



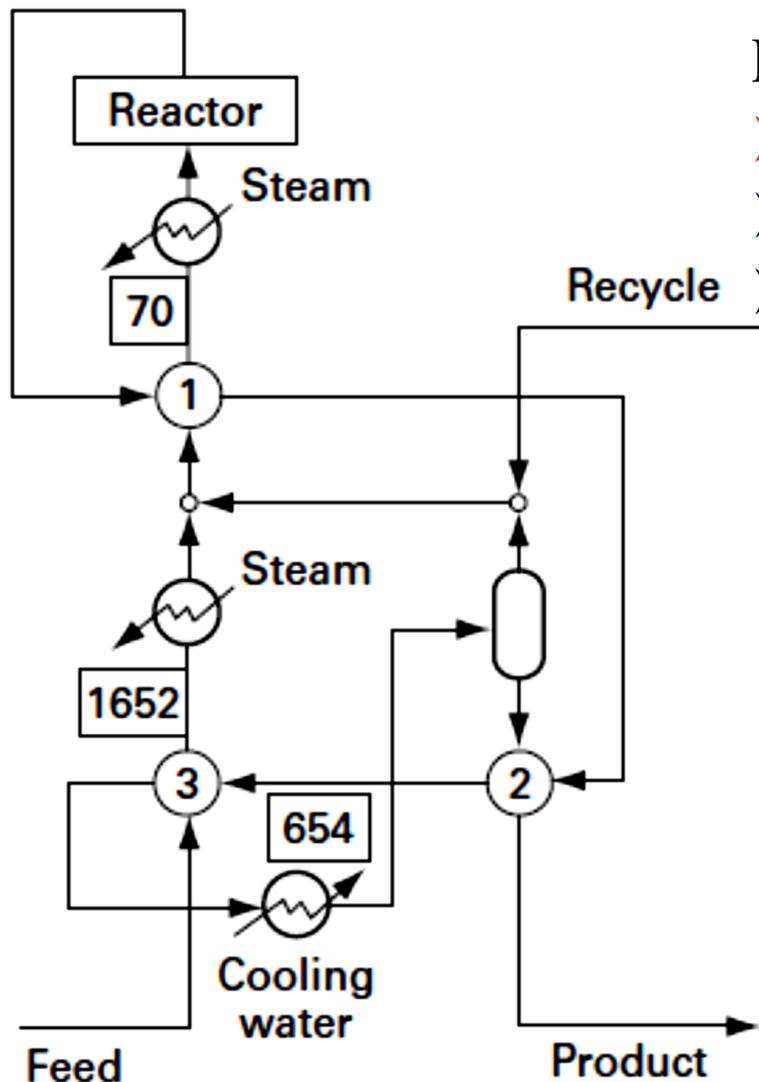
CHE526: PINCH TECHNOLOGY

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WHAT IS PINCH TECHNOLOGY?



Let's consider a typical chemical process



For this scheme, we want to know;

- The heating utility requirement?
- The cooling utility requirement?
- How many heat exchange units do you have?

Answer:

- ✓ heating utility requirement = 1722
- ✓ cooling utility requirement = 654
- ✓ heat exchange units = 6

Figure 1a: A typical traditional PFD for a specialty chemicals process

Consider this alternative scheme for the same process:

