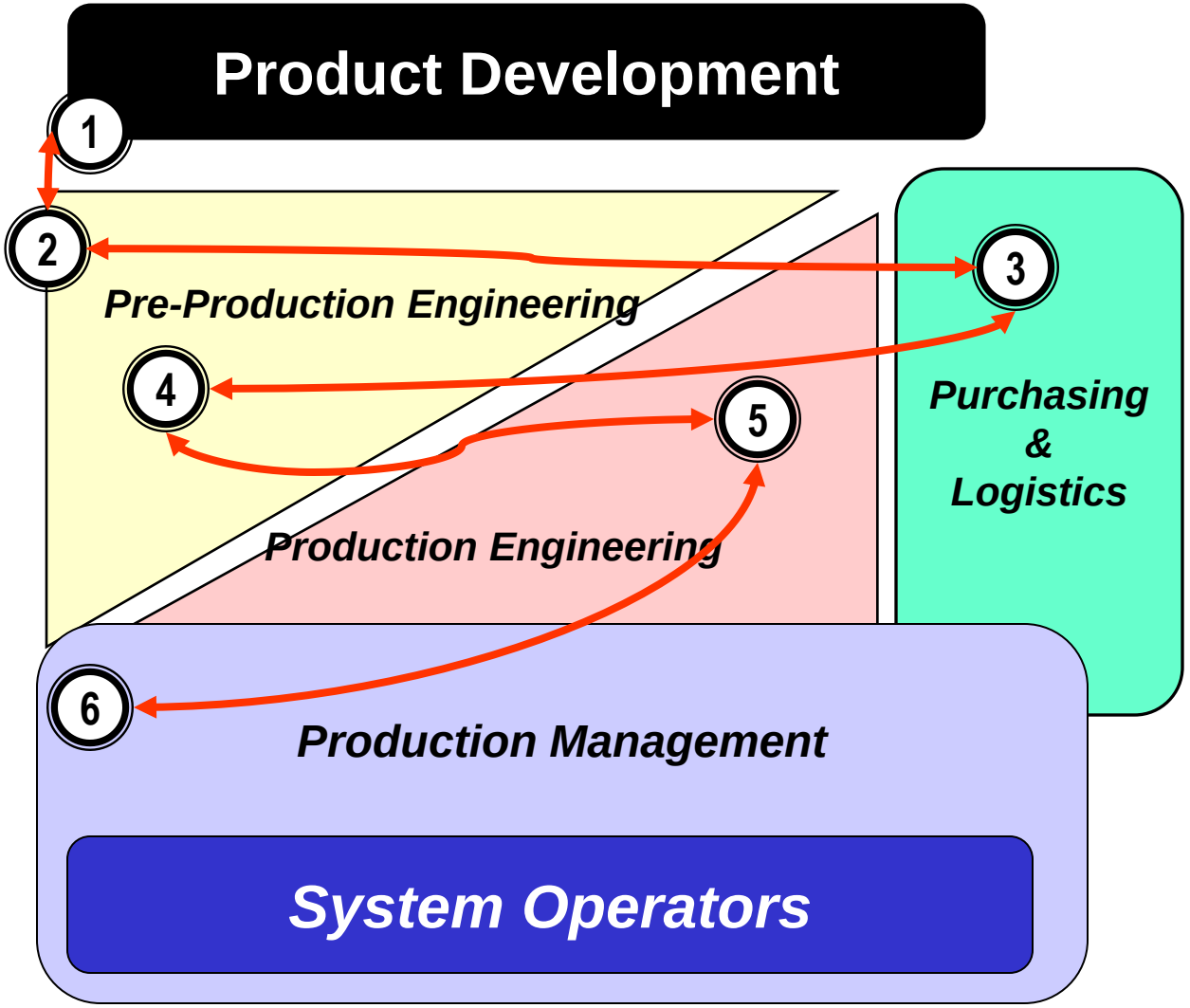


(Neumann et al., Submitted)

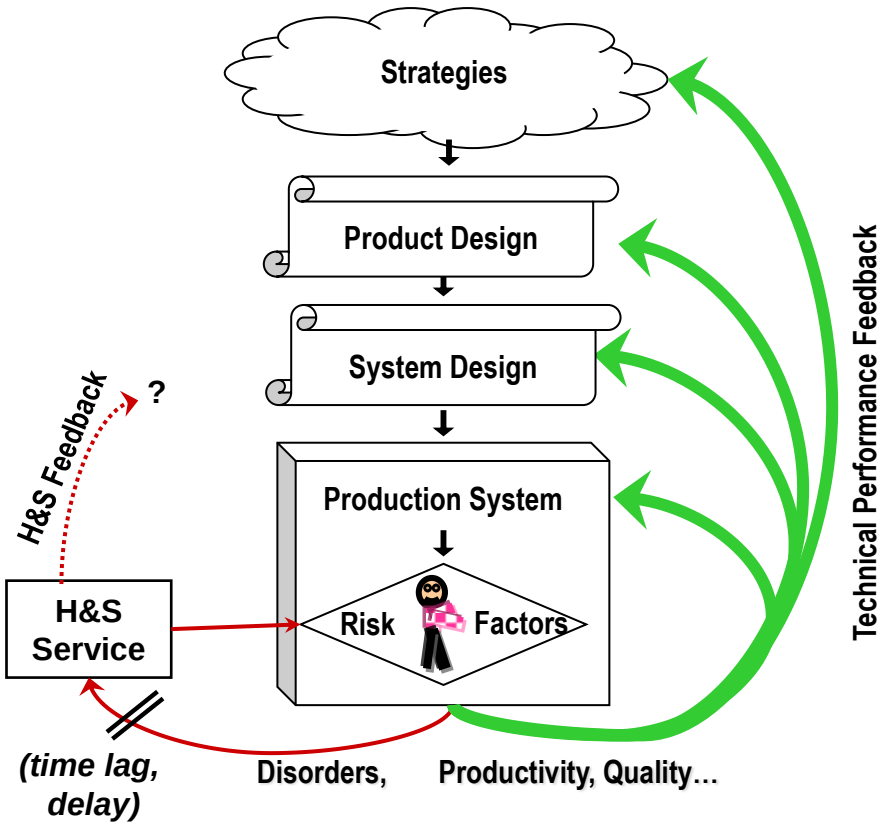
Enter the Design process



Outcomes?



Who Controls Risk?
No one & Everyone.



Source of HF problems Is throughout Development process

Outcomes include Performance & Wellbeing

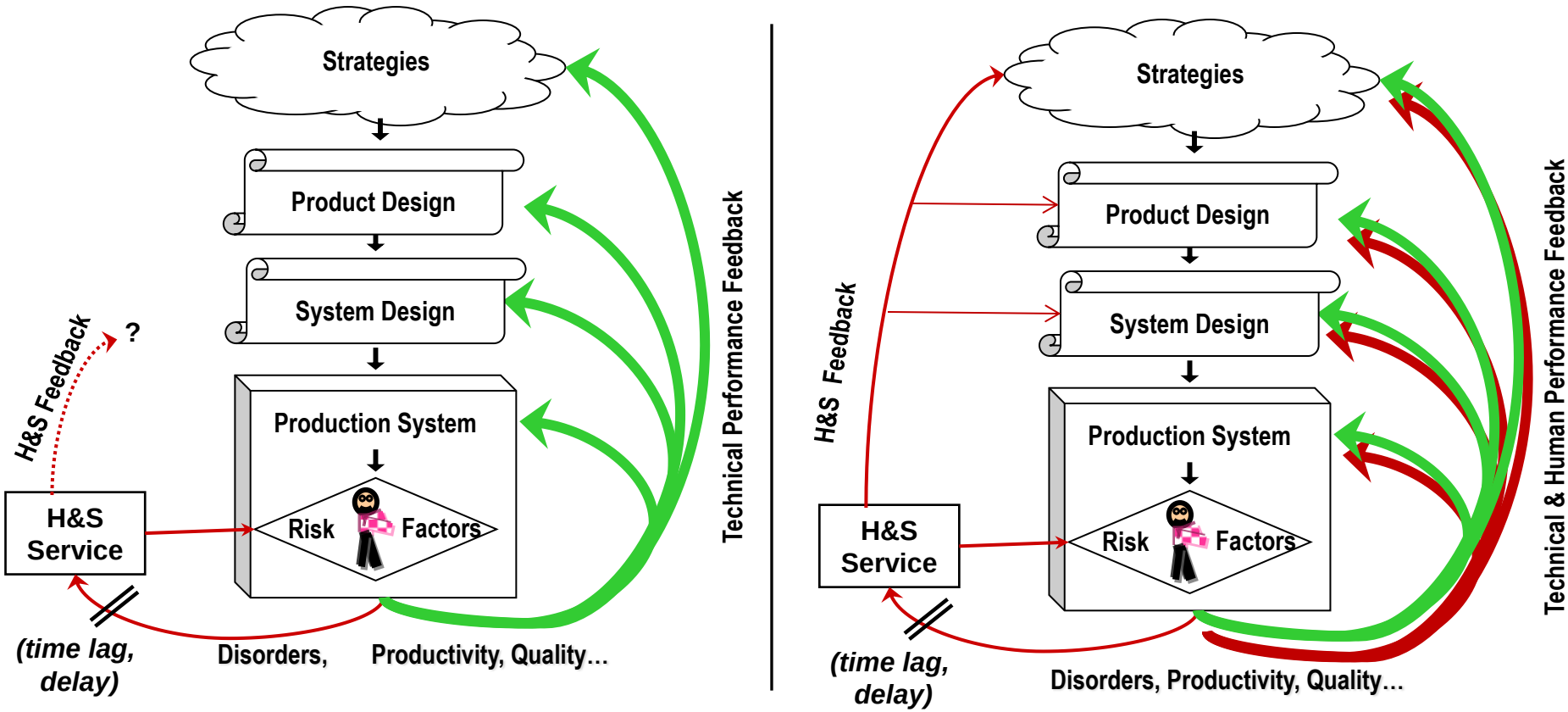
OHS is isolated.

‘Side Car’ OHS Structure?

Ergonomist

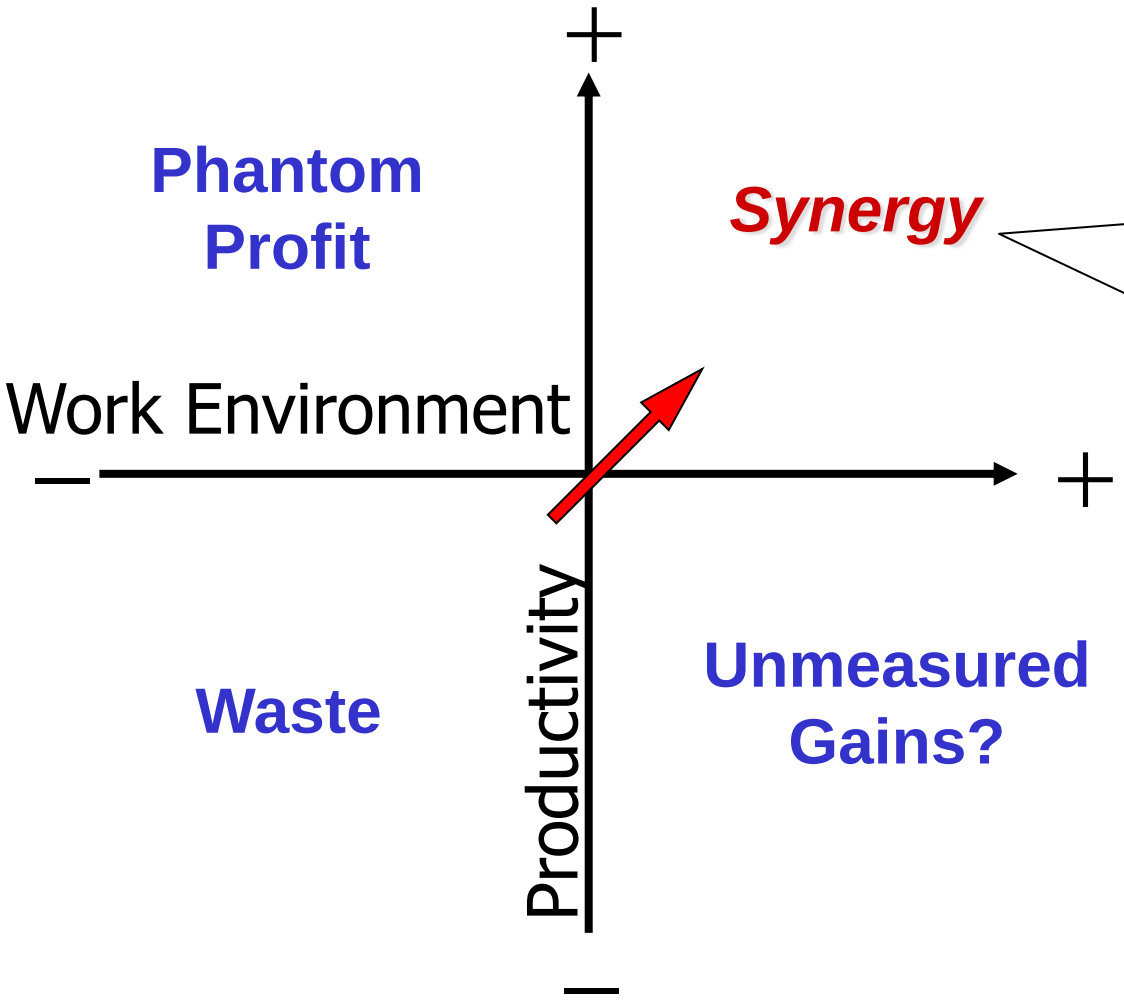
“the irony of ergonomics” Health focus opens doors, but limits its application

(Theberge & Neumann, 2013, IR/RI)


Strategies
Product Design
System Design
Production System
Risk
Factors
H&S Service
H&S Feedback
?
(time lag, delay)
Disorders,
Productivity, Quality…
Technical Performance Feedback
Strategies
Product Design
System Design
Production System
Risk
Factors
H&S Service
H&S Feedback
(time lag, delay)
Disorders, Productivity, Quality…
Technical & Human Performance Feedback

