

Creating a Continuous Process Improvement (CPI) Culture using TOC, Lean and Six-Sigma

Maximizing the Return on Your Improvement Dollars

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Creating a CPI Culture Requires an Enterprise Focus

- Enterprise Focus Requires
 - CPI be Driven by Leadership Top Down
 - Leadership must lead and direct the change to a CPI Culture
 - Change Policies, Rules, Measurements, etc. to enable CPI and
 - Know where, when and why CPI efforts are successful
 - Business Strategy that provides CPI with direction aligned with Enterprise Goals
 - Understanding the needs of the Customer enables alignment of Strategy with Enterprise Goals

Creating a CPI Culture Requires an Enterprise Focus

- Enterprise Focus Requires (cont.)
 - Tactics aligned with Business Strategy
 - Enables Customer needs to be addressed (i.e., form, fit, function and availability)
 - Provides the targeting and sequencing of CPI efforts at all levels and within all functions across the Enterprise
 - Measurements that Reinforce Alignment of Tactics with Strategy
 - Documentation of Best Practices to provide New Standard Operating Procedures (SOP)
 - CPI Tools and Methods that are Integrated to Support Enterprise Focused CPI efforts

Creating a CPI Culture Requires an Enterprise Focus

- Enterprise Focused CPI efforts provide:
 - A clear understanding of the **Current State (AS-IS)** that includes:
 - Identification and verification of the policies, rules, measurements and SOPs that must be changed, including:
 - The problems they cause, and
 - The benefits they produce
 - A documented understanding of what parts of the physical environment need to be reconfigured, including:
 - Repositioning of equipment, new equipment needed, point of use tools/inventory, kitting, etc.
 - An initial cost/benefit analysis related to the proposed changes as defined by the Current State

Creating a CPI Culture Requires an Enterprise Focus

- Enterprise Focused CPI efforts provide (cont.):
 - A clear understanding of the **Future State (TO-BE)** that includes:
 - A definition of the new policies, rules, measurements and SOPs that will replace the existing ones, including:
 - The expected outcomes
 - How the benefits, if any, of the policies, rules, measurements and SOPs they will replace are to be maintained
 - Any new problems these changes would create and a proposal for preventing or mitigating them

Creating a CPI Culture Requires an Enterprise Focus

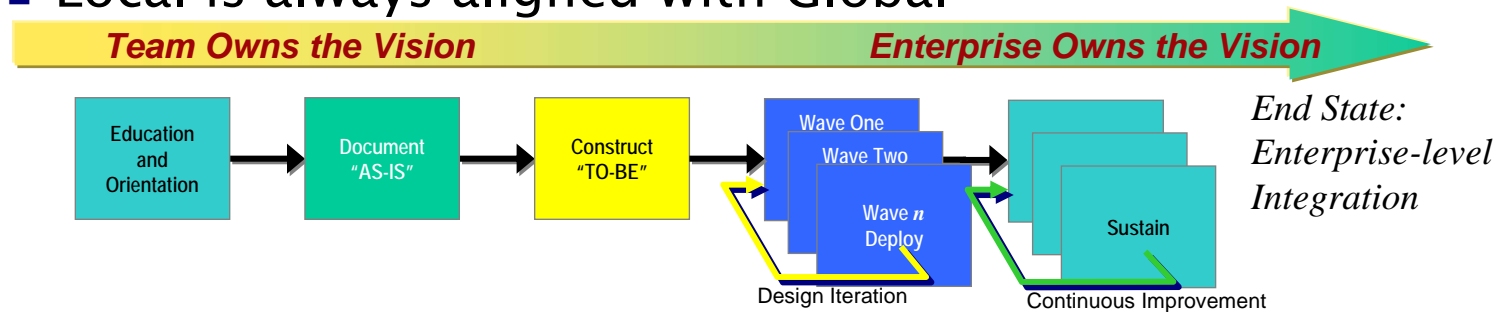
- Enterprise Focused CPI efforts provide (cont.):
 - A clear understanding of the **Future State (TO-BE)** that includes (cont.):
 - A documented understanding of what the reconfigured physical environment will look like, including:
 - Repositioning of equipment, new equipment needed, point of use tools/inventory, kitting, etc.), and
 - Any new problems these changes would create and a proposal for preventing or mitigating them
 - A refined cost/benefit analysis related to the proposed changes as defined by the Future State

Creating a CPI Culture Requires an Enterprise Focus

- Enterprise Focused CPI efforts Develop **Future States** based on:
 - Simple, Uniform, Scalable Concepts
 - e.g., Pull means Production/Repair and Replenish processes are only activated by Customer Demand
 - Concepts which are Replicable and Maintainable across the Enterprise
 - Training and Facilitation that Provides Customization of Concepts without Compromise
 - Local is always aligned with Global