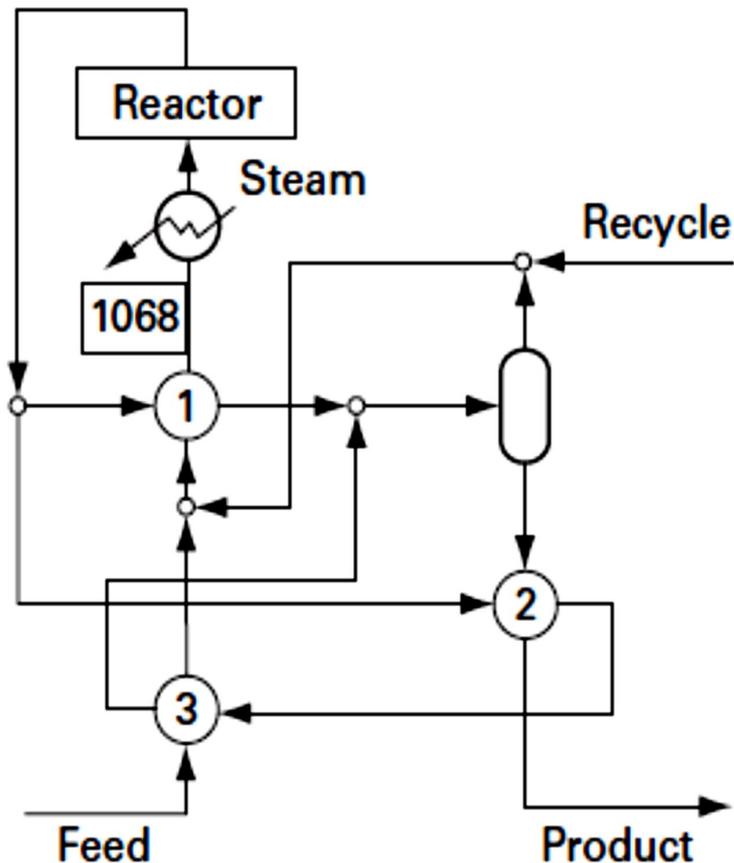


Figure 1b: A target design for a specialty chemicals process

For this scheme;

- What is the heating utility requirement?
- What is the cooling utility requirement?
- How many heat exchange units do you have?

CAN YOU GUESS THE ANSWER?

Answer:

- heating utility requirement = 1068
- cooling utility requirement = 0
- heat exchange units = 4

The Big Question?

- As a process engineer, which of the schemes will you choose and why?