People (not tek.) provide sustainable strategic advantage and good work environment helps realize that advantage (RBV View of the firm)

(Dul & Neumann, 2009)



95% of studies show win-win effects when HF use in design

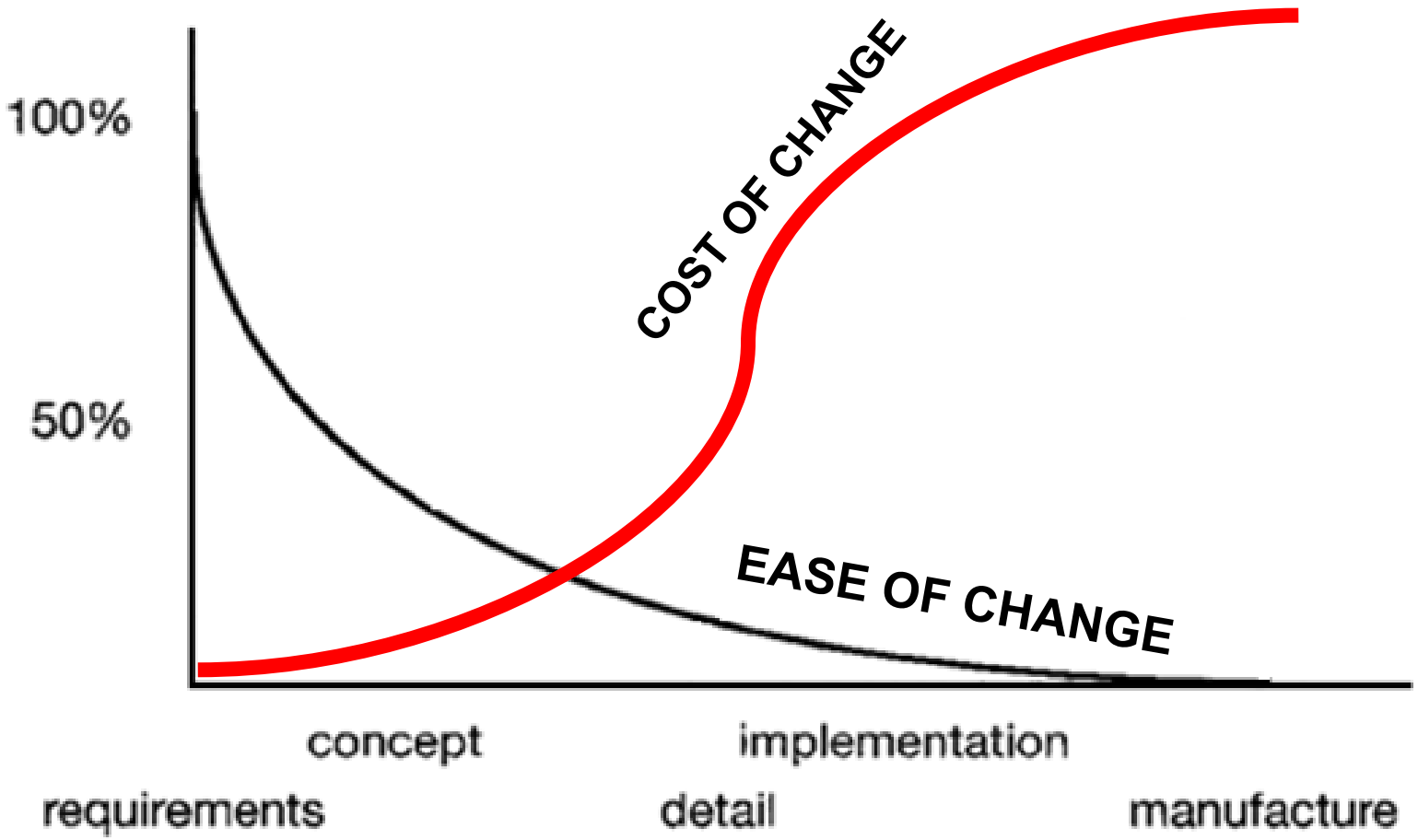
(Neumann & Dul, 2010, IJOPM)

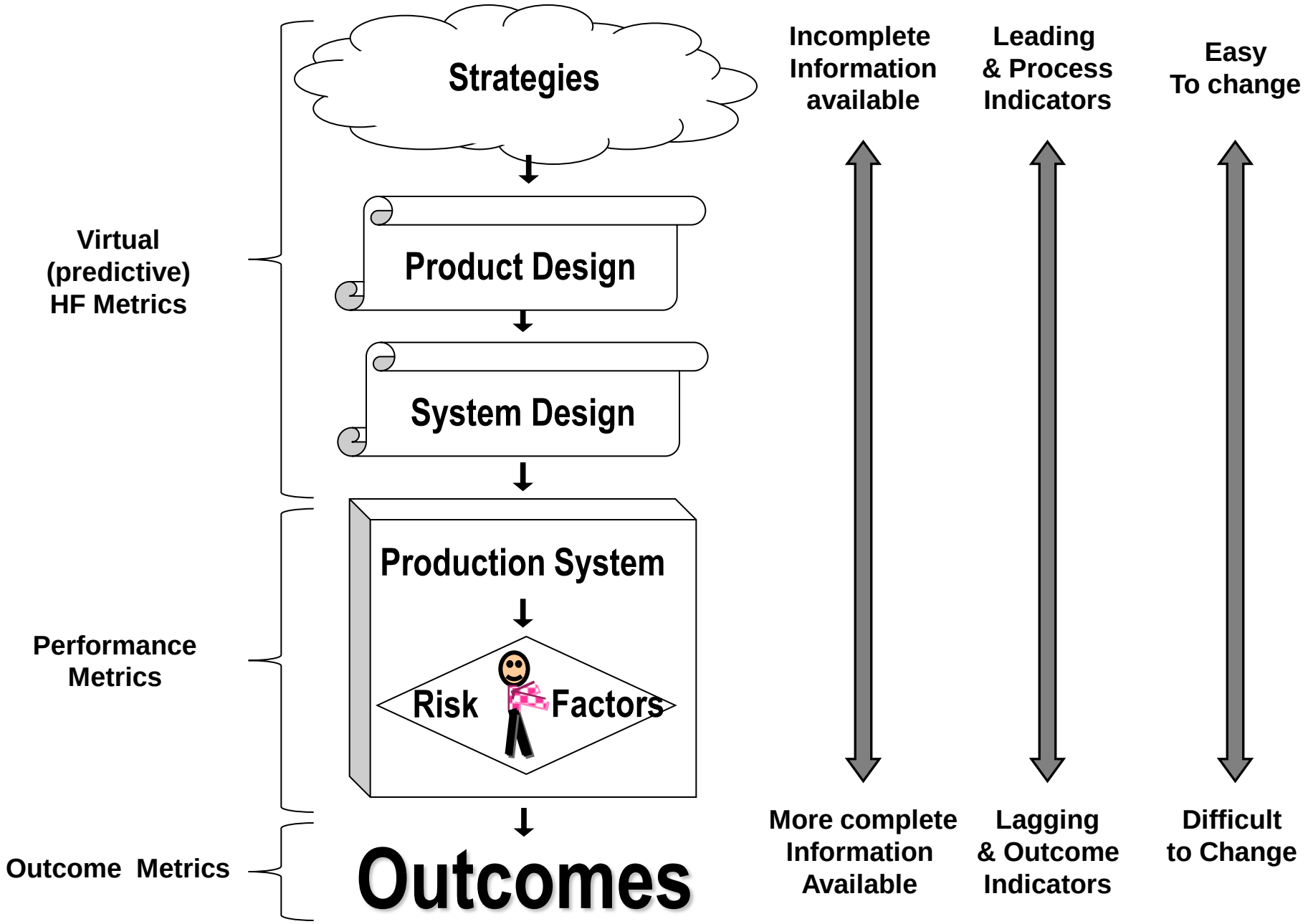
What have you got to offer Designers?

Safety = performance

Use Goal Hooking Strategies...

Change costs more later





(Neumann et al., 2013, ICMR)

Why Engineers Don't Consider WE

TABLE 1. Ranking of Constraints to the Integration of Work Environment (WE) Considerations Into Engineering ($n = 441$) (Three Marks).

Type of constraint	%
Lack of time	44
Lack of work environmen	44
Lack of methods and tools	40
Customers do not demand ent	28
Management does not app	17
It is difficult to use the au	17
Management is not comm	15
There is no tradition for d	13
It is troublesome	11
It is not required by the au	7
The safety organization does not ask for it	6
The subject does not have my interest	5

1. **Lack Time**
2. **Lack Knowledge**
3. **Lack Tools**
4. **Lack Mandate**

(Broberg, 1997, IJIE)

Niccolo Machiavelli, 1469-1527

- *“human beings are wretched creatures, governed only by the law of their own self-interest.“*

1. Change is a process
2. Expect resistance
3. Build support

- *Innovation makes enemies of all those who prospered under the old regime, and only lukewarm support is forthcoming from those who would prosper under the new.*

Think, don't fight!

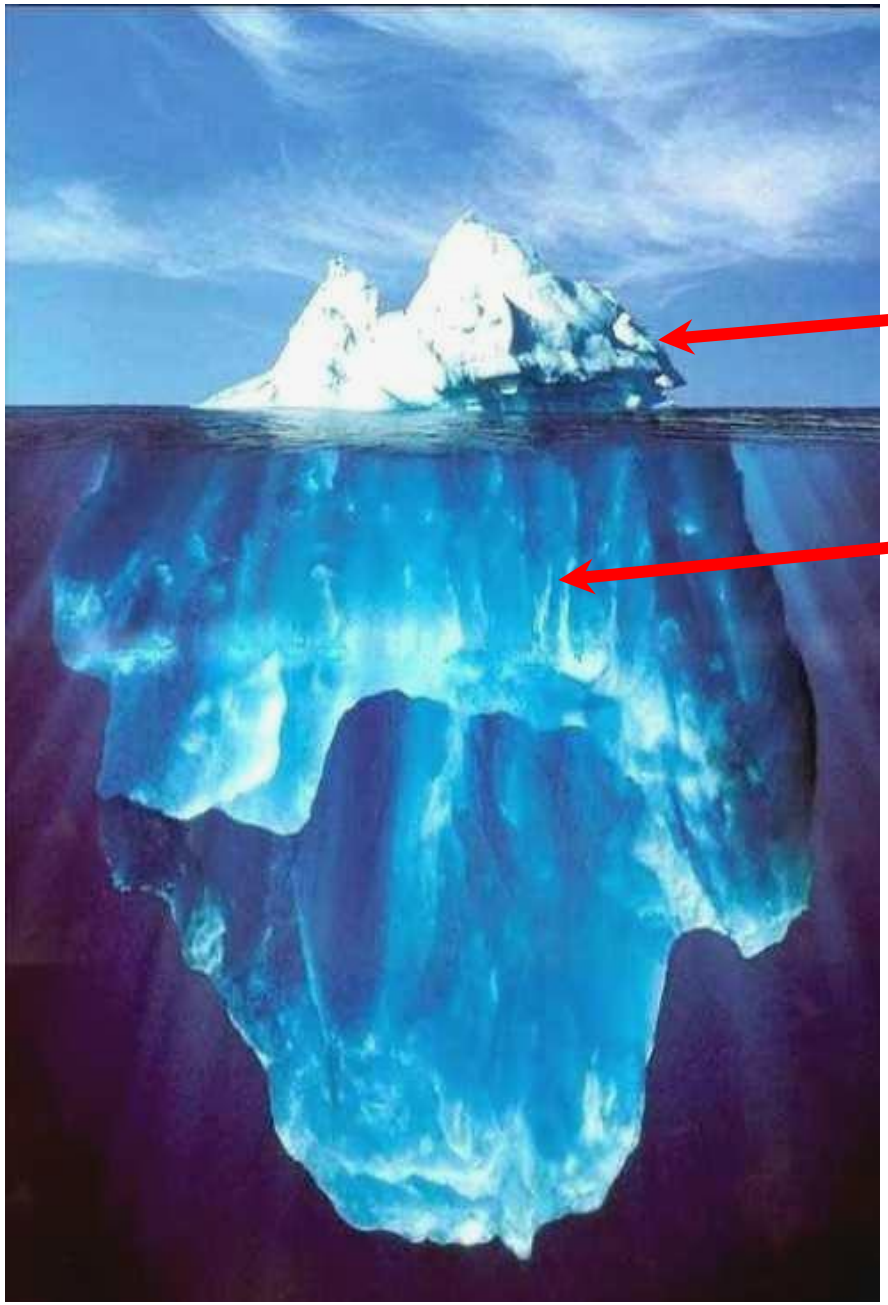
Organisational Work

- RESISTANCE?