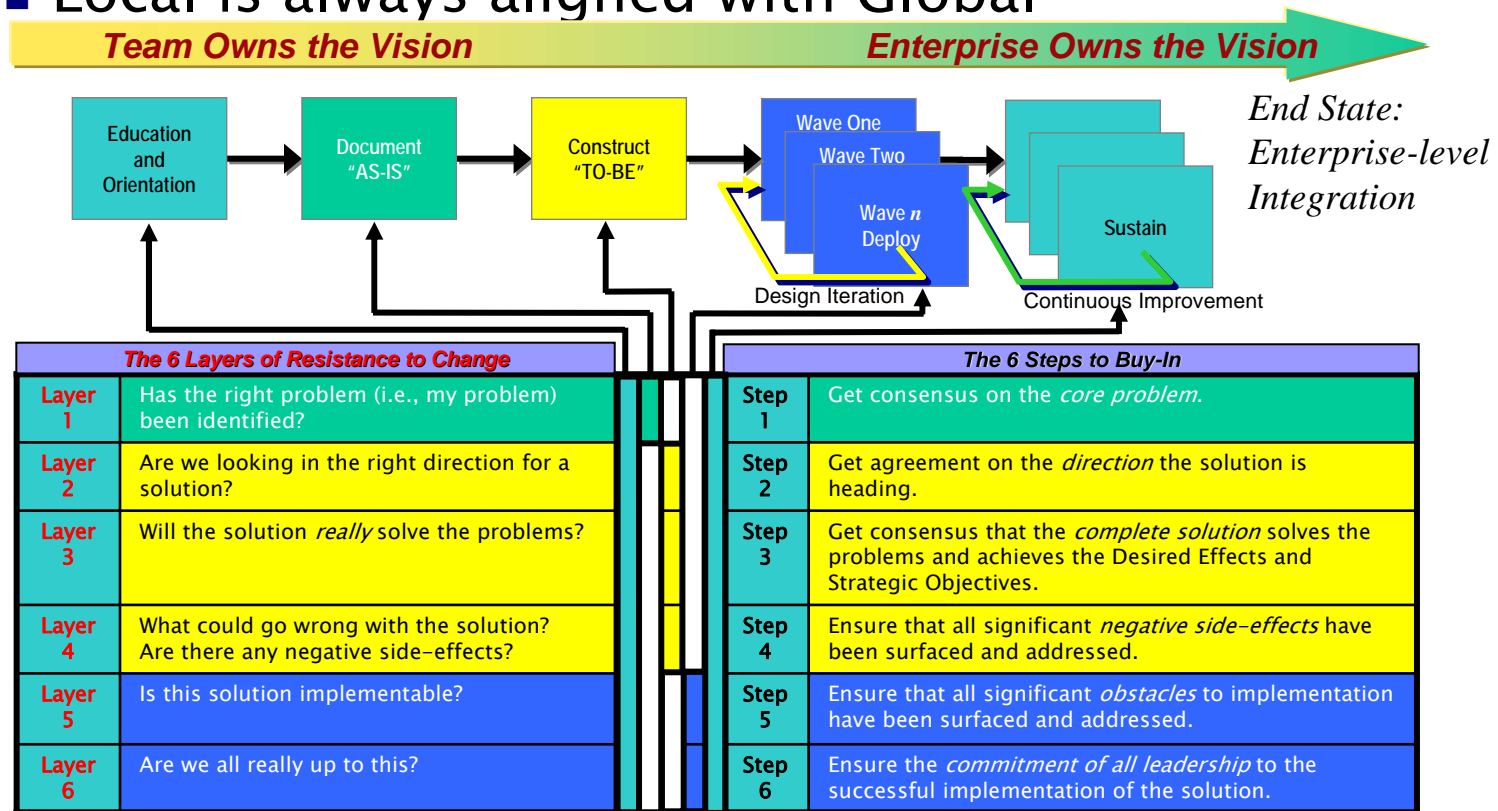
Creating a CPI Culture Requires an Enterprise Focus

- Enterprise Focused CPI efforts provide (cont.):
 - Training and Customization without compromise
 - Local is always aligned with Global