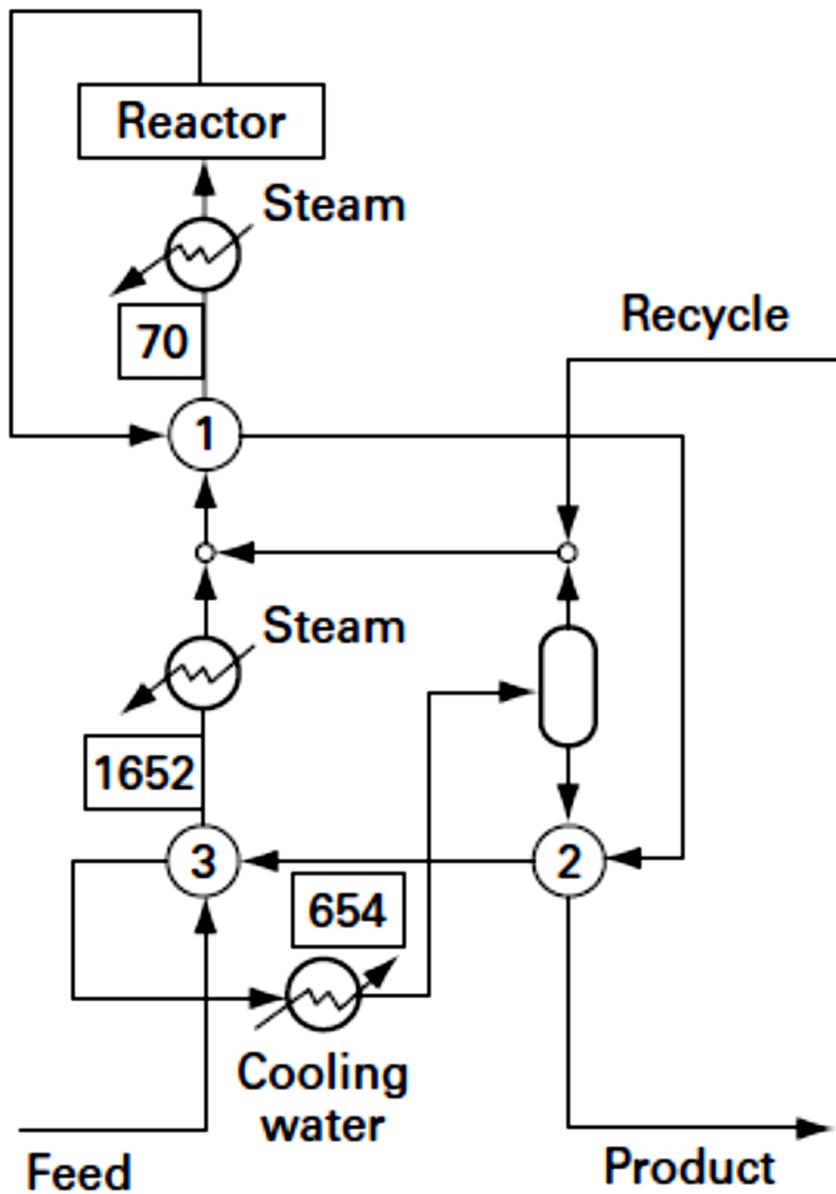


Figure 1a: A typical traditional PFD for a specialty chemicals process

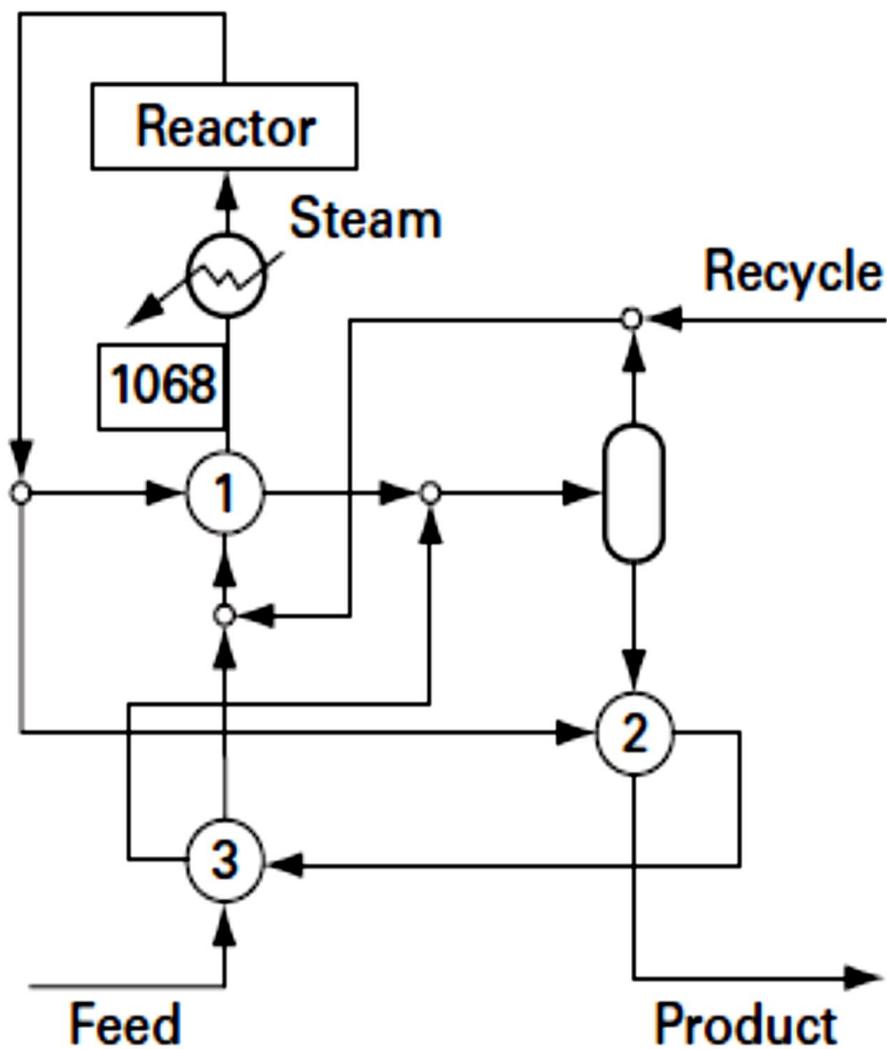


Figure 1b: A target design for a specialty chemicals process

PINCH TECHNOLOGY

- What is Pinch Technology (PT)?
- “Pinch Technology” also known as “Process Integration” was introduced by Prof. Bodo Linnhoff and Vredeveld of UMIST about 4 decades ago.
 - Linnhoff started the area of pinch (bottleneck identification) at UMIST in the 70’s, focusing on the area of Heat Integration
 - it is an unconventional development in process design and energy conservation.
 - it is a set of thermodynamically based methods that guarantee minimum energy levels in design of **heat exchanger networks**.
 - **PI is not really easy to define...**

Definition of process integration

The International Energy Agency (IEA) definition of process integration

"Systematic and General Methods for Designing Integrated Production Systems, ranging from Individual Processes to Total Sites, with special emphasis on the Efficient Use of Energy and reducing Environmental Effects"

From an Expert Meeting
in Berlin, October 1993

Definition of process integration

Later, this definition was somewhat broadened and more explicitly stated in the description of its role in the technical sector by this Implementing Agreement:

- *"Process Integration is the common term used for the application of methodologies developed for System-oriented and Integrated approaches to industrial process plant design for both new and retrofit applications.*
 - *Such methodologies can be mathematical, thermodynamic and economic models, methods and techniques. Examples of these methods include: Artificial Intelligence (AI), Hierarchical Analysis, Pinch Analysis and Mathematical Programming.*
- *Process Integration refers to Optimal Design; examples are: capital investment, energy efficiency, emissions, operability, flexibility, controllability, safety and yields.*
- *Process Integration also refers to some aspects of operation and maintenance".*

Definition of process integration

- “Process integration (PI) is the synthesis of process control, process engineering and process modeling and simulation into tools that can deal with the large quantities of operating data now available from process information systems.
- It is an emerging area, which offers the promise of improved control and management of operating efficiencies, energy use, environmental impacts, capital effectiveness, process design, and operations management.”

North American Mobility Program in Higher Education
(NAMP)-January 2003

Definition of process integration

PI is a holistic approach to process design, retrofitting, and operation which emphasizes the unity of the process.

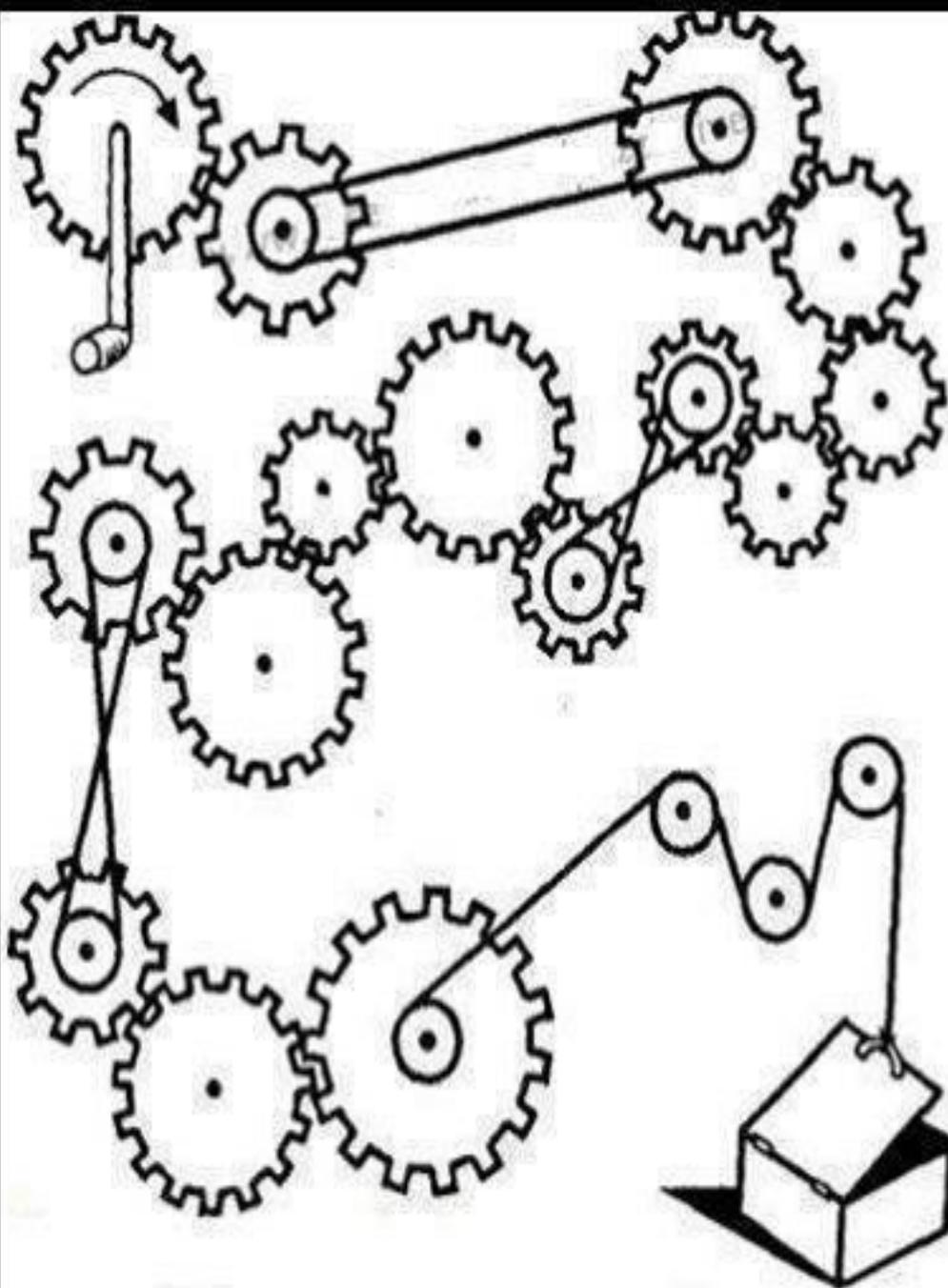
In light of the strong interaction among process units, streams, and objectives, PI offers a unique framework for fundamentally understanding the global insights of the process, methodically determining its attainable performance targets, and systematically making decisions leading to the realization of these targets.