USE MORE QUANTITATIVE TOOLS

HOOK TO EXISTING GOALS

(Theberge & Neumann, 2010)

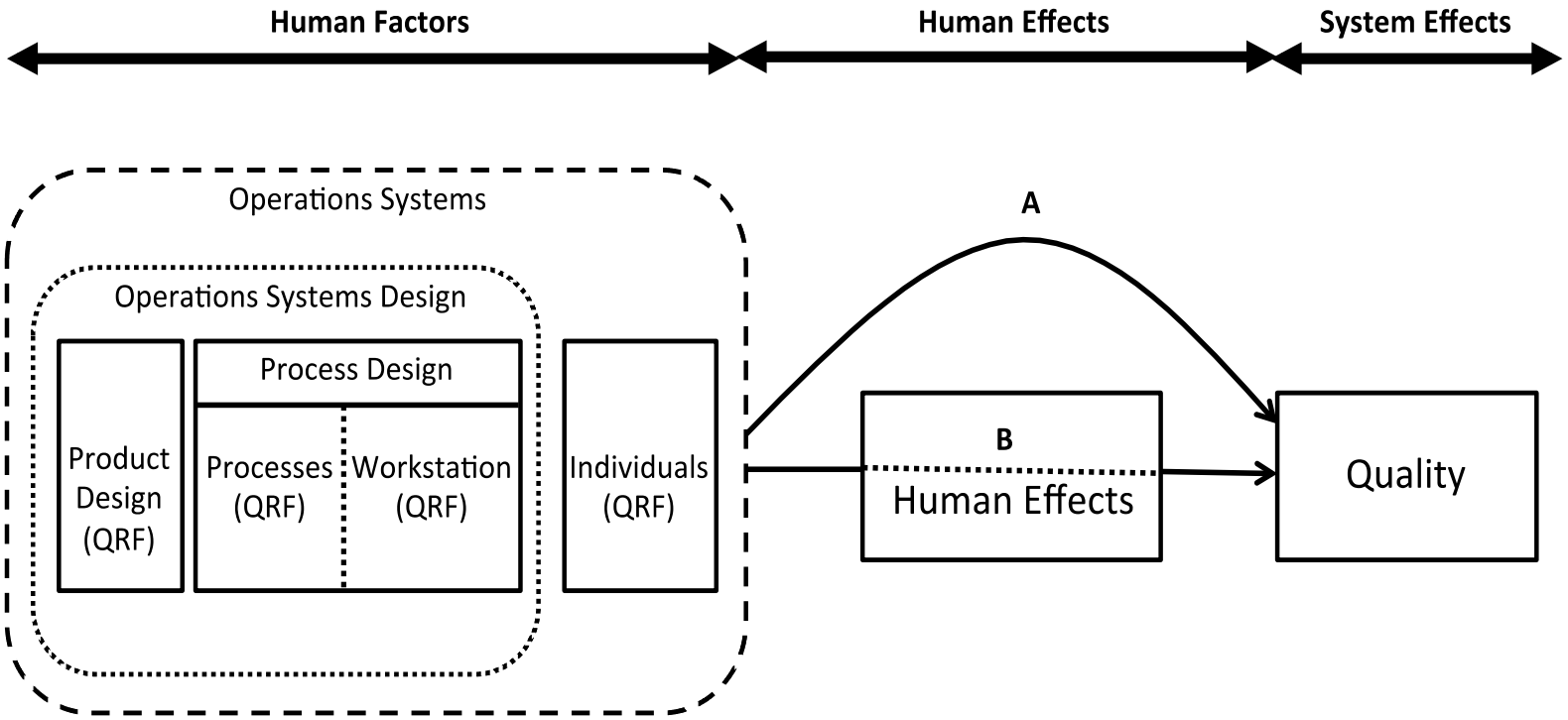


Gains with Ergonomics:

- Sickness & abs.

- Productivity
- Lead Time
- Delivery Precision
- Quality
- Flexibility
- more…

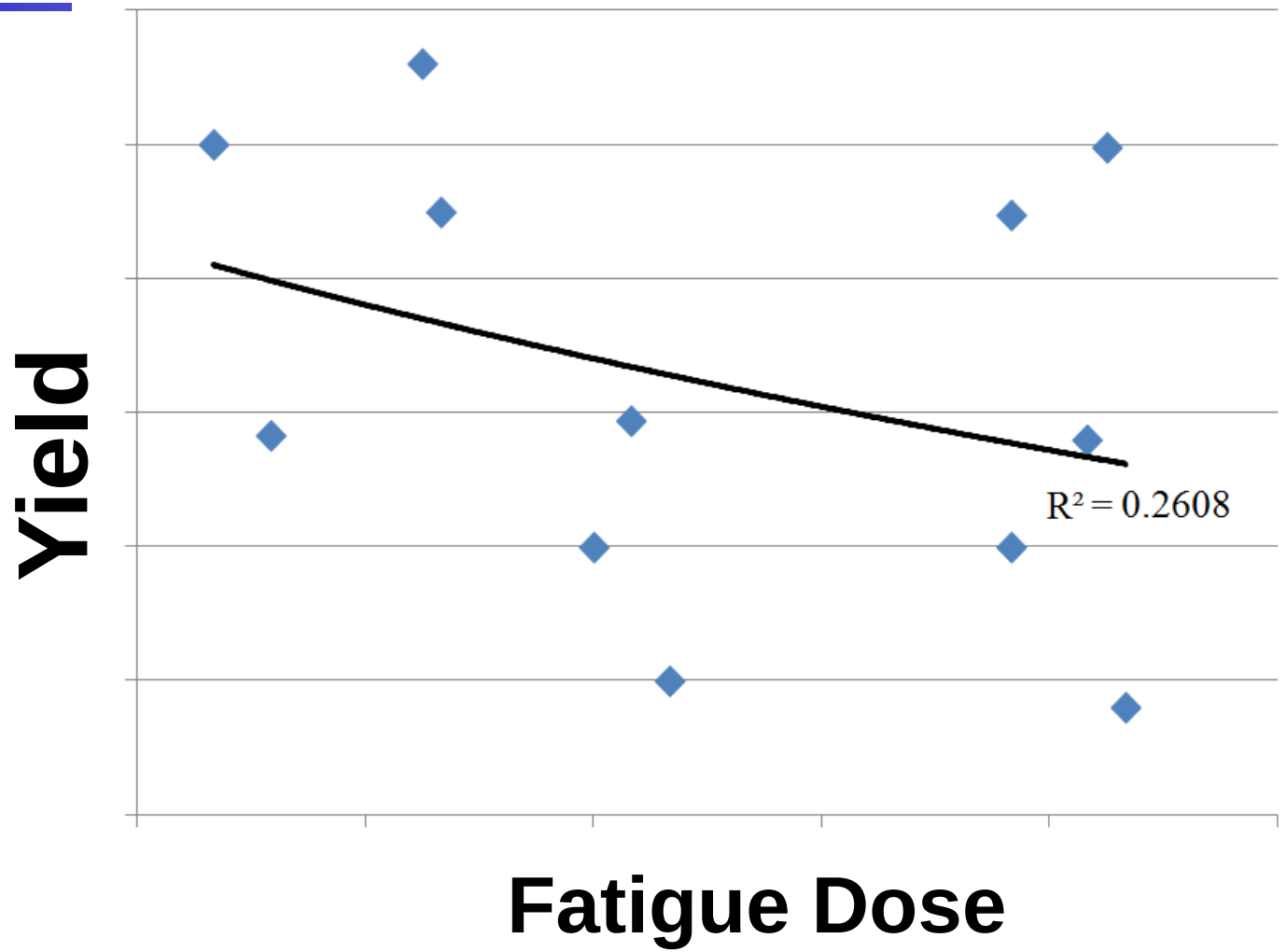
Quality as a common interest.



71 Studies, ½ identify fatigue as a factor

(Kolus et al., submitted)

Fatigue Dose and Quality

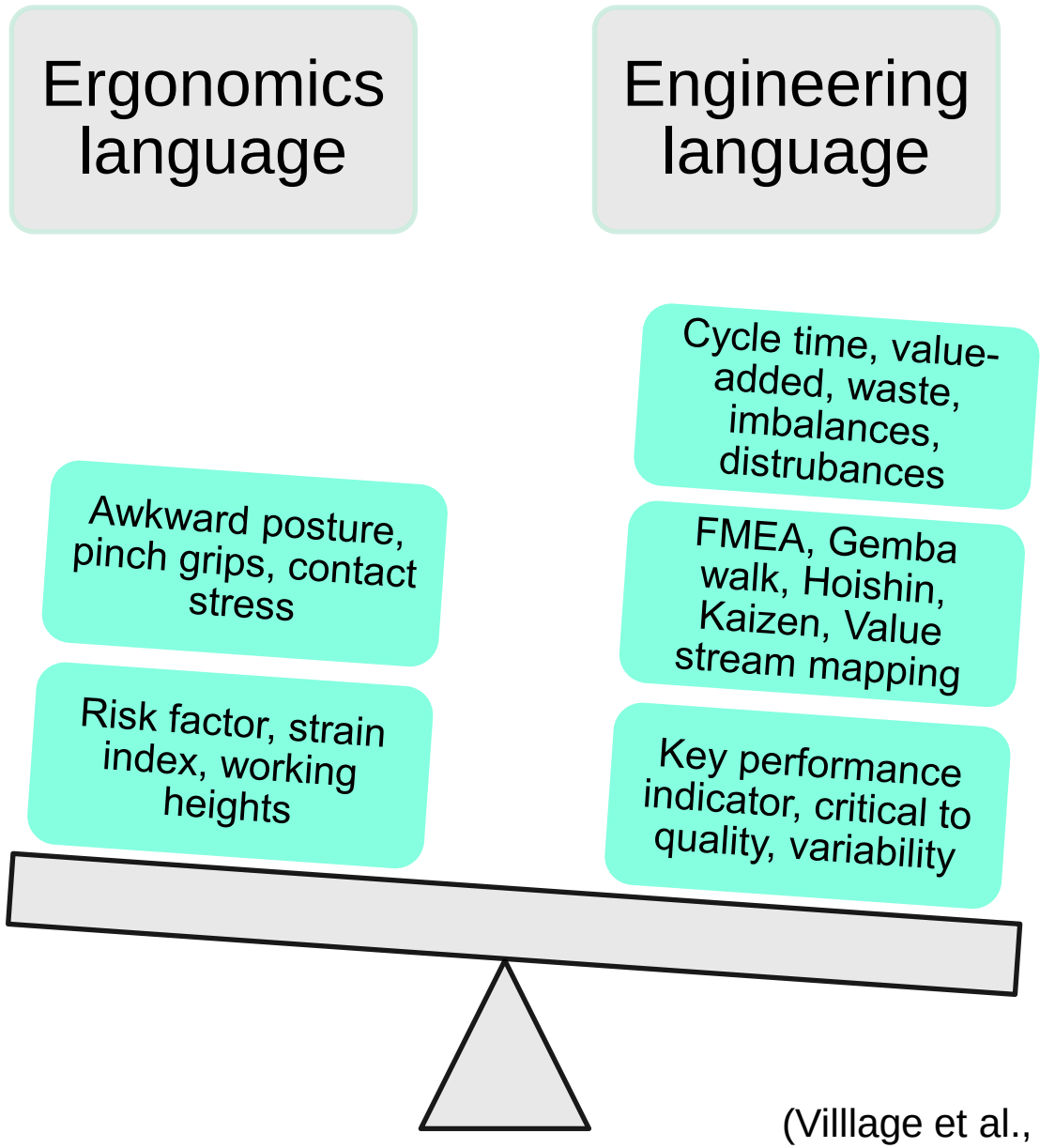


(Dode et al., 2016 IJPR)

Blackberry Case – Embedding HF into Design

(Village et al., 2015, Ergonomics)

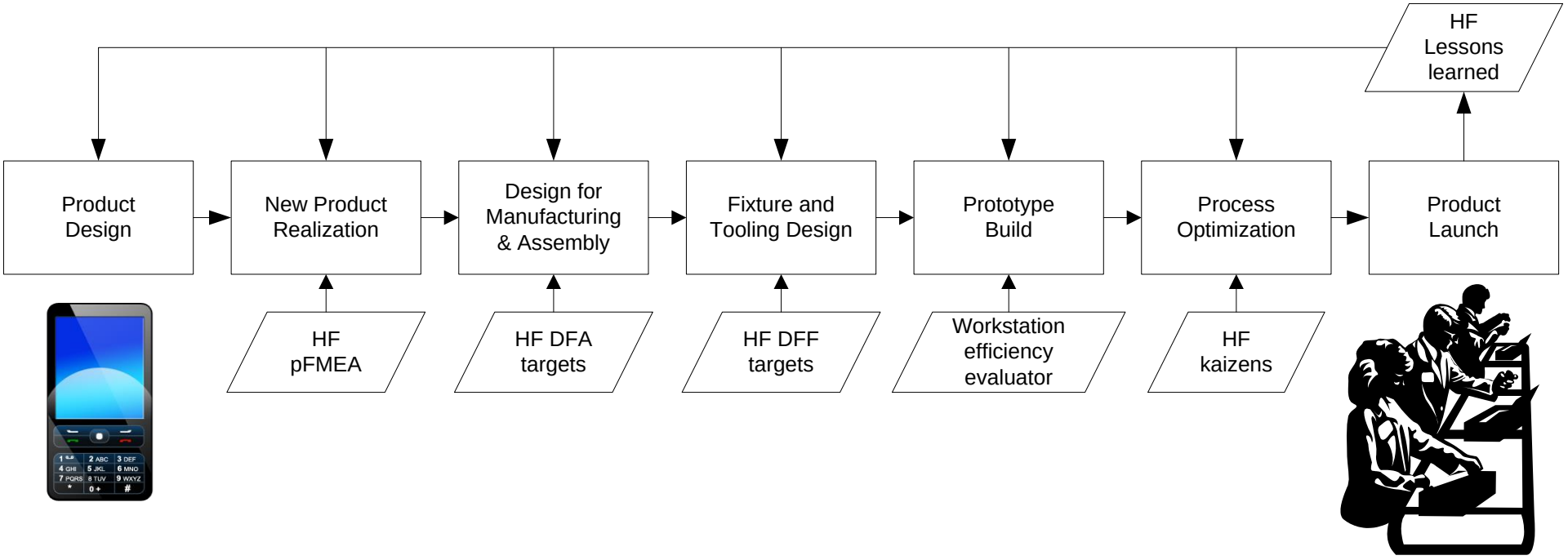
Learn to talk to Engineers.



