

Is it possible to design harvesters that
are more productive without
compromising their ability to optimize
value recovery:
Applying a systematic problem solving
methodology.

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What do harvesters do?



Fell tree



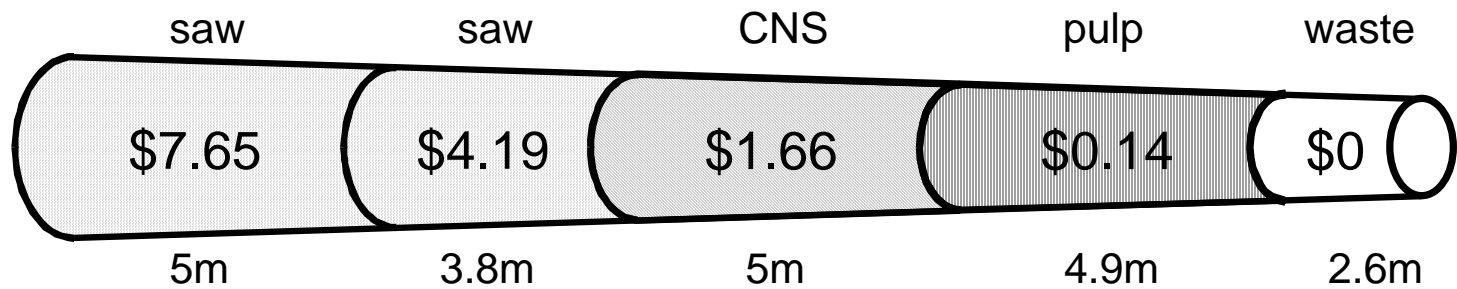
Debranch, debark (optional),
optimize (to ensure optimal value
recovery), cross-cut stem

OPTIMIZATION

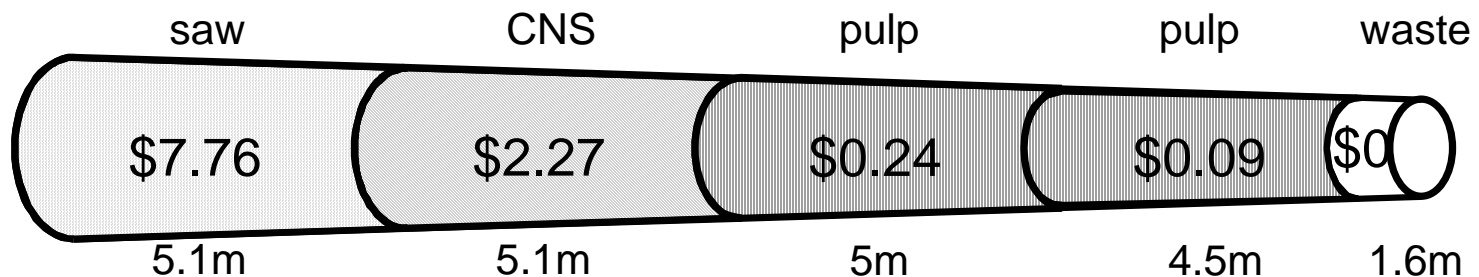
Length = 21.3

	Sawlogs	CNS	Pulp
Lengths (m)	3,8; 5,0; 6,2	3,8 & 5,0	3,6 to 4,9
Min SED (cm)	20	15	5
Defects	No whorl knots Limited sweep		No limit
Stumpage (\$/ton)	\$30,75	\$12,75	\$2,10

What is optimal value recovery?



OPTIMAL: Total value = US\$13.74 Value loss = 0%



ACTUAL: Total value = US\$10.37 Value loss = 25%

How do harvesters optimize value recovery?

- Log specifications are entered into optimizing computer.
- Harvester head measures diameter and lengths along length of stem. ➡
- Operator makes assessment of qualitative characteristics of stem (e.g. knots, rot, sweep, etc.) ➡
- Optimizing computer makes suggested cuts
- Operators over rides suggested cuts, if required
- What do we want?
 - Accuracy and productivity

Measuring system: Harvester head



- Current feed speeds = 4 to 6 meters/second



Measuring system: Operator

- Part of system
- Difficult to see defects at current speeds of 4 m/s (Gellerstedt)



The contradictions

D1 - Increase the feed speed of the harvester head

C1 – Productivity increases (useful effect).

