EVERGREEN ENGINEERING

Engineering and Construction Services

Pellet Fuels Institute

**2015 Annual Conference**

# Tools to Optimize Pellet Manufacturing

*Identify Bottlenecks in Your Plant System*

**Evergreen provides customized support to our clients by delivering practical engineering solutions, project leadership and technical expertise**

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# Introduction

- Justin Price, P.E.

# Two Phenomena Exist

Dependent Events

Statistical Fluctuations

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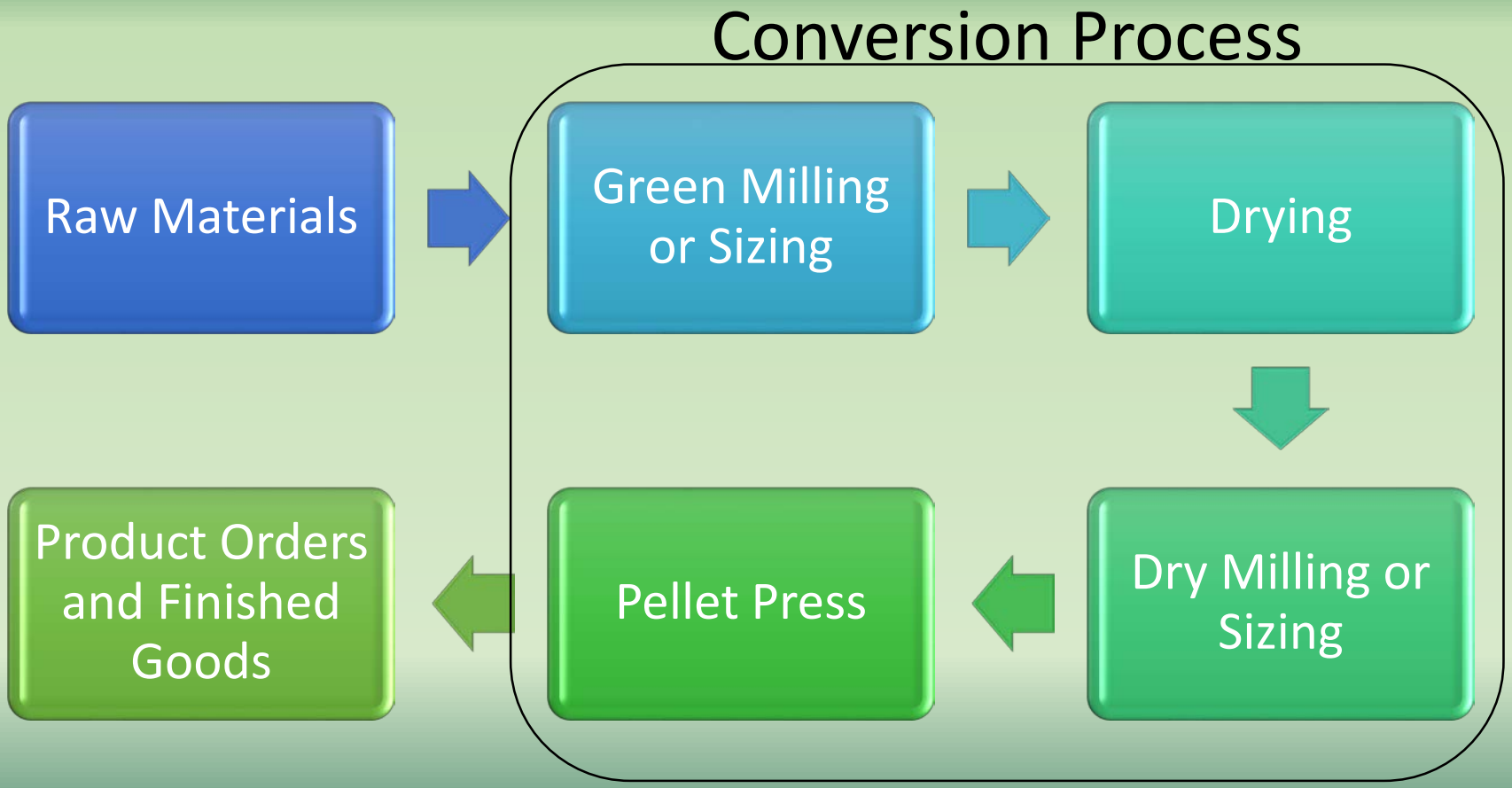
# Dependent Events