(Villlage et al., 2015, Ergonomics)

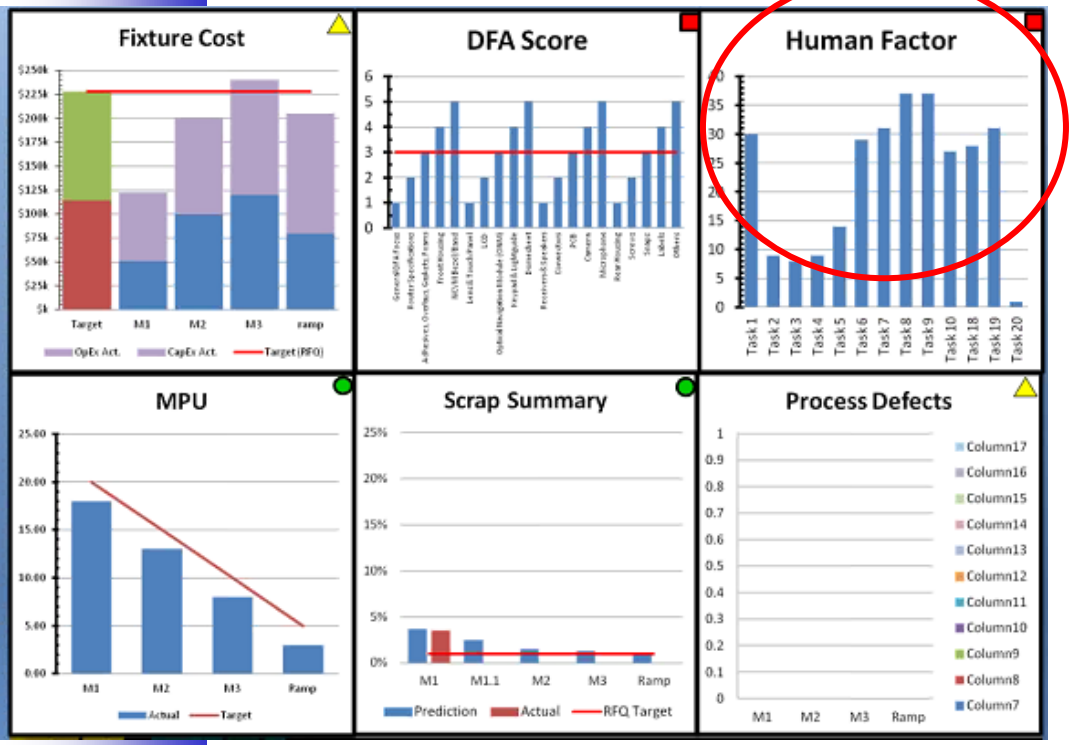
Adapt tools to suit the local design process

METHOD + PROCESS!



(Village et al., 2014, IIE-TOEHFS)

Locking the HF-DFA into Process



Engineer:

"HF that accommodates KPIs (targets) fits well with DFA - along with cost, scrap etc -this fits in perfectly"

Final Messages

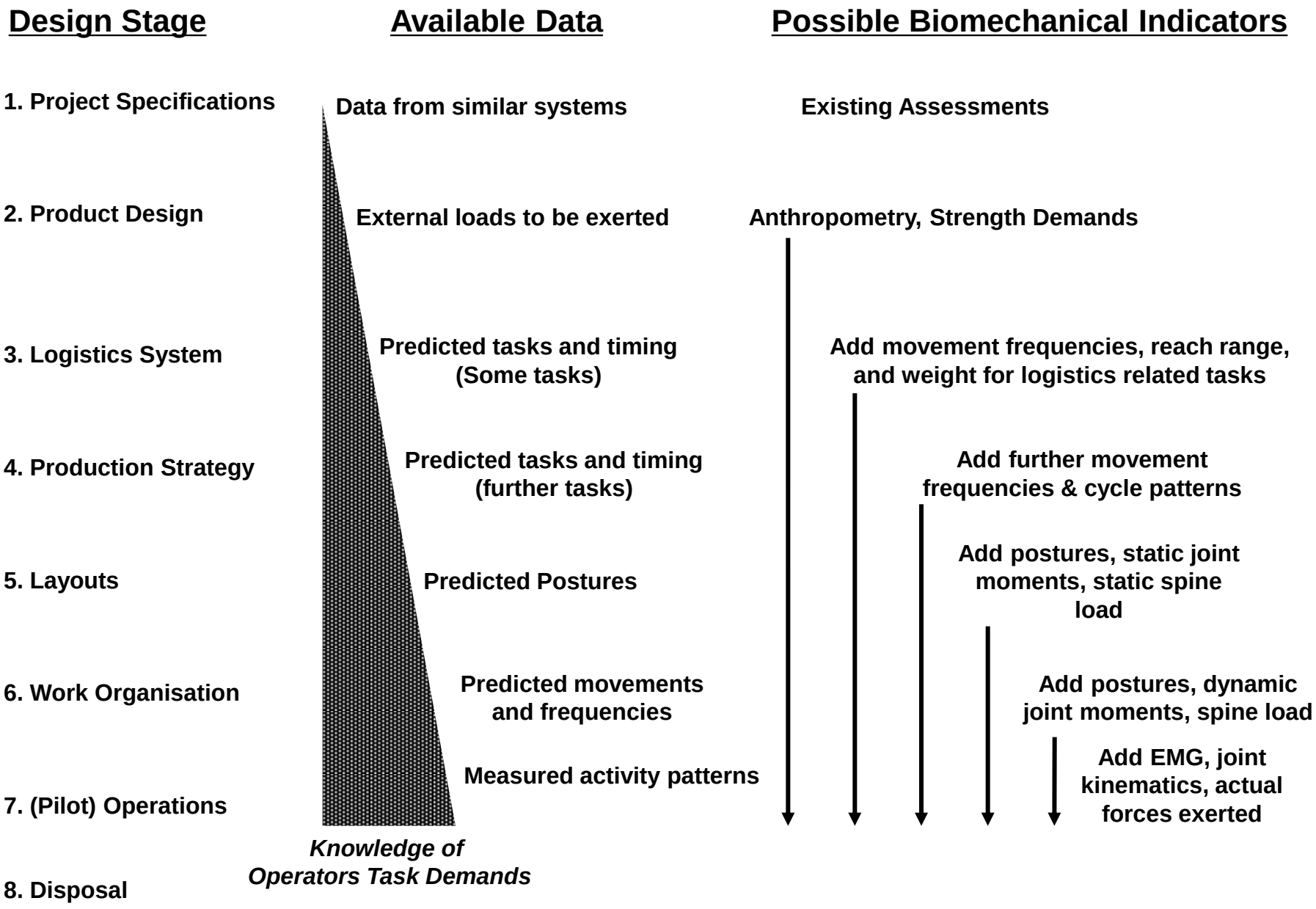
- Risk is EMERGENT, use a systems view
- Risk yields poor performance
- Goal hook: use performance gains to get designer buy-in
- Design teams need training & methods
- OHS is too important to leave to OHS specialists
- Work in design stages for prevention

STOP TALKING ABOUT HERE

STOP TALKING ABOUT HERE

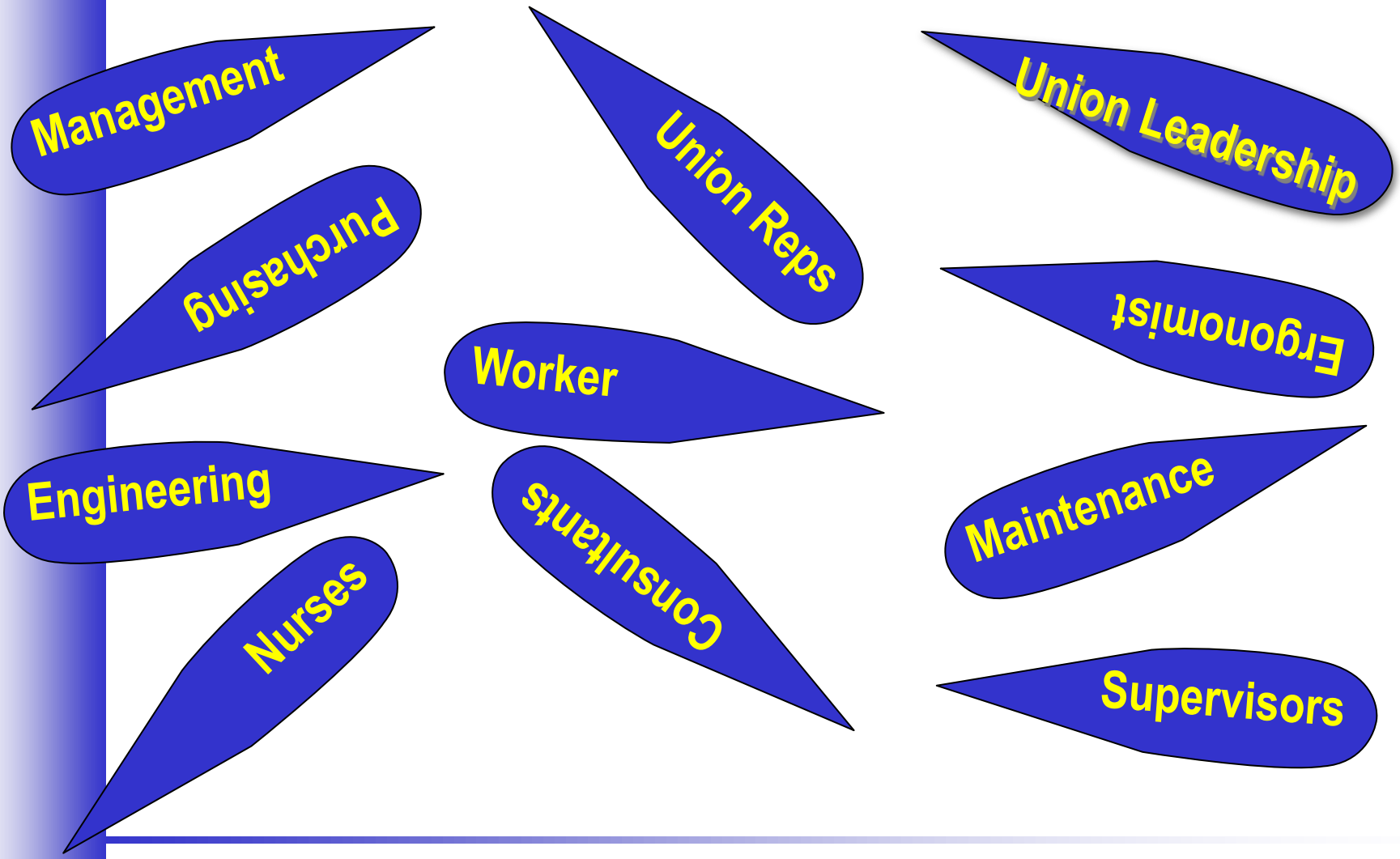
STOP TALKING ABOUT HERE

STOP TALKING ABOUT HERE



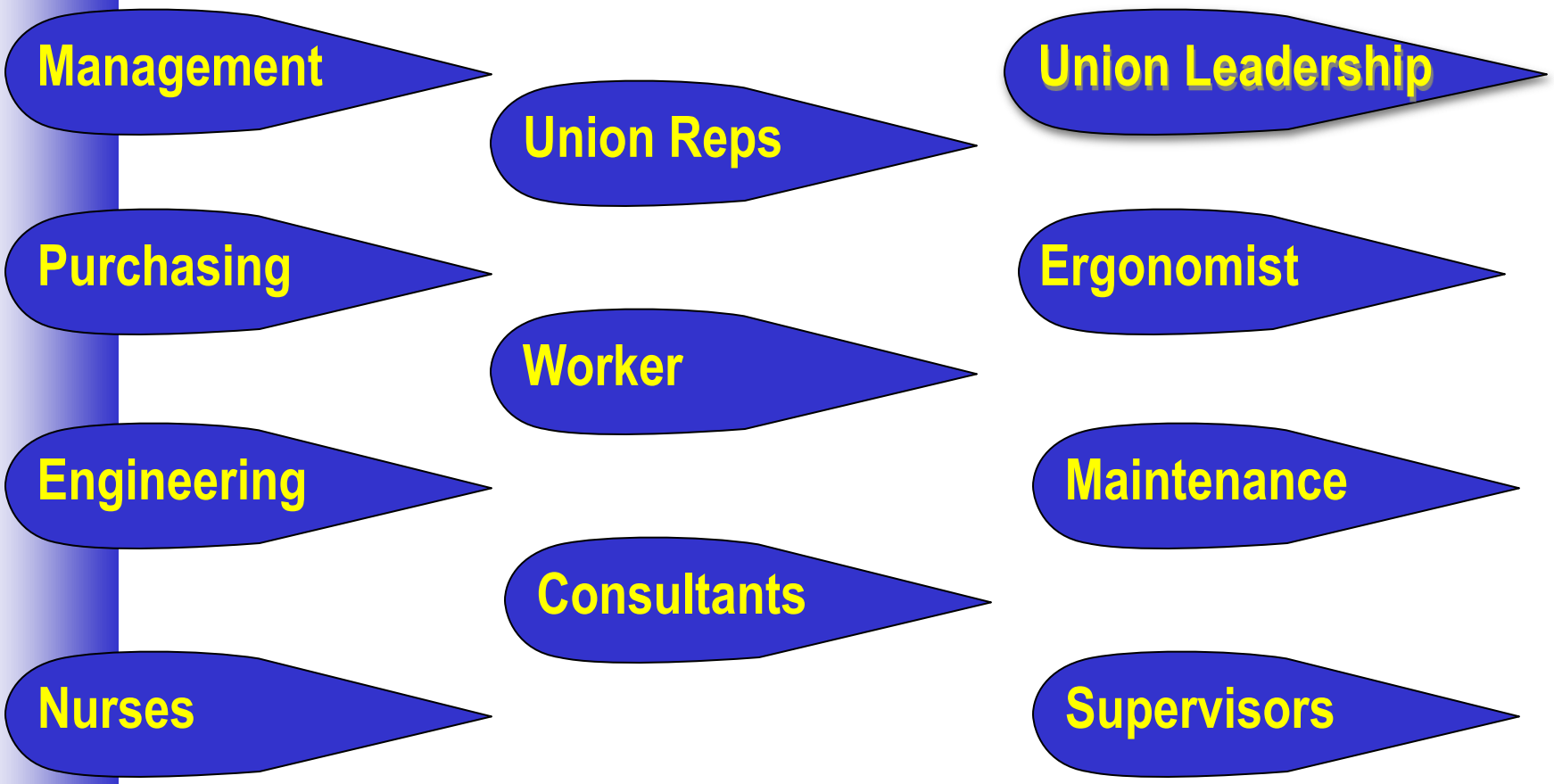
(Neumann & Wells, 2006, CRC Press)

Who is involved? Who has knowledge?