Technical contradiction

B2 - Measuring accuracy decreases (harmful effect).

B1 - Measuring accuracy increases (useful effect).

Technical contradiction

C2 – Productivity decreases (harmful effect).

We feel pressure to do D1

We feel pressure to do D2

Physical contradiction

D2 - Decrease the feed speed of the harvester head

Is there a systematic way to solve the contradiction?

- Normal approach = Trial-and-error
- A systematic approach
 - TRIZ (Theory of Innovative Problem Solving)

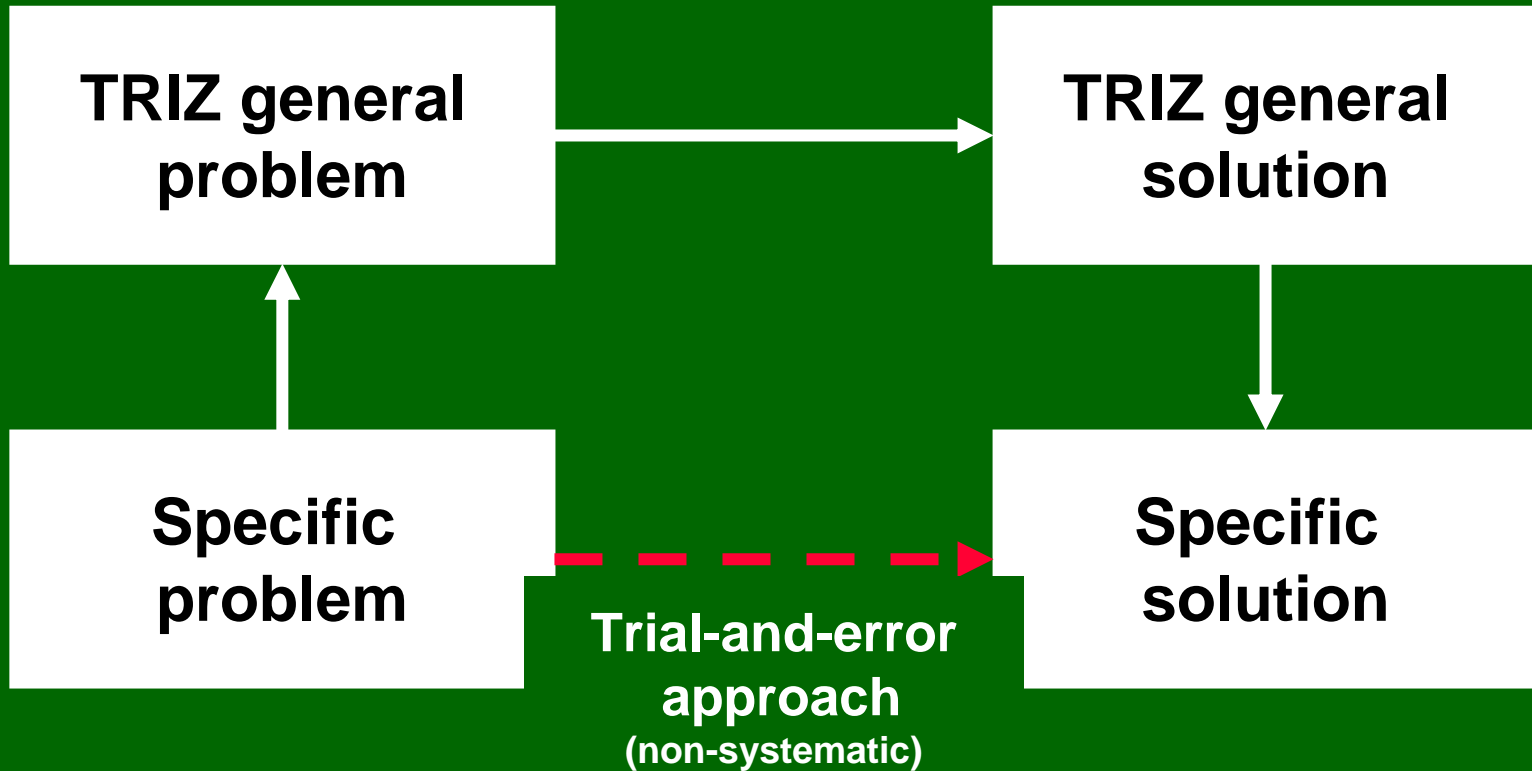
Who uses TRIZ?