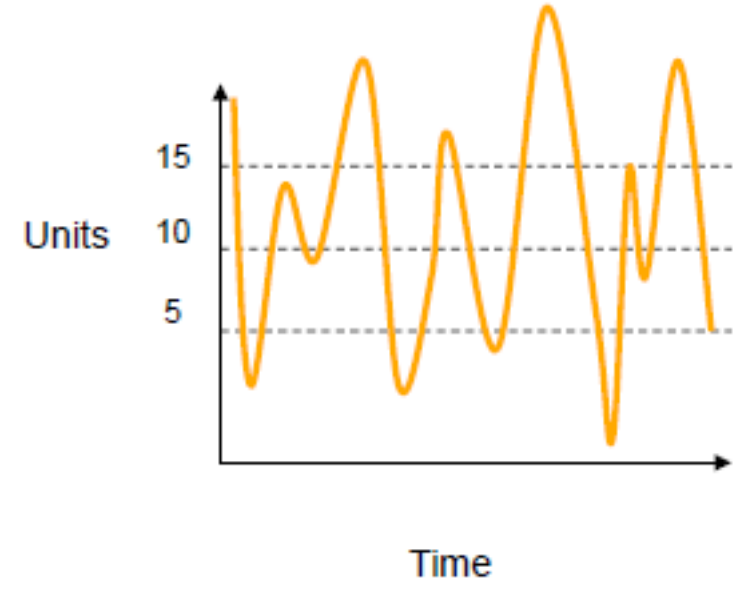


# Dependent Events

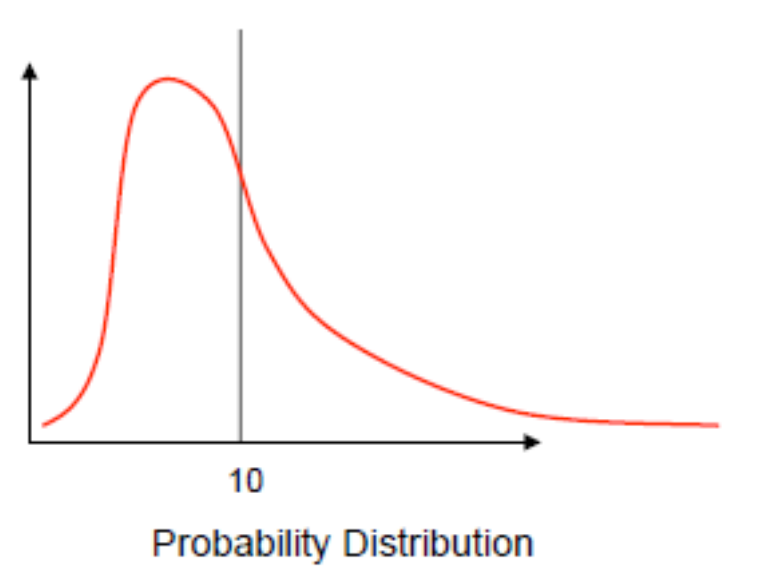
- Drying cannot yield more than what Green Milling/Sizing provides
- Green Sizing cannot do its job until it receives Raw Material
- Pellet Press cannot produce more than Dry Milling/Sizing

# Statistical Fluctuations

The output of any resource fluctuates over time




**OR**



# Statistical Fluctuations

- On average, this resource will produce 10 units/day
- On average, this resource will deliver 10 units/day
- On average, this customer will require 10 units/day

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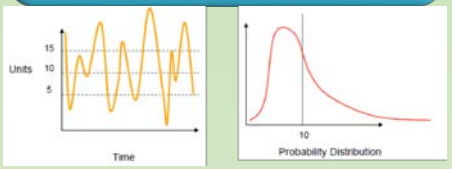
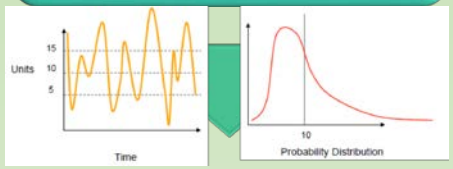
# Combining These Principals