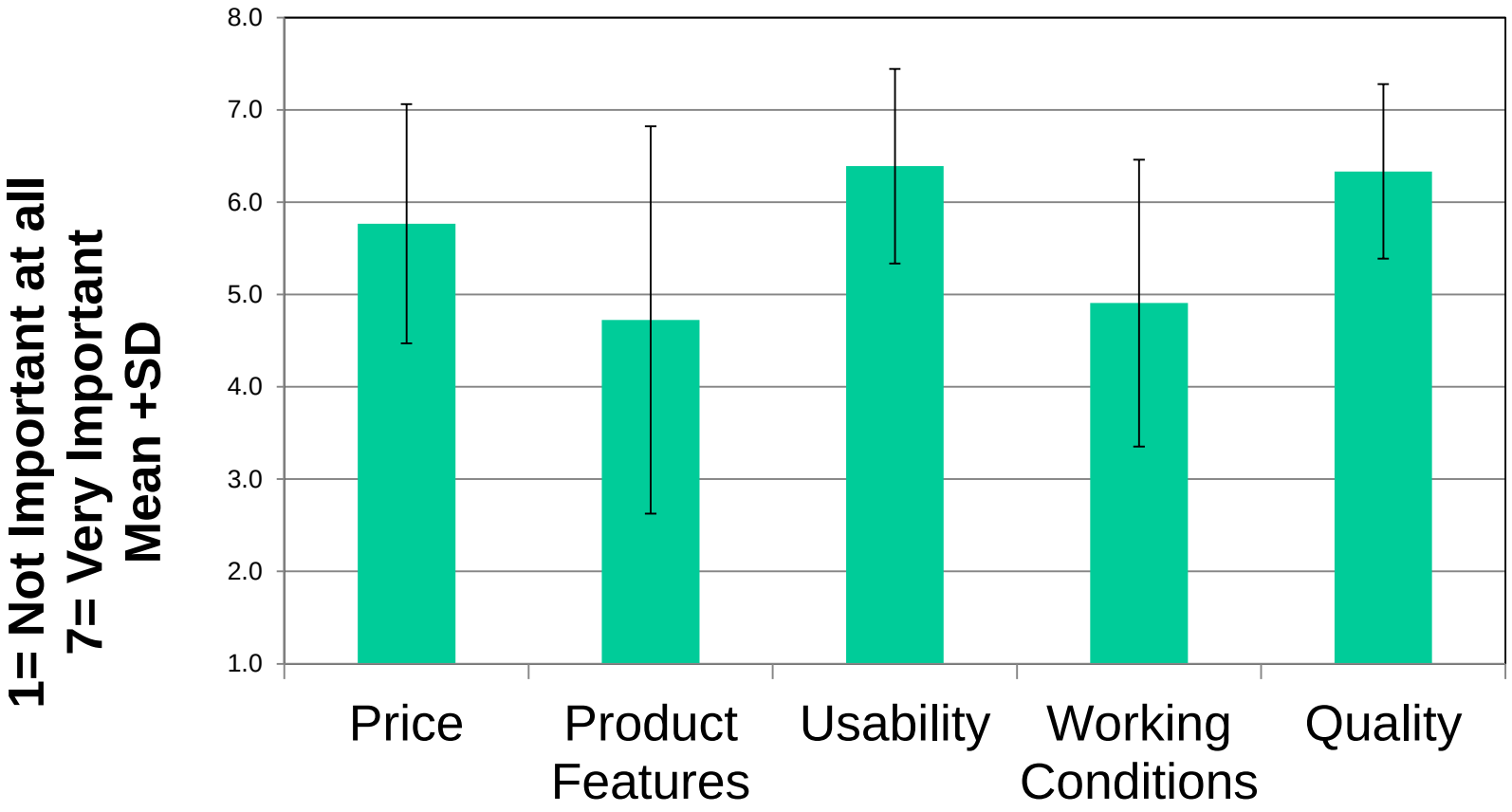
Neumann et al. (ACE - 1999) Roles and Relationships…

Roles in Ergonomics



Neumann et al. (ACE - 1999) Roles and Relationships…

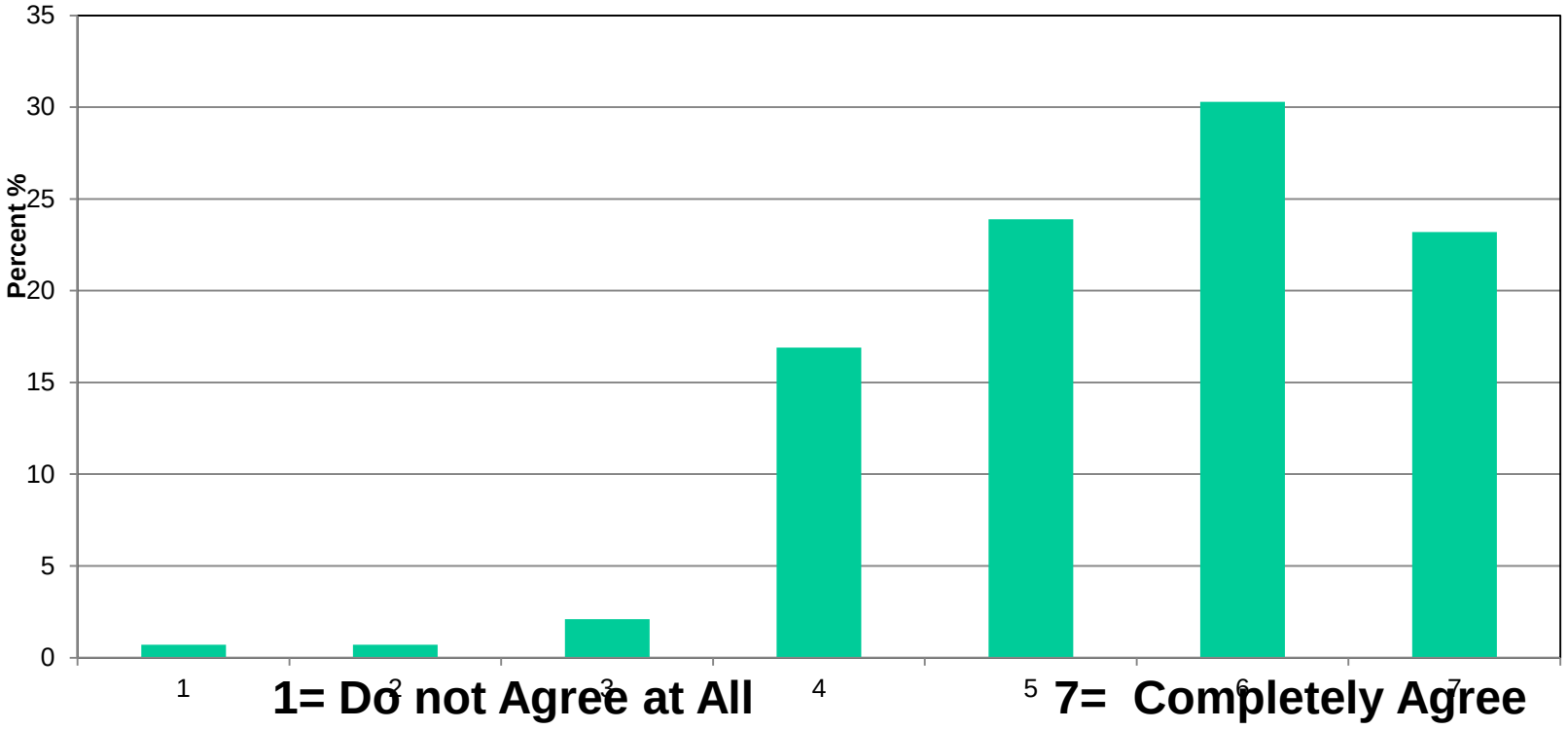
Factors most Central in Purchasing Decisions (Mean +-SD)



WC and PF not sign. Different, but are from P, U & Q

(Neumann et al., Ergonomics, 2014)

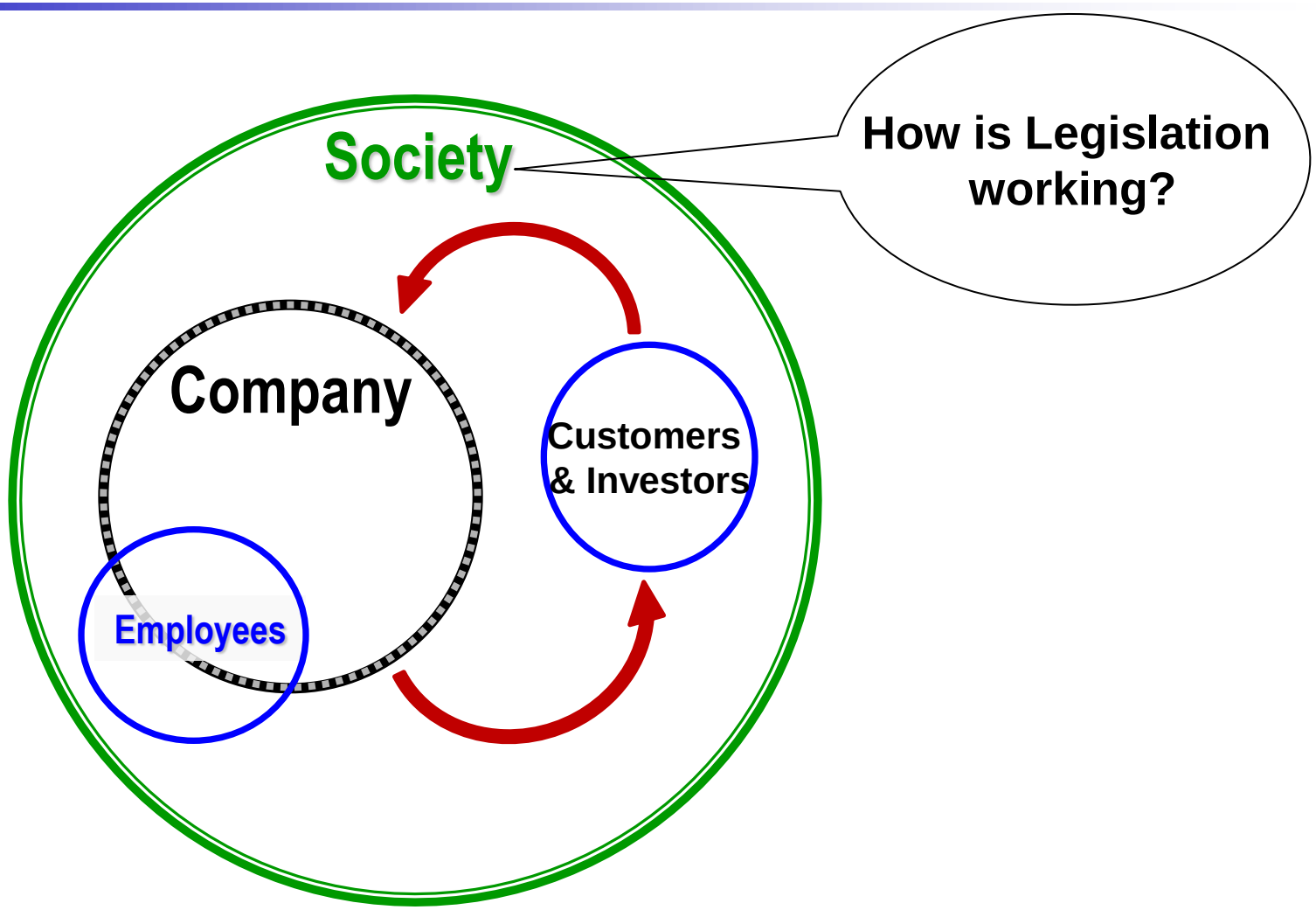
preferences for purchasing goods made under healthy working conditions



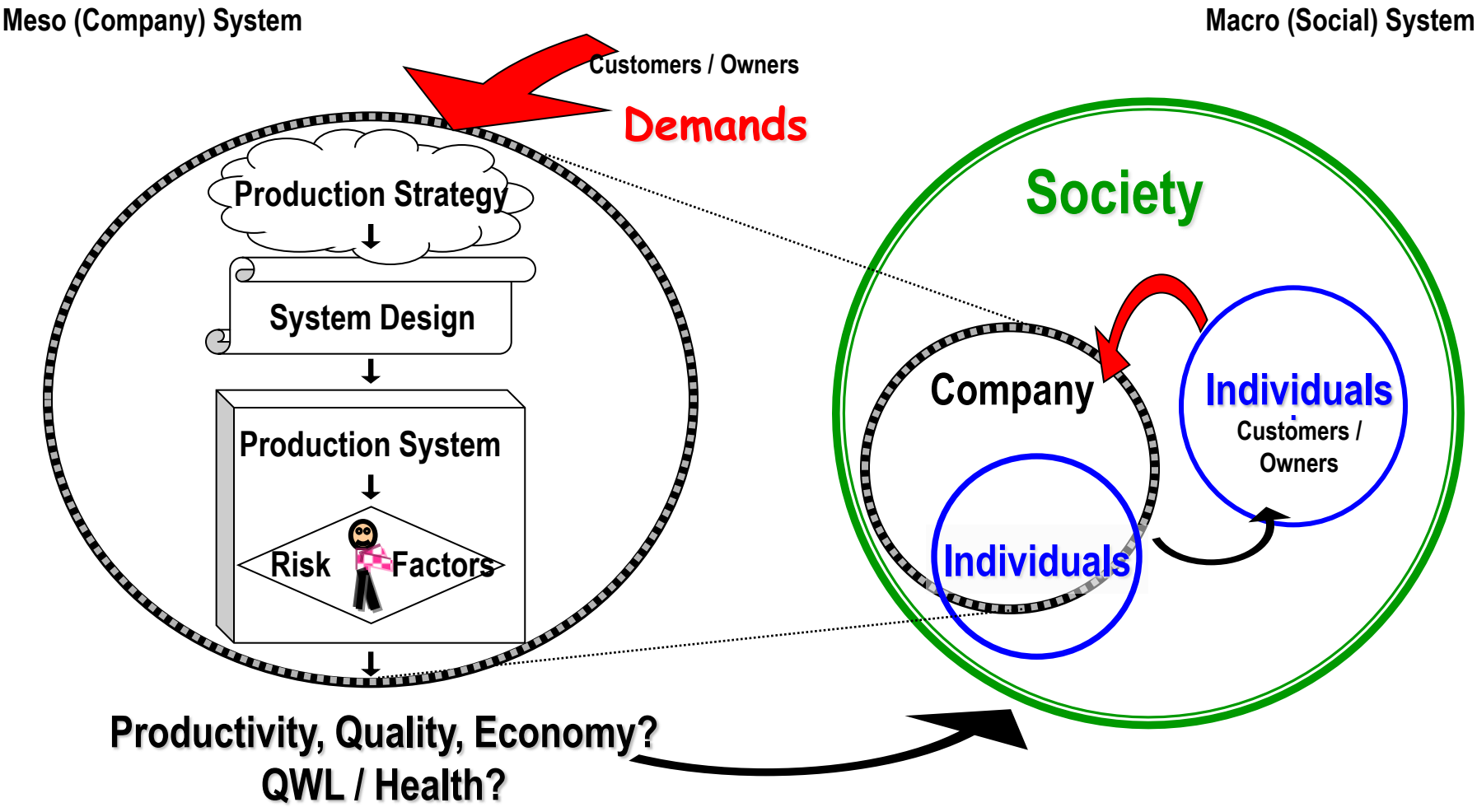
Participants claim willing to pay 17.5% more on a $100 product