- Boeing
- Unilever
- Nestle
- Procter and Gamble
- Shell
- Toyota, Nissan, BMW, Ferrari
- Samsung, Toshiba, Fuji Xerox
- Nokia

TRIZ

- Theory of Innovative Problem Solving
 - Started by Genrich Altshuller, 1946
 - Development continues
 - Analysed 3 million patents
 - Problems & solutions repeated across industries
 - Patterns of technical evolution repeated across industries
 - Innovations used effects outside of field where it was developed
 - Identified 39 contradictions (improving & worsening) features
 - Identified 40 inventive principles to solve contradictions

TRIZ problem solving model



Contradiction matrix (39x39) and inventive principles (40)

Worsening feature Improving feature	Measurement accuracy	Ease of operation	Device complexity
Productivity	1, 10 34, 28	12, 17 28, 24	1, 28 7, 10	
Ease of operation				
Device complexity				
....				

Inventive principles

- Most “probable” solutions
 - # 1: Segmentation
 - # 10: Preliminary action
 - # 34: Discarding and recovering
 - # 28: Replace mechanical systems with fields
- Some TRIZniks try all 40 inventive principles
- Software available

Inventive Principle # 28

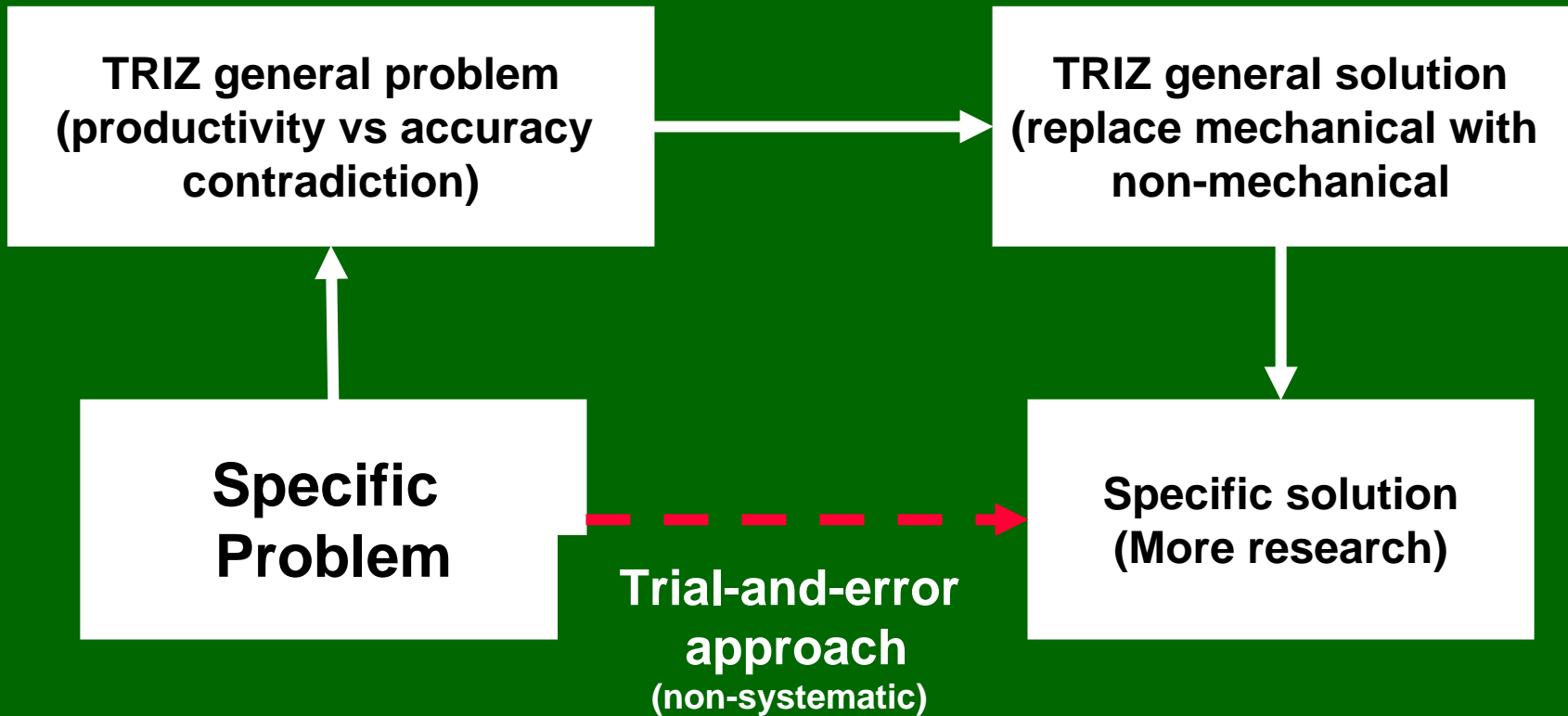
- Replace mechanical systems with fields
 - Replace a mechanical means with a sensor (optical, acoustic, taste, smell)
 - Create a field that can be detected or measured
 - Etc.