Creating a CPI Culture Requires an Enterprise Focus

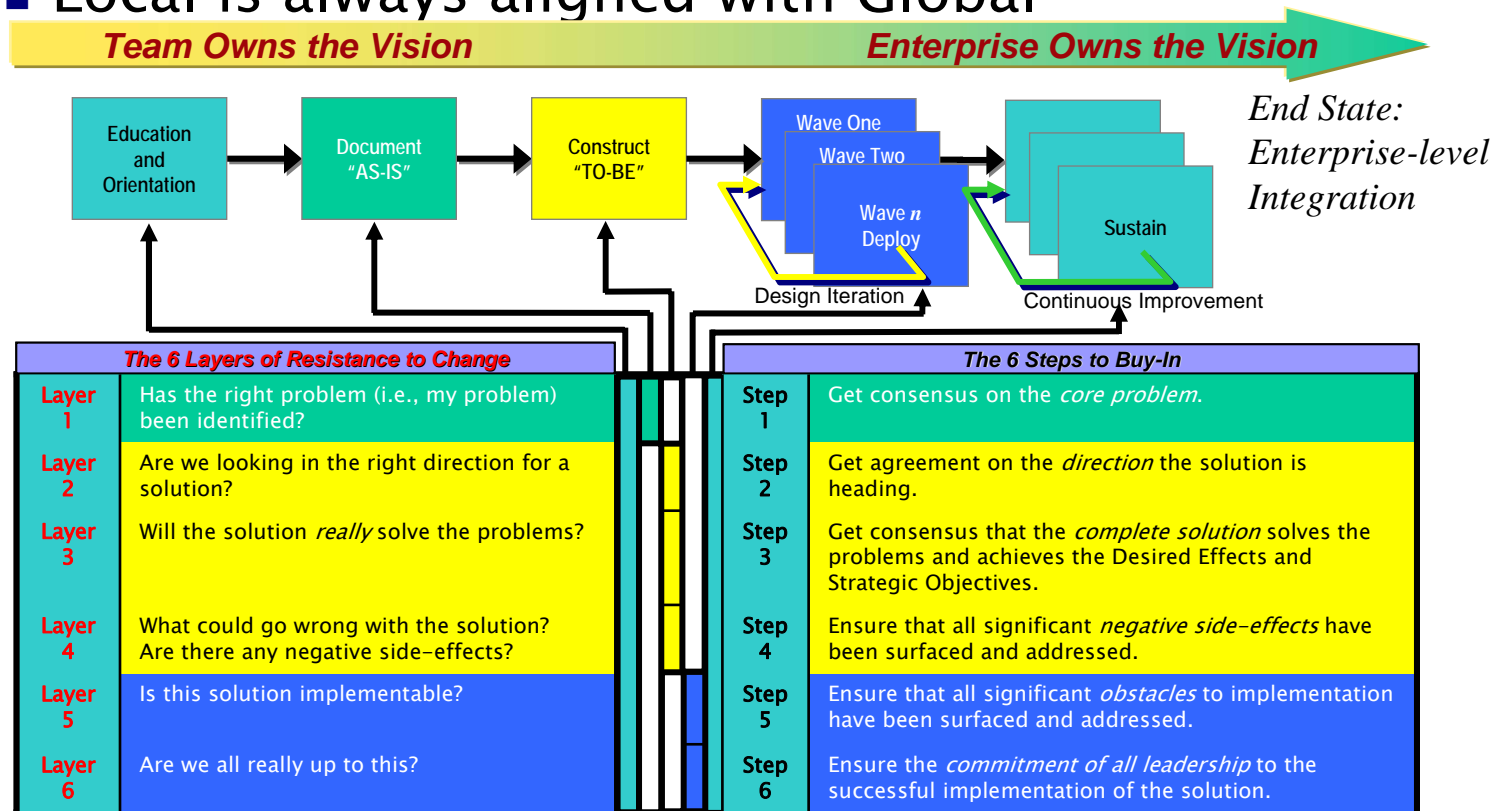
- Enterprise Focused CPI efforts provide (cont.):
 - Training and Customization without compromise
 - Local is always aligned with Global



Creating Culture Change – Overcoming Resistance and Getting Buy-In

Creating a CPI Culture Requires an Enterprise Focus

- Enterprise Focused CPI efforts provide (cont.):
 - Training and Customization without compromise
 - Local is always aligned with Global



Creating Culture Change – Overcoming Resistance and Getting Buy-In

Creating a CPI Culture Requires an Enterprise Focus

- Enterprise Focused CPI efforts provide (cont.):
 - A plan to manage the **Transition** from **Current** State to **Future** State that includes:
 - Resources required to implement
 - A time line to reach the Future State
 - A process for achieving buy-in to the changes needed to establish the Future State
 - Documentation of Best Practices and Lessons Learned

What is Theory of Constraints?

A high level overview...