There are three key components in any comprehensive process integration methodology: **synthesis, analysis, and optimization.**”

El-Halwagi, M. M., 1997.

Importance of Process Energy Management

- In most process industries, energy costs are second only to raw material costs.
- Energy is an inevitable cost in doing business
- Energy use is not just a concern for the utilities department, as an energy manager, ONE must separate the cost of doing business from the cost of doing business well
- Other benefits flow from focusing on energy include:
 - a reduced environmental impact
 - a cultural change toward reducing waste
- the scope of any energy management program is determined by its economic value



According to direction shown
on the drive pinion ,,,

**what will happen
for the box ?**

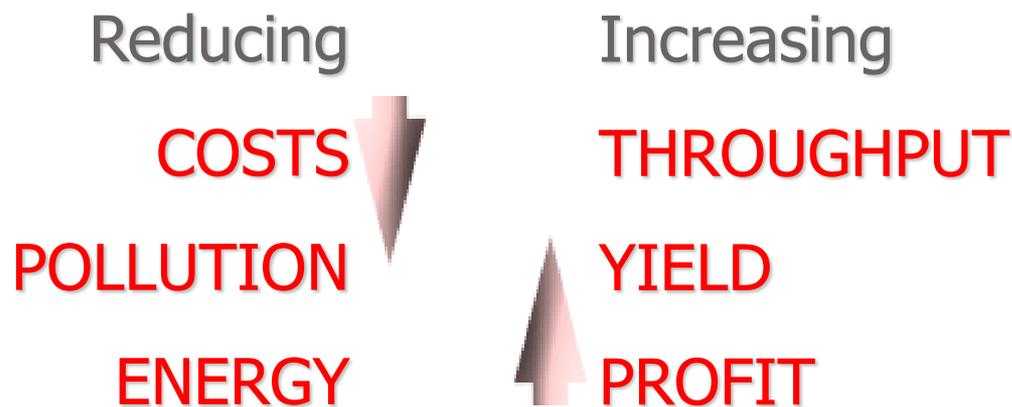
Open or Close ?

Modern Process Integration context

- Process integration is primarily regarded as process design (both new and retrofits design), but also involve planning and operation.
 - The methods and systems are applied to continuous, semi-batch, and batch process.
- **Business objectives currently driving the development of PI:**
 - a) Emphasis is on **retrofit** projects in the “**new economy**” driven by Return on Capital Investment (ROI)
 - b) PI is “**Finding value in data quality**”
 - c) Corporations wish to make more knowledgeable decisions:
 1. **For operations,**
 2. **During the design process.**

Modern Process Integration context

- **Possible Objectives:**
 - Lower capital cost design, for the same design objective
 - Incremental production increase, from the same asset base
 - Marginally-reduced unit production costs
 - Better energy/environmental performance, without compromising competitive position