Sensors & Fields

- No more mechanical measurements for length and diameter
- No more defect assessment by operator
- Solutions
 - Ultrasound
 - Radio waves
 - Micro-waves
 - X-rays
 - Lasers



TRIZ problem solving model



Examples

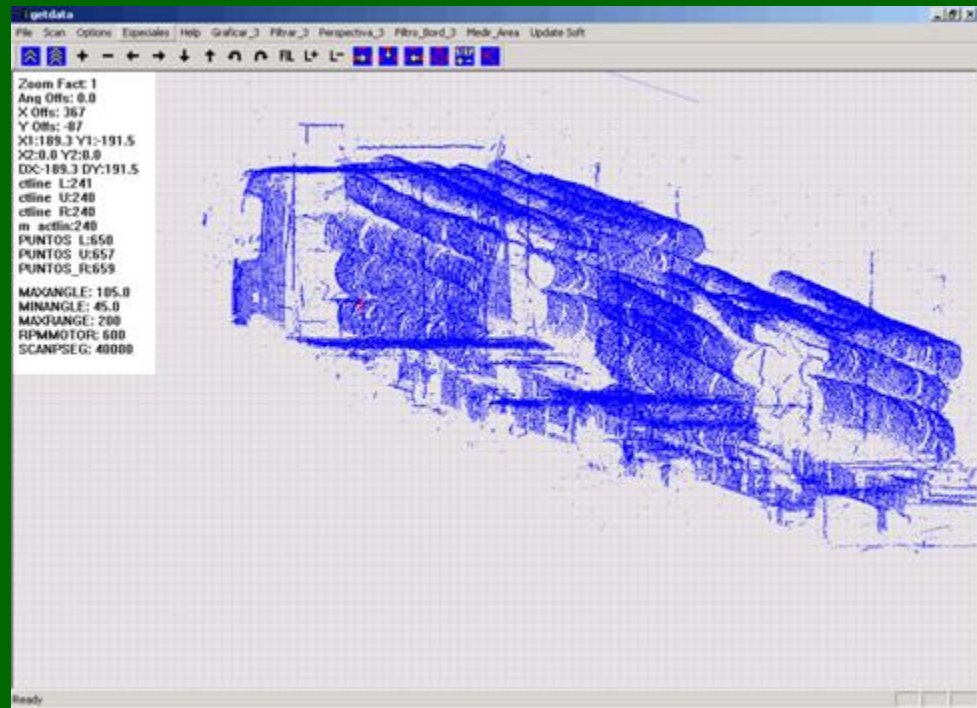
Lasers to measure length, diameter and sweep



Courtesy: Logjiztix/Buckmaker

Examples

Lasers to measure volume of logs on trucks



Courtesy: Excelsys

Conclusion

- TRIZ provides a systematic way to solve contradictions
 - Find the contradiction
 - Find the inventive principle
 - Better than trail-and-error
- Contradiction matrixes
 - Business problems
 - Software problems
- Many other TRIZ tools

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Do they know something we don't?