Raw Materials

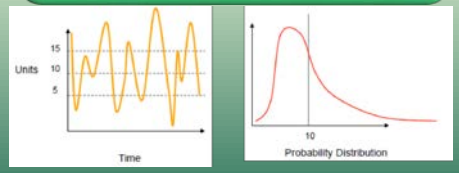
Green Milling or Sizing



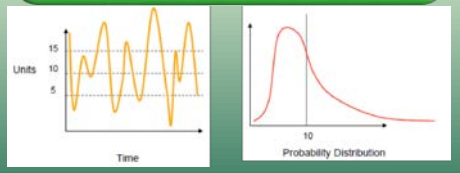

Drying




Dry Milling or Sizing




Pellet Press




Product Orders and Finished Goods

# Productivity

- Determine the limiting process center by:
  - Work-in-progress – Inventory
    - Do you have areas within the process of inventory (material in silos that never run empty)?
  - Process centers that “out run” others
    - Do you have areas that are waiting for material (silos that are always empty)?
  - Process center statistical deviations
    - Can you measure the production rate at each major machine center and trend this over a short duration?
    - What are the high’s and low’s of each process center?

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# Design on the Average

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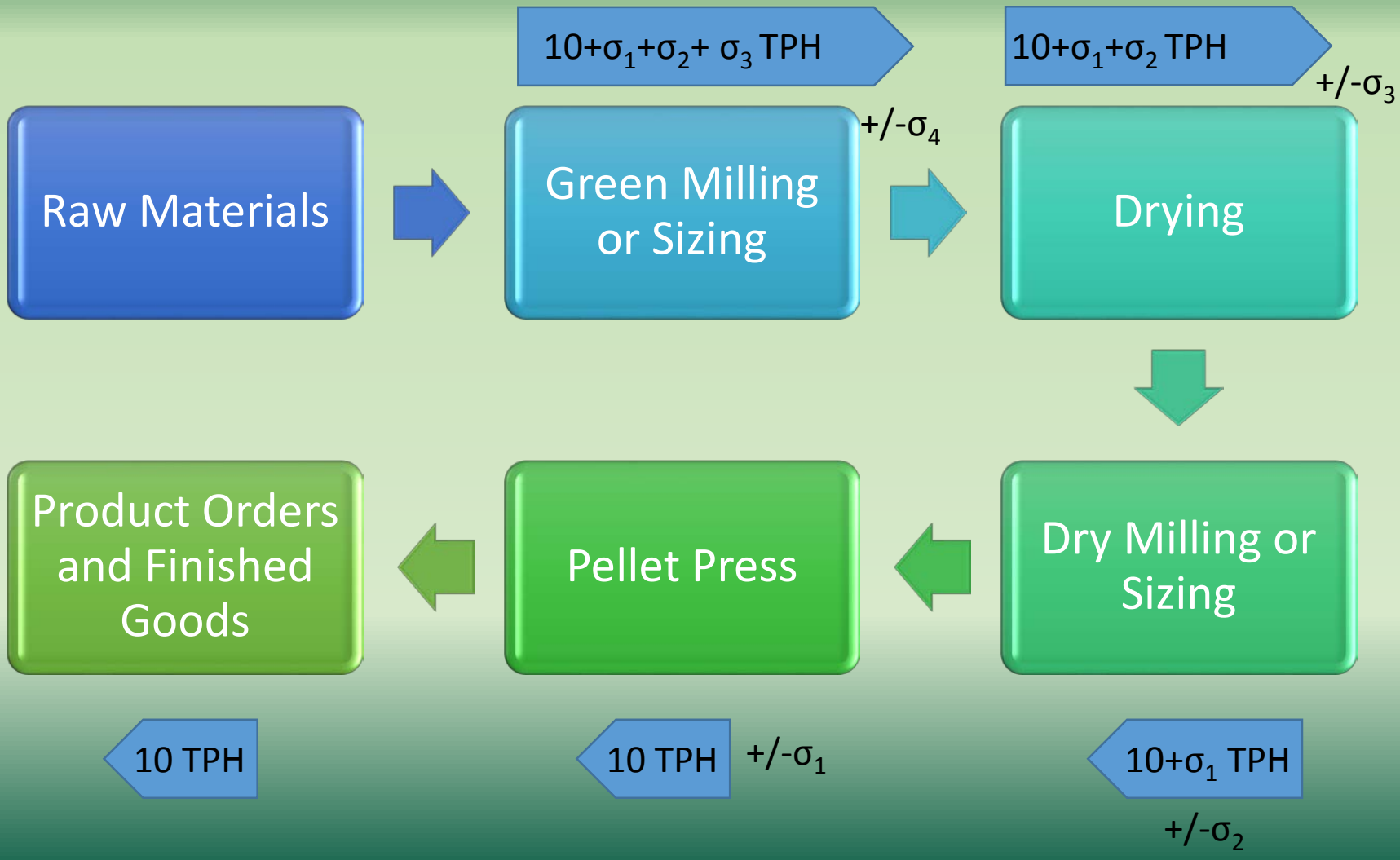
# Ideal Plant Design