(Neumann et al., Ergonomics, 2014)

“Ergo”Brand as differentiation strategy



ODAM SYSTEM



WIDE RANGE OF STAKEHOLDERS not only Managers, Engineers, Operators…

Material Supply Strategy

Heavy Product with poor layout… and manual handling remained a problem

(LBP the single most reported MSD in the shop with >70% incidence)

(Neumann & Medbo, 2010 – Big Box vs. Narrow Bin, IJIE)

HFE Industrial Engineering R&D Human Factors Engineering Lab

RYERSON UNIVERSITY


VOLVO
VOLVO
'09 1 28

Manufacturing Strategies…

1.	TQM	Total quality management
2.	JIT	Jut in time production
3.	MC	Manufacturing cells
4.	ICBT	Integrated computer based technology
5.	CE	Concurrent engineering
6.	TPM	Total productive maintenance
7.	TBW	Team-based working
8.	EMP	Empowerment
9.	LC	learning culture
10	OS	Outsourcing
11	SCP	Supply-chain partnering
12.	BPR	Business process reengineering

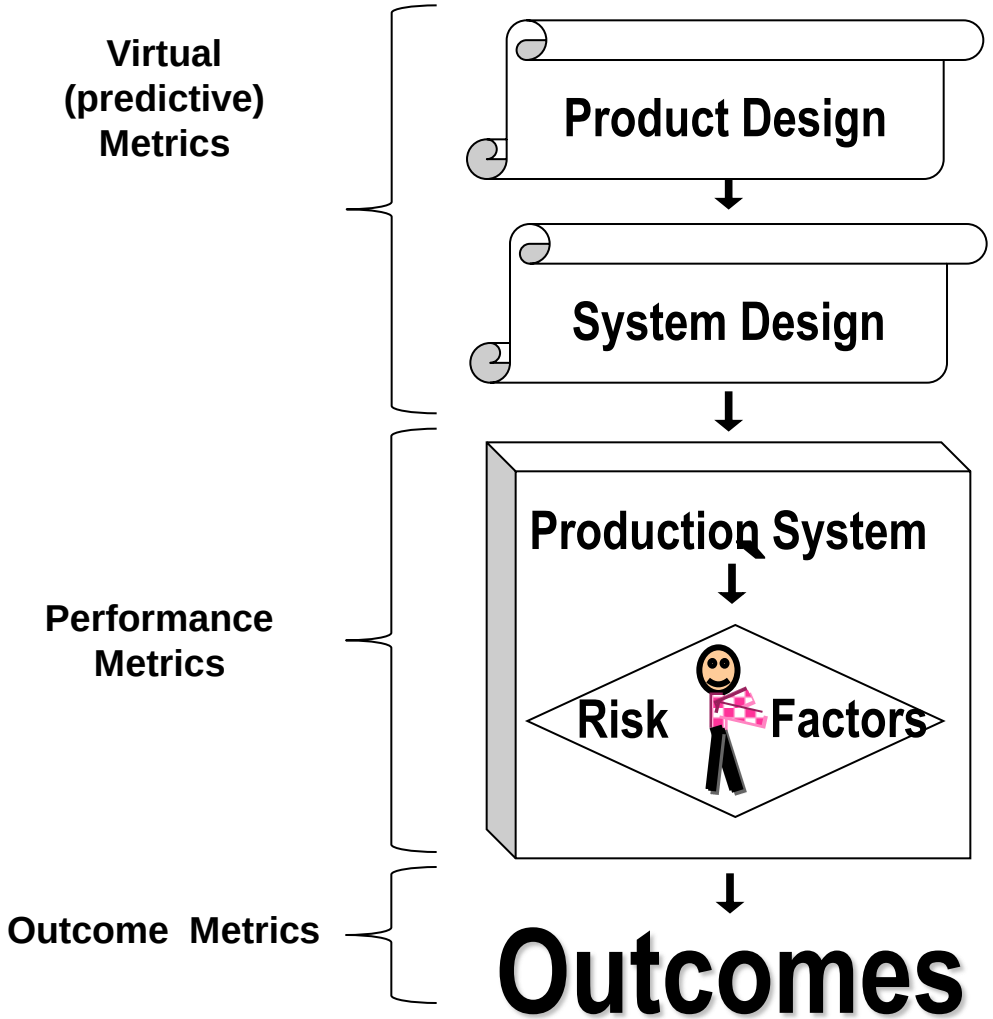
Arenas of Design – Tools needed

- **Organisational Design**
  - Organisation of Development
  - Structure, Strategy, Processes, Accountability
- **Product/Service Design**
  - Defines Assembly Task
  - Defines Market Relationship (and hence demand)
- **Production/Opertaions System Design**
  - Technology
  - Work Organisation

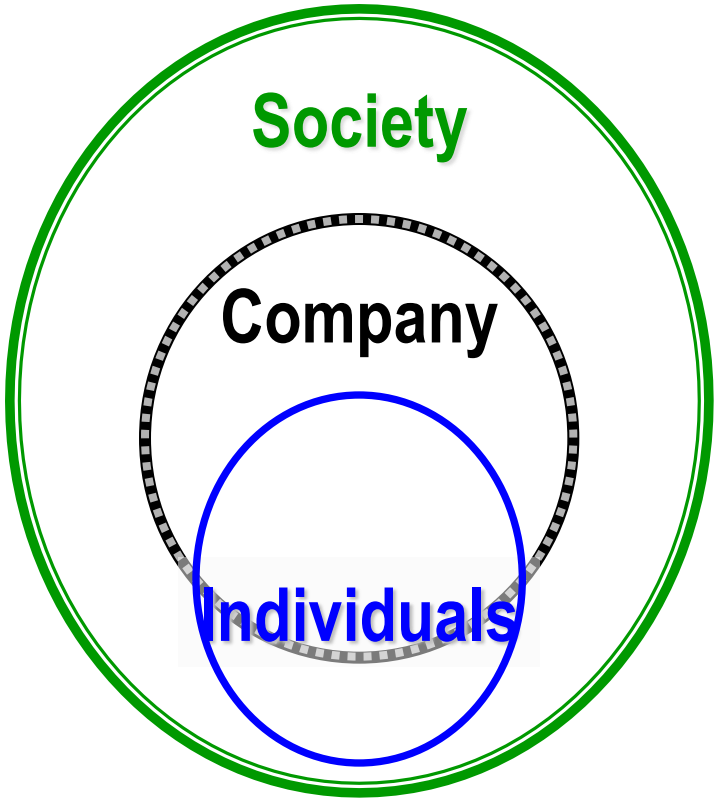

'02 5 24


VOLVO
V-EMB
FÖRSTA HJÄLPEN
VOLVO

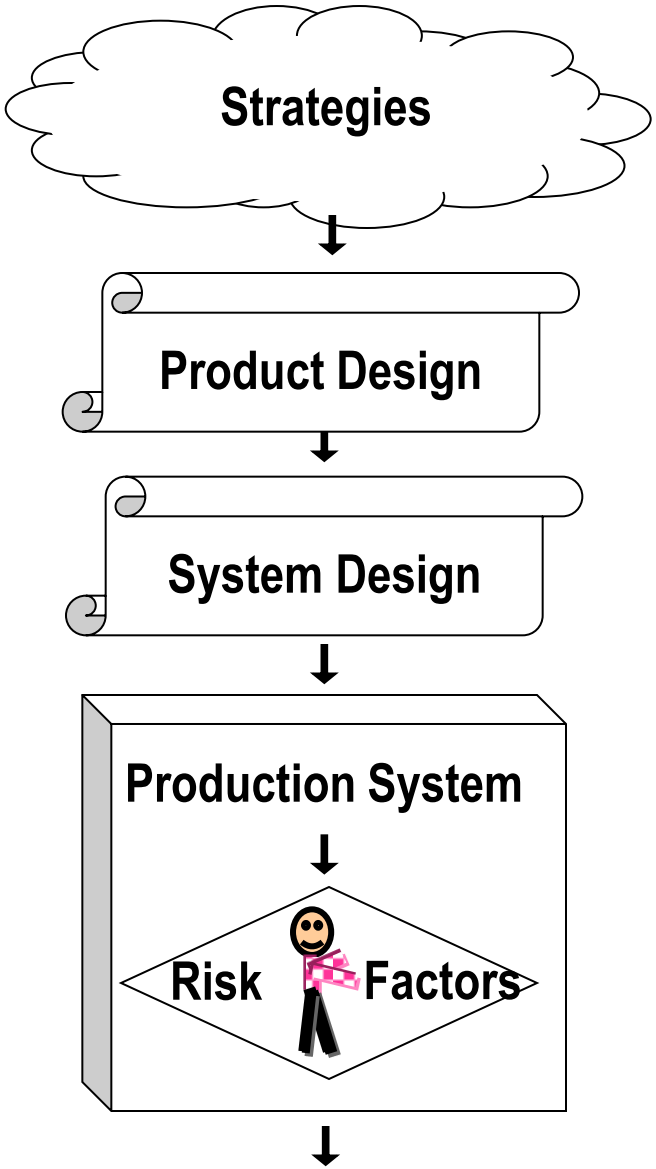
What of missing Human Factors aspects?



System Contexts



- **Globalization** (Netherlands 16th c.)
- **'Hyper-Competition'** (D'aveni 1994)
- **Consumer Power** (Klein)



Source of HF problems Is throughout Development process

Outcomes include Performance & Wellbeing

Company Strategies

Product Design

System Design

Production System

Risk Factors

H&S Service

H&S Feedback

?

Technical Performance Feedback

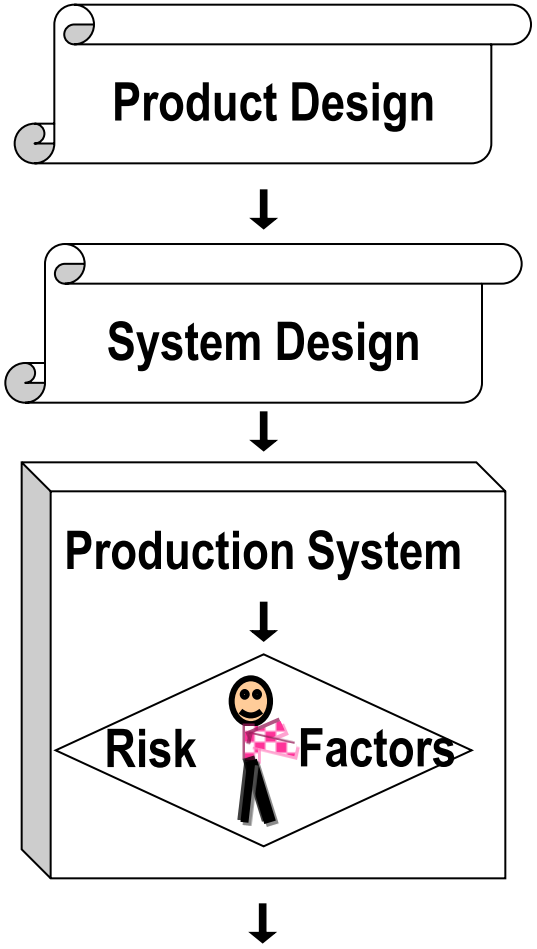
(time lag, delay)

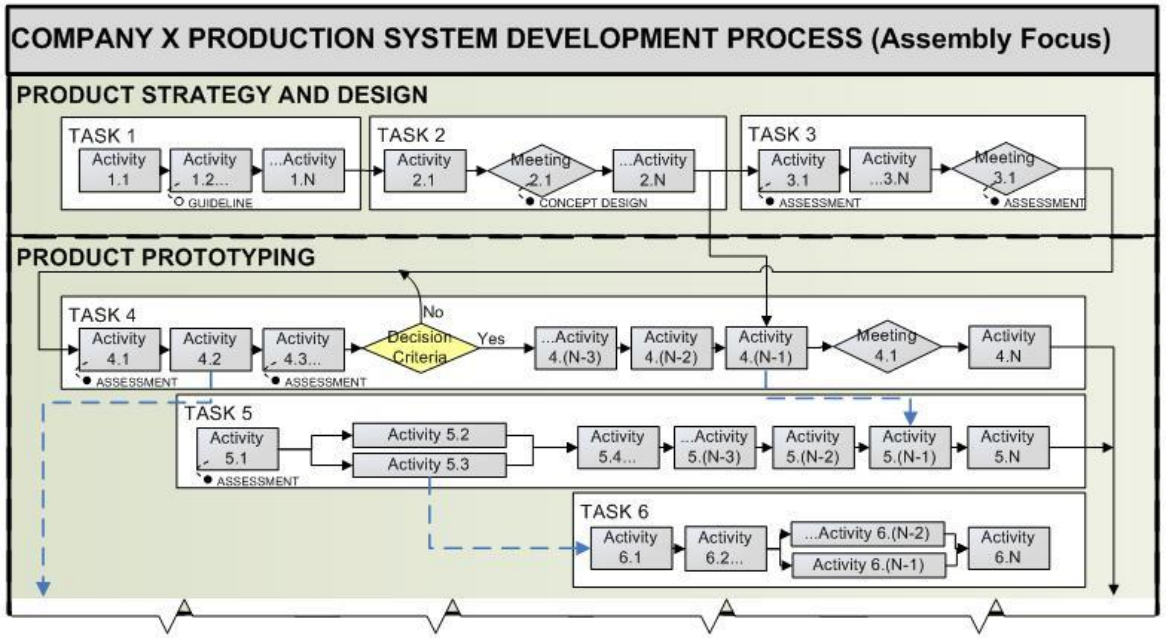
Disorders, Productivity, Quality…

Ergonomics 'Side Car'