Modern Process Integration context

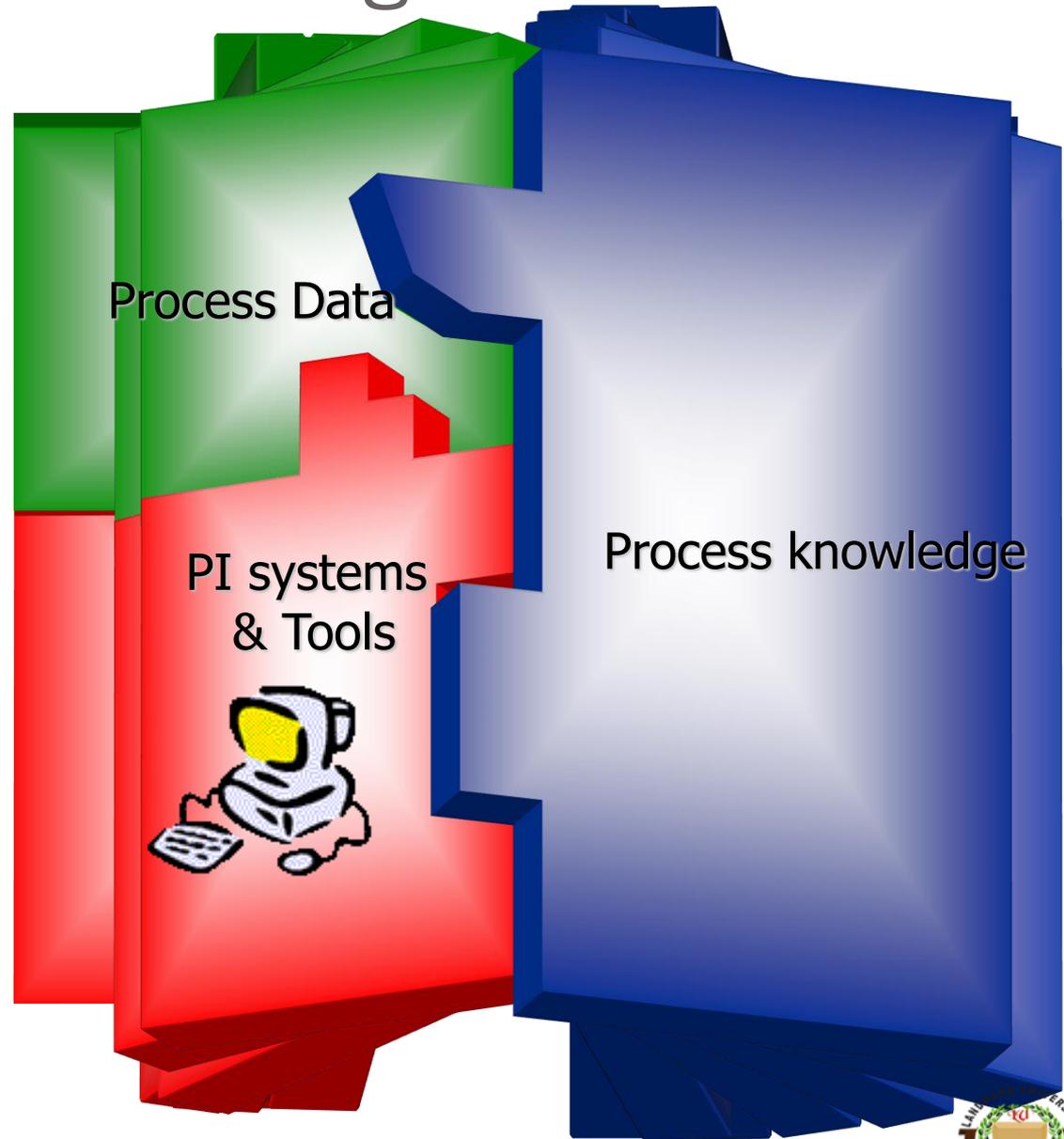
Among the design activities that these systems and methods address today are:

- Process **Modeling** and **Simulation**, and **Validations** of the results in order to have accurate and reliable process information.
- Minimize **Total Annual Cost** by optimal Trade-off between Energy, Equipment and Raw Material
 - Within this trade-off: minimize **Energy**, improve **Raw Material** usage and minimize **Capital Cost**
- Increase **Production Volume** by Debottlenecking
- Reduce **Operating** Problems by correct (rather than maximum) use of Process Integration
- Increase Plant **Controllability** and **Flexibility**
- Minimize undesirable **Emissions**
- Add to the joint Efforts in the Process Industries and Society for a **Sustainable** Development.

Summary of Process Integration elements

Improving overall plant facilities energy efficiency and productivity requires a multi-pronged analysis involving a variety of technical skills and expertise, including:

- Knowledge of both conventional industry practice and state-of-the-art technologies commercially available
- Familiarity with industry issues and trends
- Methodology for determining correct marginal costs.
- Procedures and tools for Energy, Water, and raw material Conservation audits
- Process information systems