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# Ideal Plant Design

| | AVE TPH | Std. Dev | Max | Min |
|---|---|---|---|---|
| Finished Good | 10.00 | | | |
| Pellet Press | 10.00 | 5% | 10.50 | 9.50 |
| Dry Milling | 10.50 | 2% | 10.71 | 10.29 |
| Dryer | 10.71 | 10% | 11.78 | 9.64 |
| Green Milling | 11.78 | 2% | 12.02 | 11.55 |

Recommended/Preferred Bottleneck in Plant Design


The Maximum Deviation of a preceding process sets the starting point of the subsequent operations

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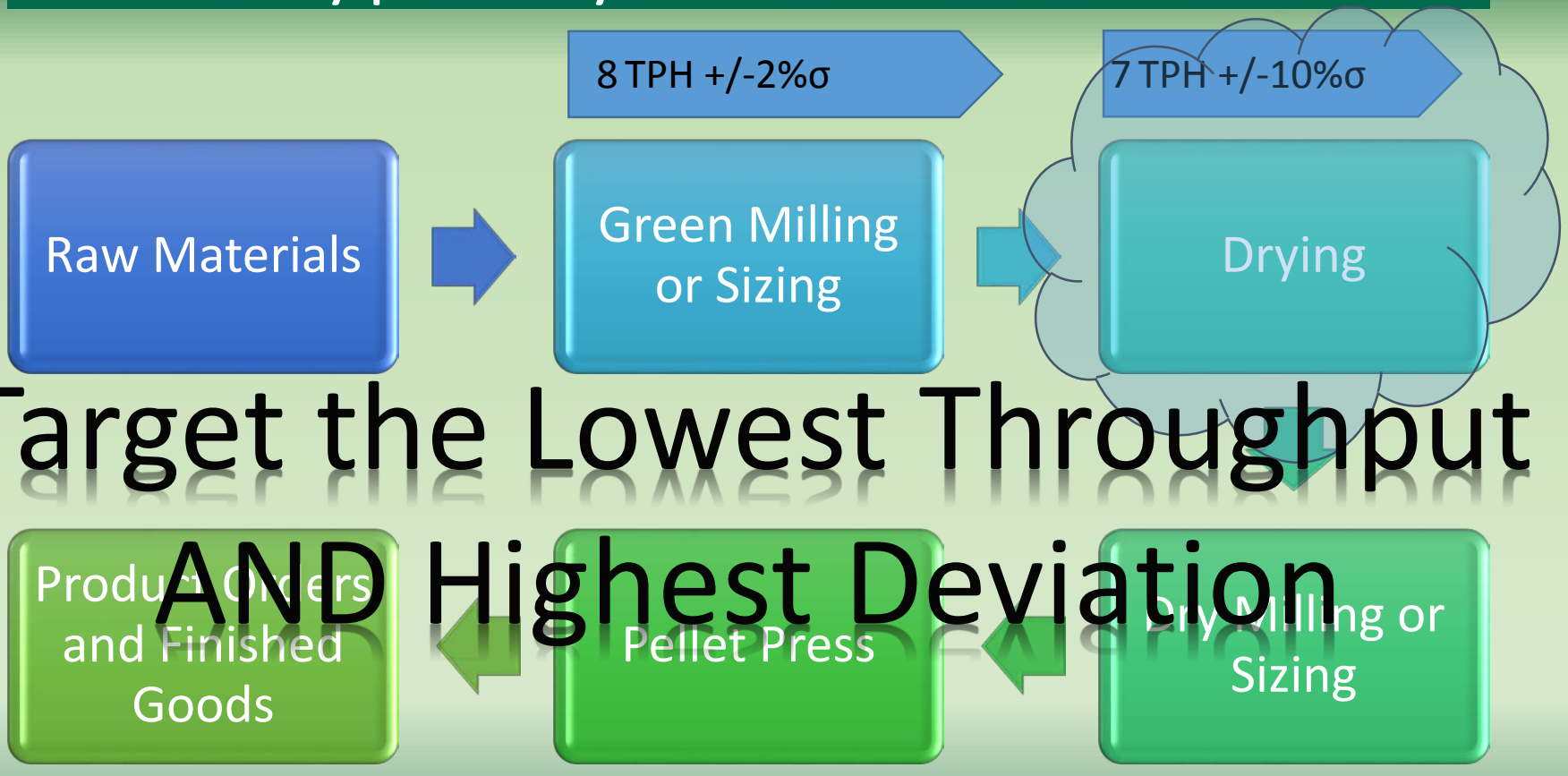
# Typically What We See