(Neumann & Village, 2012, Ergonomics)

MAP THE DESIGN PROCESS

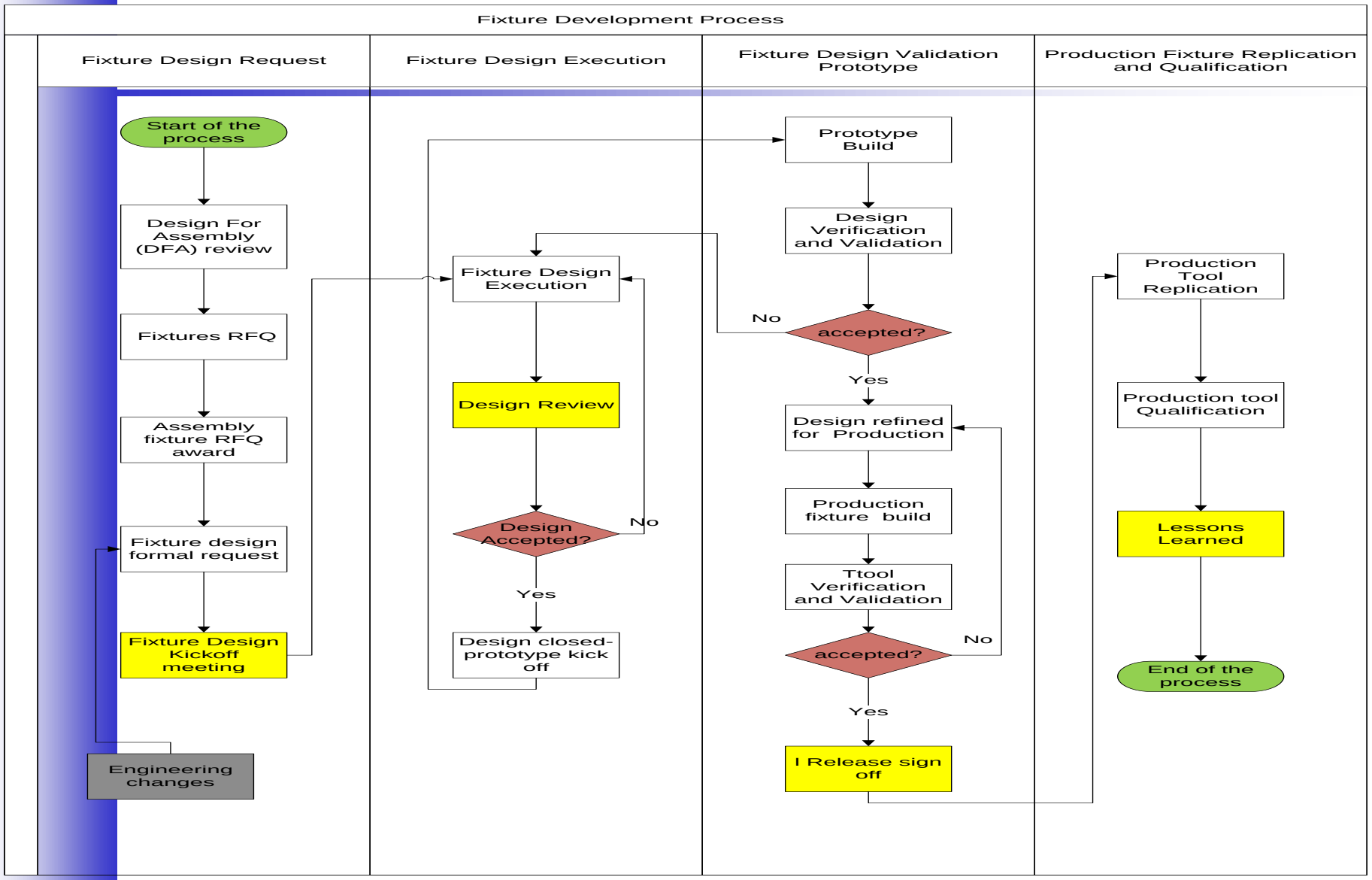




- Watch out for detail level
- Adapt as needed
- Use participatively to
- Identidy Opportunities`

Health, Productivity, Quality…

Process Mapping – of Design Process: Where does HF fit?`

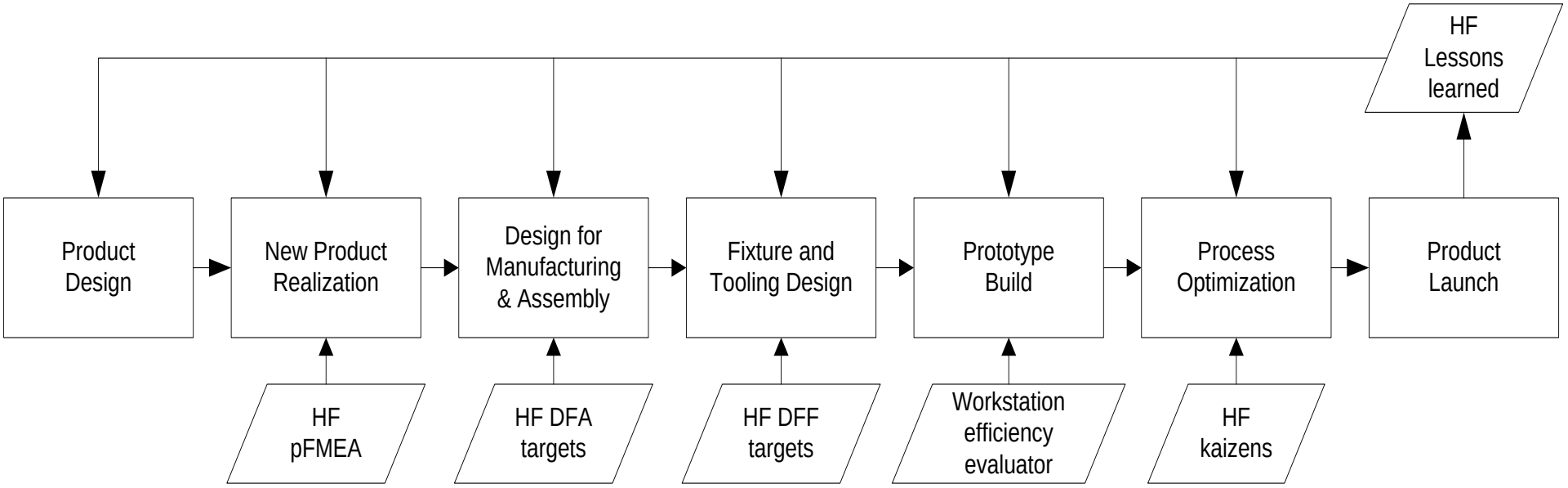


Note: HF sign-off required at yellow boxes

Industrial Engineering R&D
Human Factors Engineering Lab

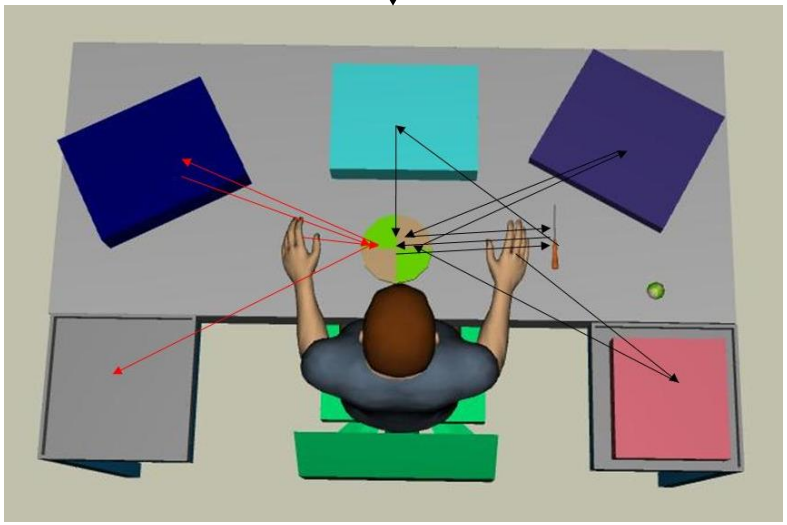
RYERSON UNIVERSITY

BlackBerry Case: Adapt IE tools to include HF and integrate in design process



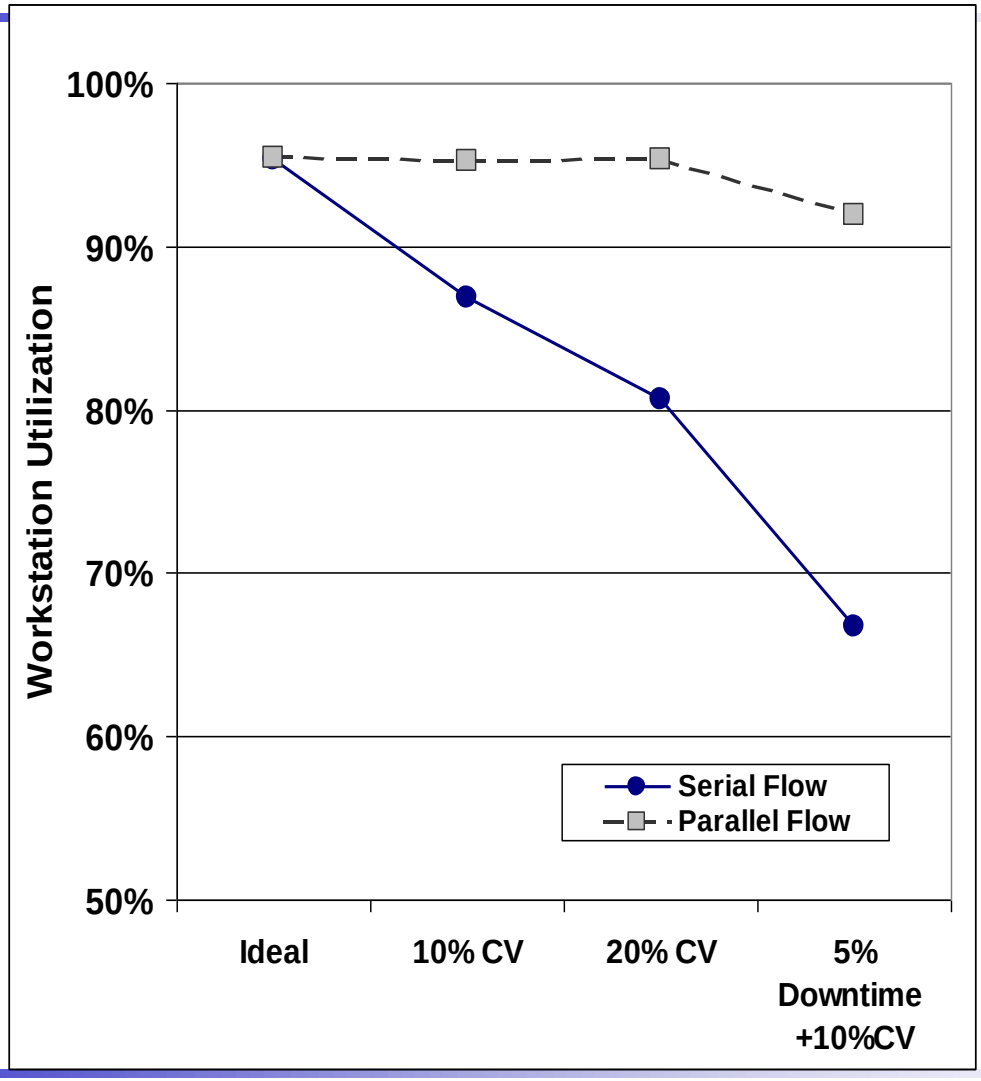
(Village et al, IIE TOEHFS, 2014)

How do you estimate worker demand in light assembly?