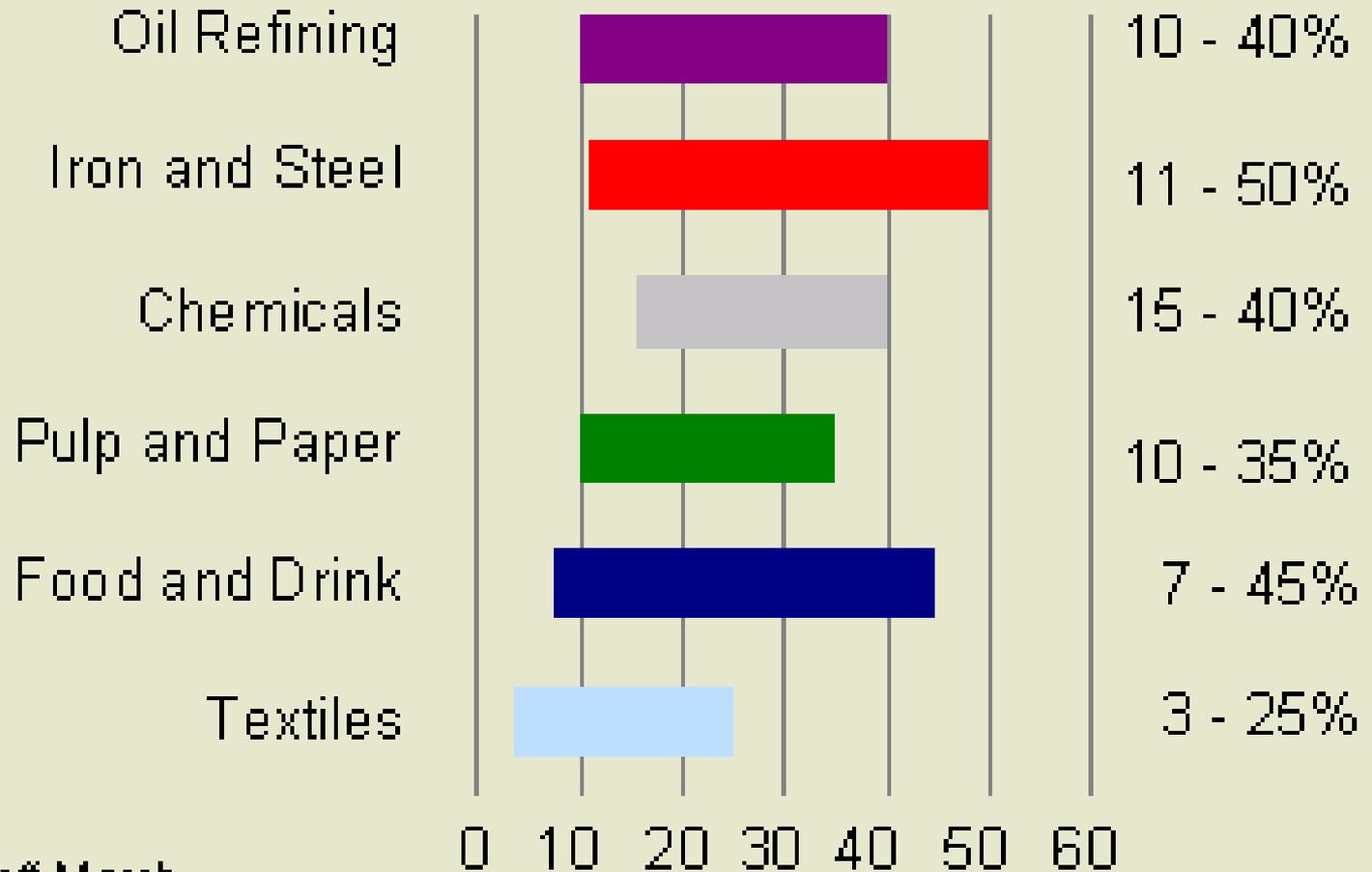


Benefits of Pinch Technology

- ❑ Pinch tells the best that can be achieved in a given system.
- ❑ Pinch gives the practical target to aim for that is less than the theoretical maximum.
- ❑ Both of the above are done before any detailed design. This target then set the basis for the design. Most importantly, it gives clear rules about how to construct a design to achieve the targets. It will also show where the inefficiency lie in the existing design.
- ❑ Pinch takes a system-wide view of the problem. This allows one to see interaction that would be difficult to spot on a process flow diagram or a flow sheet of site utility system.
- ❑ Pinch can work with incomplete data. One can refine the data in the areas where accuracy is most important. This is in the area around the pinch.
- ❑ Pinch Technology is in contrast to other design tools, which require detailed information about geometry, flow sheet structure, etc. Pinch technology is one of the few tools that really can be used in conceptual design.