## Target the Lowest Throughput AND Highest Deviation

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# Fundamental Questions

- What to Change?
- What to Change to?
- How to Cause the Change?

**To Change is to IMPROVE**

# Constraints

- Anything preventing the system from achieving the objective
  - Core principle of the Identification of Bottlenecks
  - There is always at least one and, at most, only a few
  - Can be internal or external to systems
  - Implies a need to examine the system for improvement

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# Putting it all together

- Productive
- Improvement
- Constraints

The Essence of Identifying Bottlenecks

In order to be more PRODUCTIVE we have to IMPROVE the CONSTRAINTS

THE GOAL

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# The Real Story

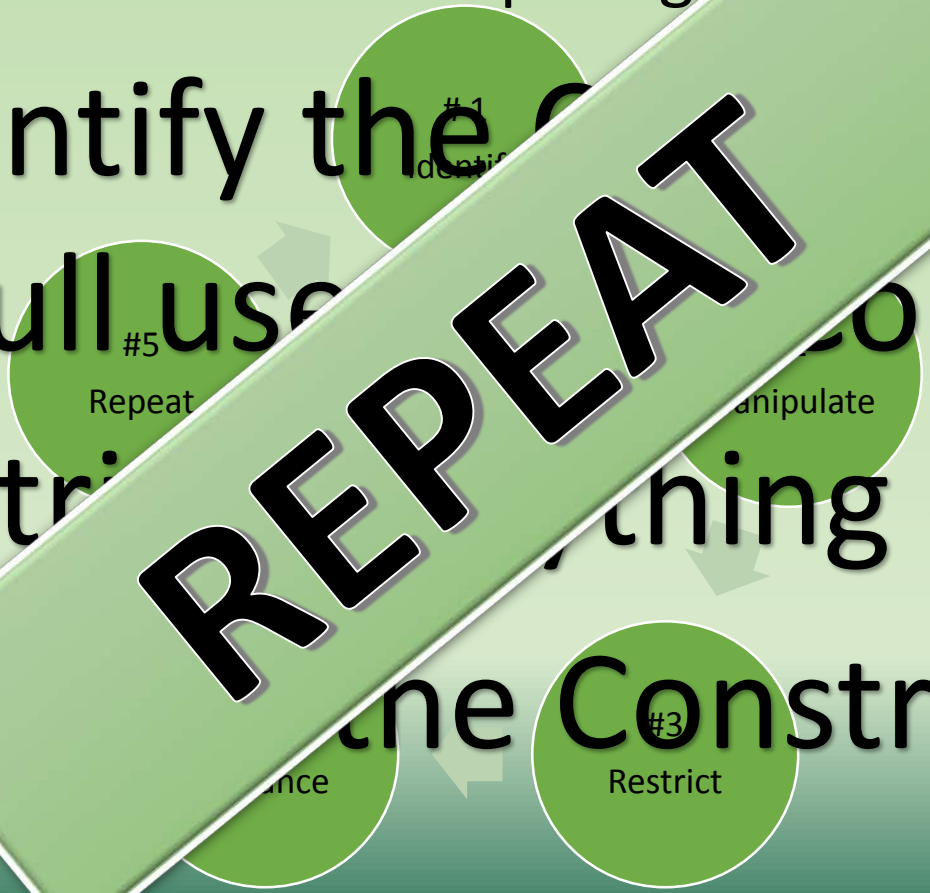
- It's Five-step Progra

Identify the C it

Make full use Constraint

Restri thing else

A the Constraint




REPEAT

# Wrap-up

- **Key to Identifying Bottlenecks**
  - **A Thinking Process**
  - **We have to Improve on the Constraints**
  - **To Improve we have to Change**
  - **It is a continuous process**

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# Questions?

- Contact information

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