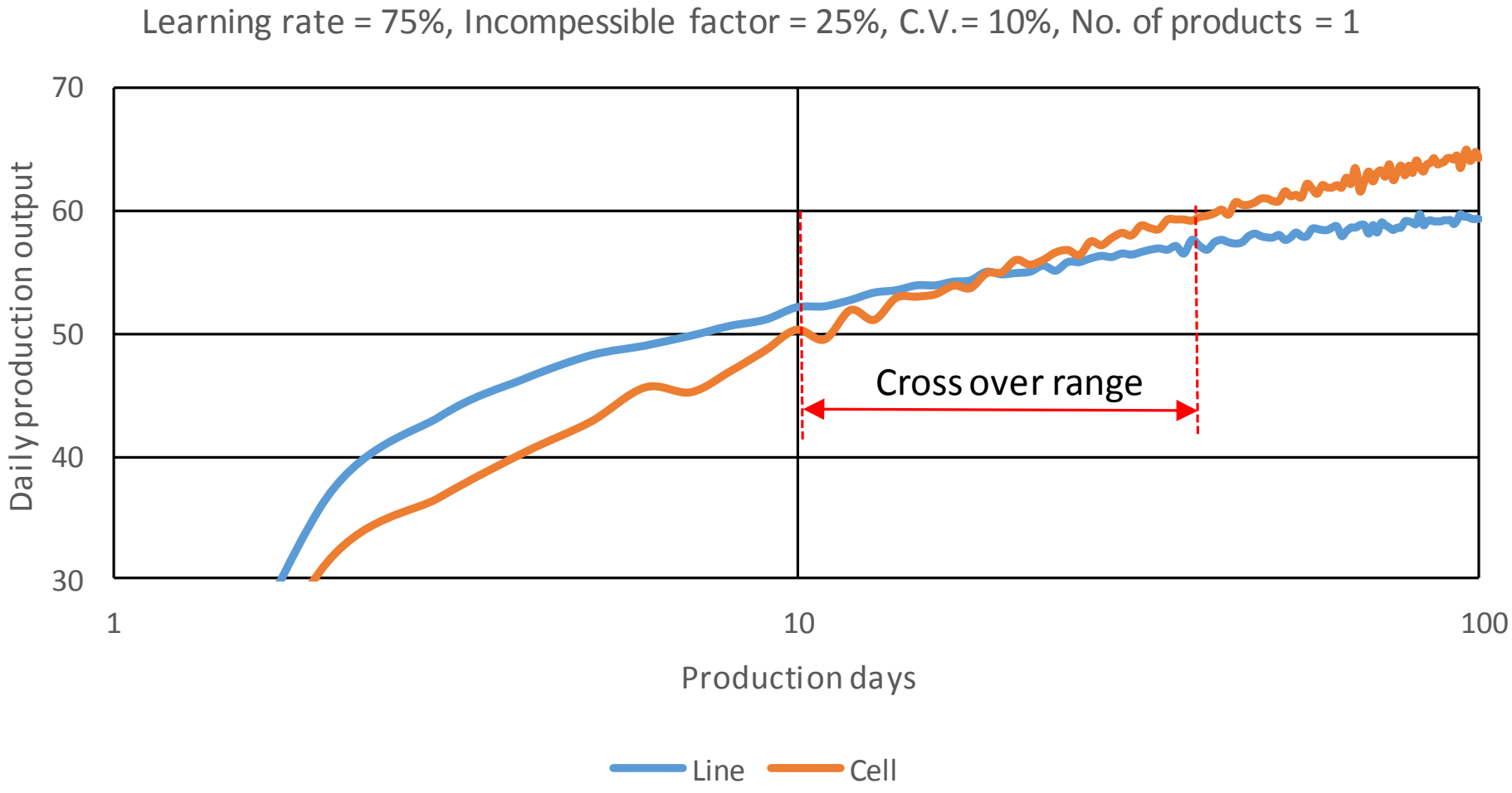
- **Create an easy to use tool that predicts light assembly worker task demands from design criteria**

Flow Simulation Model



(Neumann et al., 2009 IJOPM)

Flow Strategy & Ramp Up with Learning

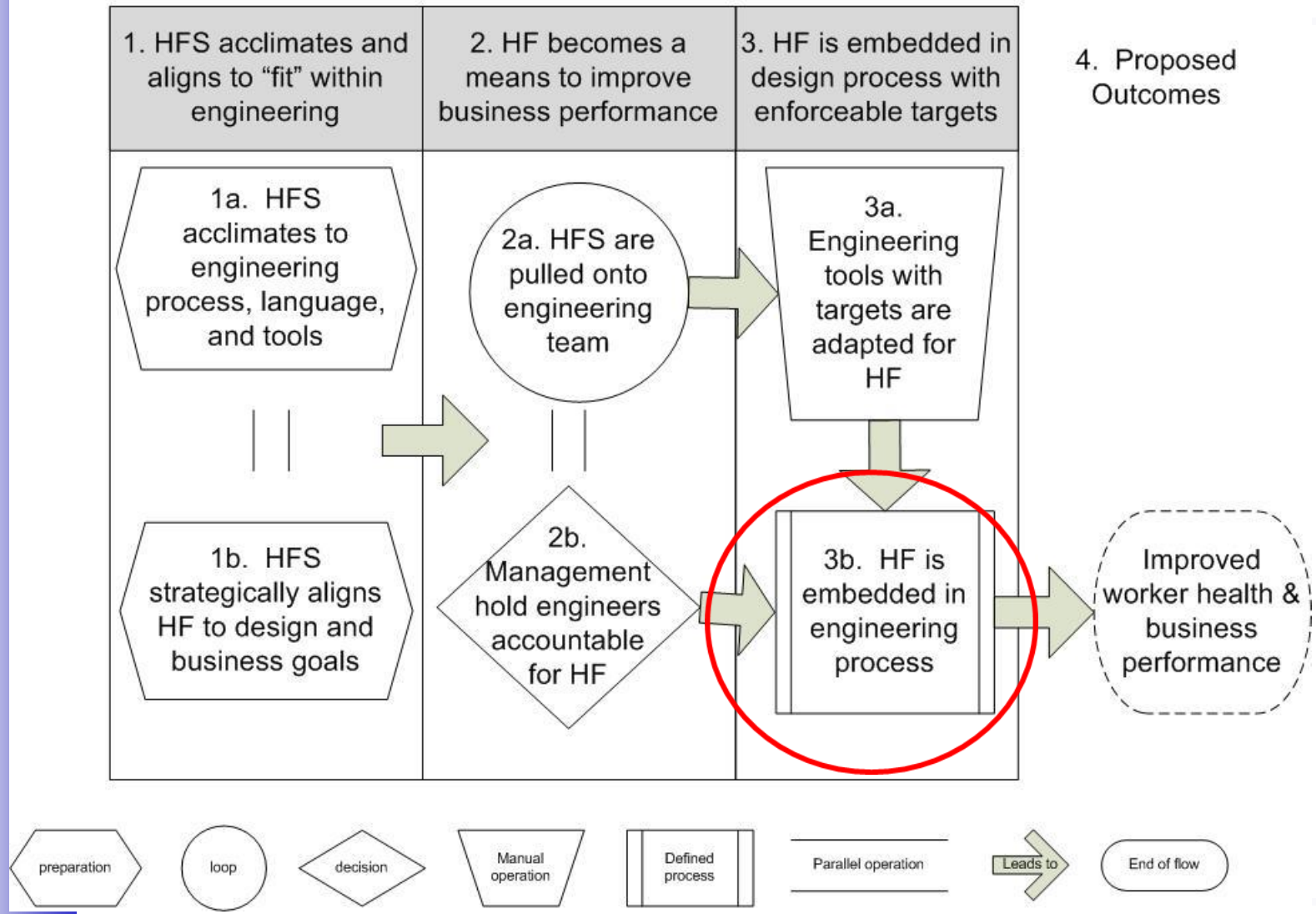


Organisational level Evaluation
The Human factors Integration Tools (HFIT)

Develop an assessment method to determine HF integration in an organization

- applicable to any organization
- inspiring systems development
- non-prescriptive

DFHF Grounded Theory



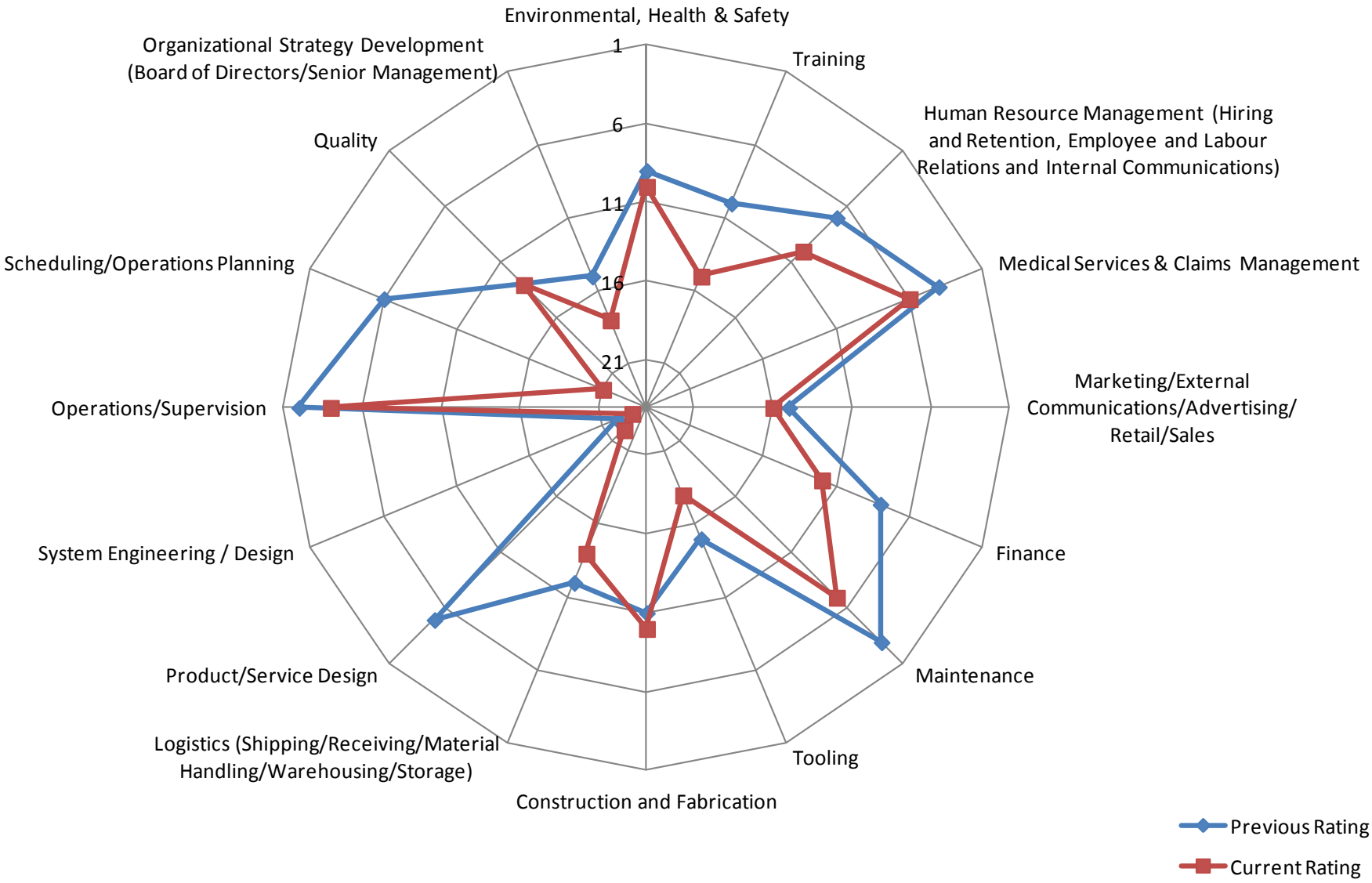
Design for DISSASSEMBLY - Simulation

HFE Industrial Engineering R&D Human Factors Engineering Lab

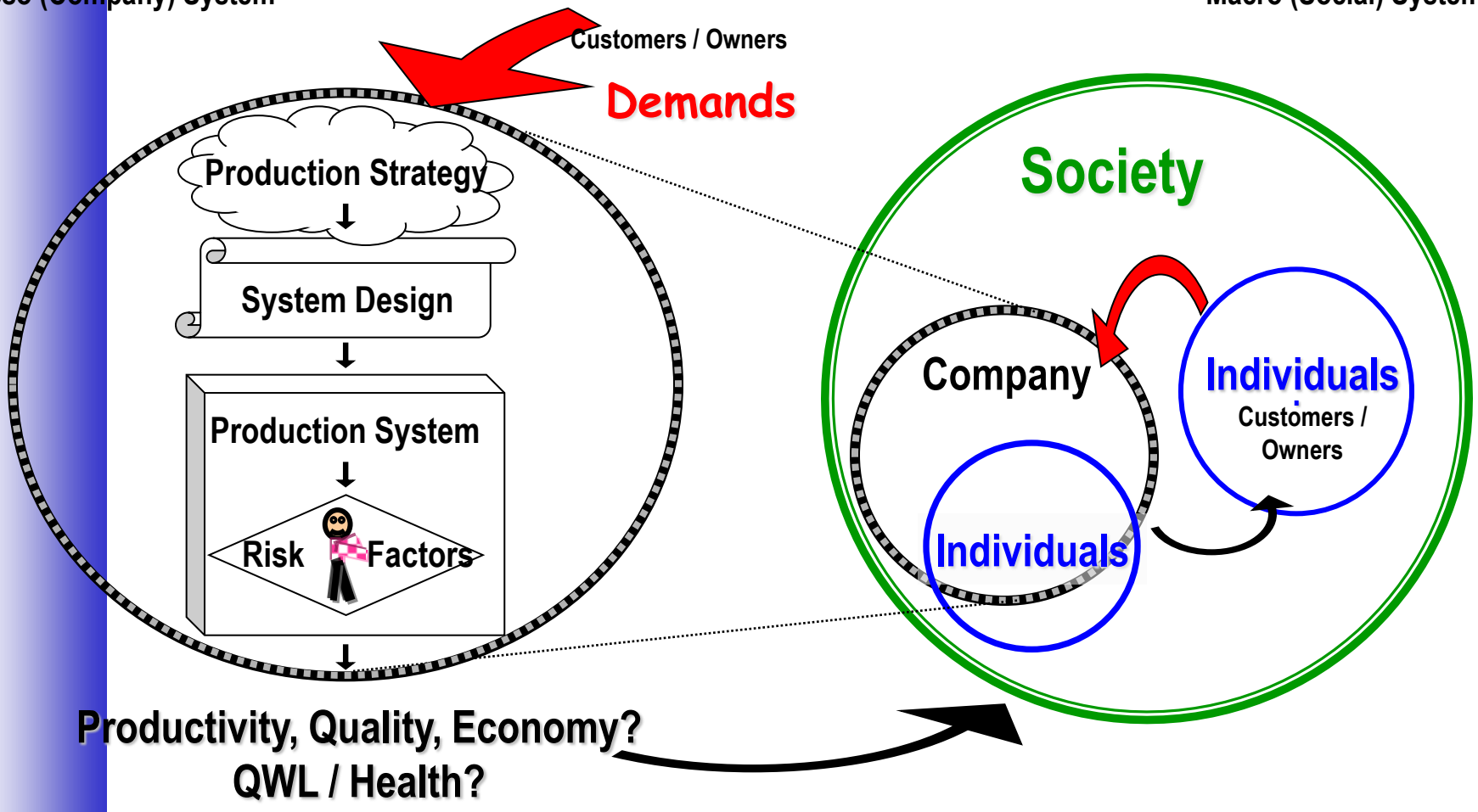
RYERSON UNIVERSITY

A new way of thinking about HF at the Org level

HF Integration Score



Industrialisation System



WIDE RANGE OF STAKEHOLDERS not only Managers, Engineers, Operators…