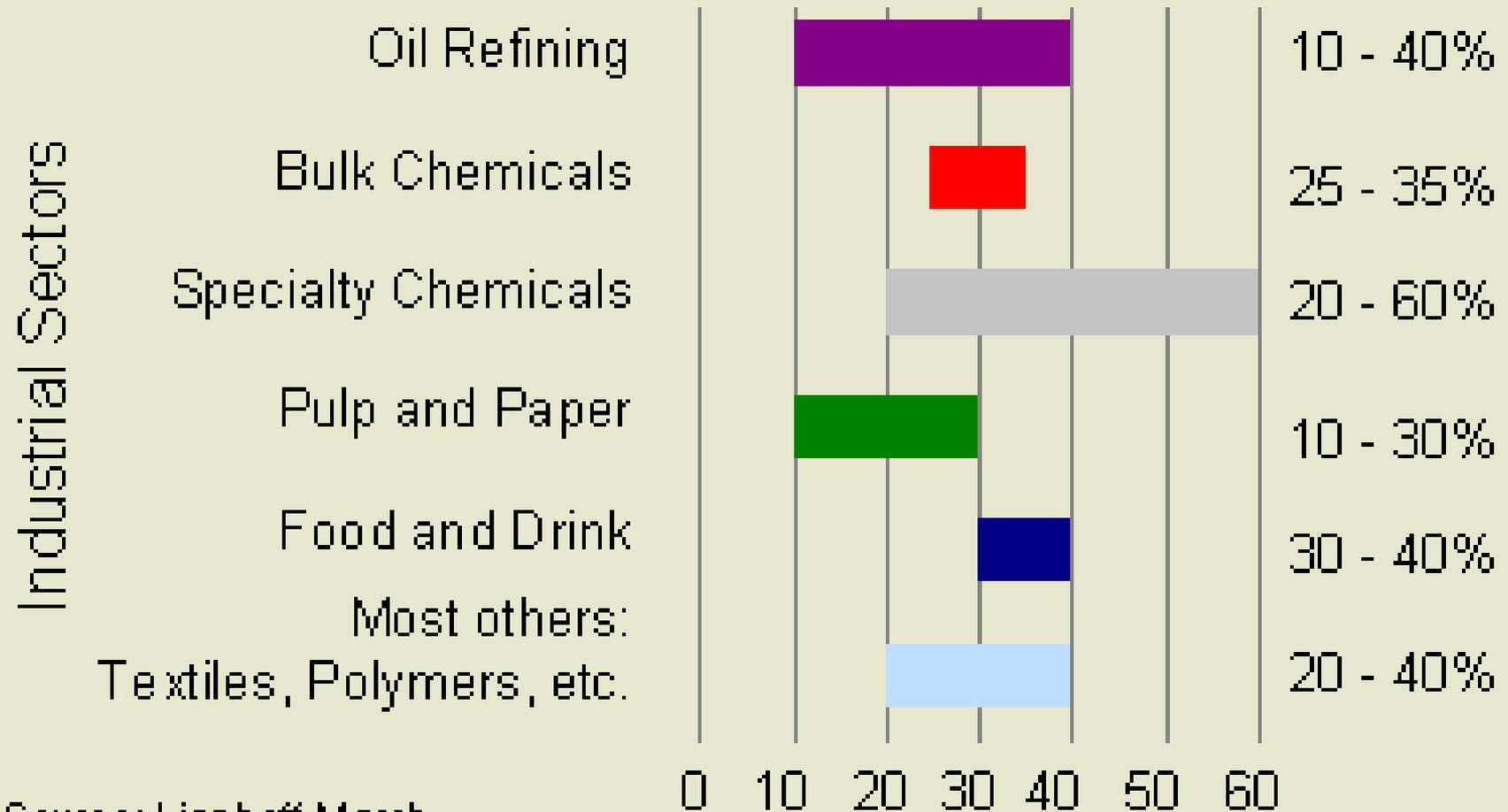
Energy Savings Potential

Industrial Sectors



Source: Linnhoff March

Water Savings Potential



Source: Linnhoff March

WORD OF WISDOM

And don't for a minute let this Book of The Revelation (this course) be out of mind. Ponder and meditate on it day and night, making sure you practice everything written in it. Then you'll get where you're going; then you'll succeed.

Josh 1:8

(from THE MESSAGE: The Bible in Contemporary Language © 2002 by Eugene H. Peterson. All rights reserved.)

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**THANK YOU
FOR
YOUR
ATTENTION!
ANY QUESTIONS?**