The Theory of Constraints (TOC)

in 100 words or less

- A **management science** based on the hard sciences, i.e., **rigorous cause-and-effect**
- TOC views organizations as **systems**:
 - Made up of different *parts, resources, processes, etc*
 - That must work *interdependently*
 - To achieve a common purpose, or *goal*
- An organization achieving infinite performance has no **constraint(s)**
- Knowing where an organization's constraint is enables focused improvements to **maximize overall performance**

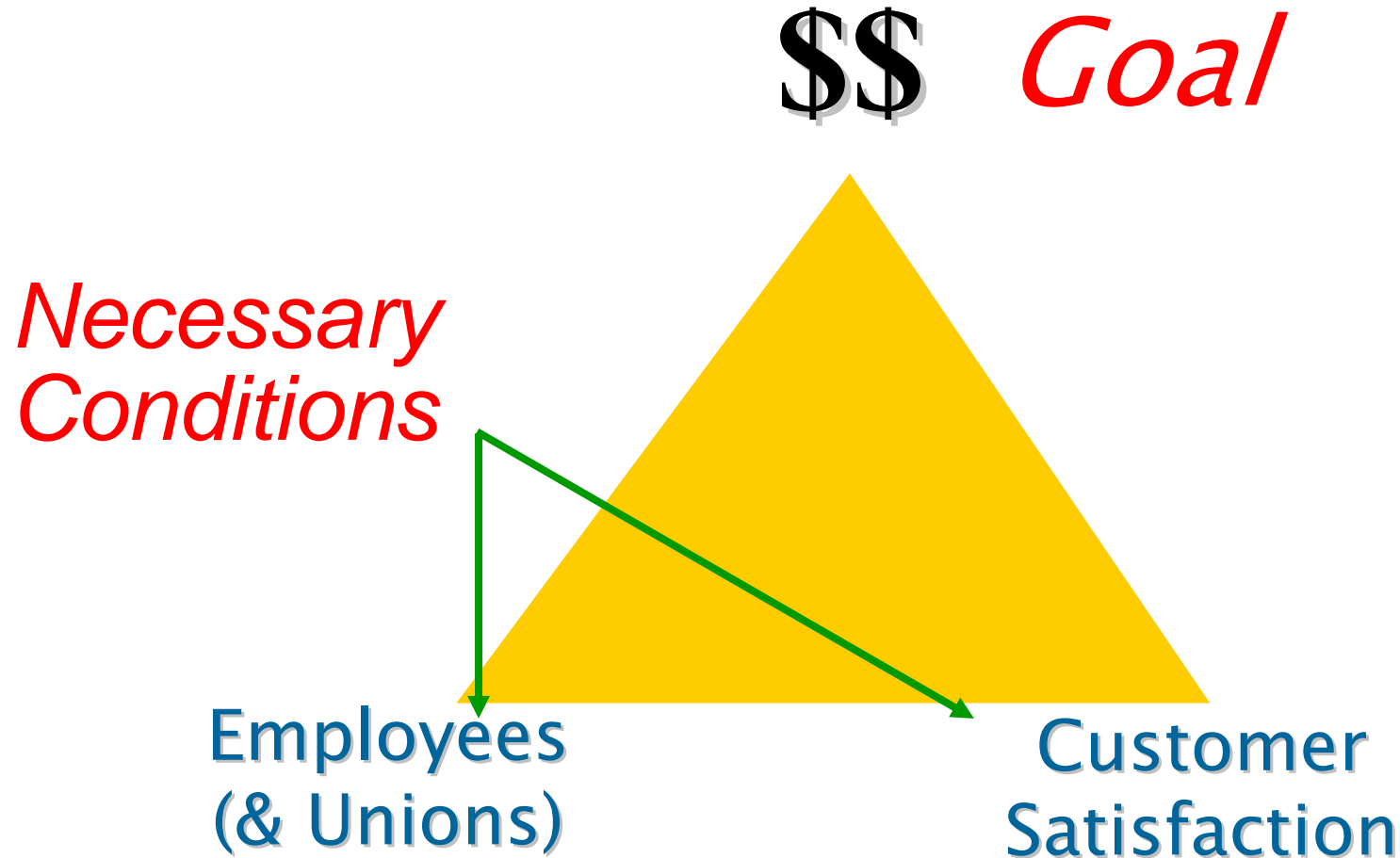
Creating a CPI Culture Requires an Enterprise Focus

Despite their apparent differences, all organizations are basically *the same*...

1. Purpose, or *Goal*
2. Global Performance Measurements
3. Business Processes
4. Local Process Measurements
5. Resource Rewards and Incentives



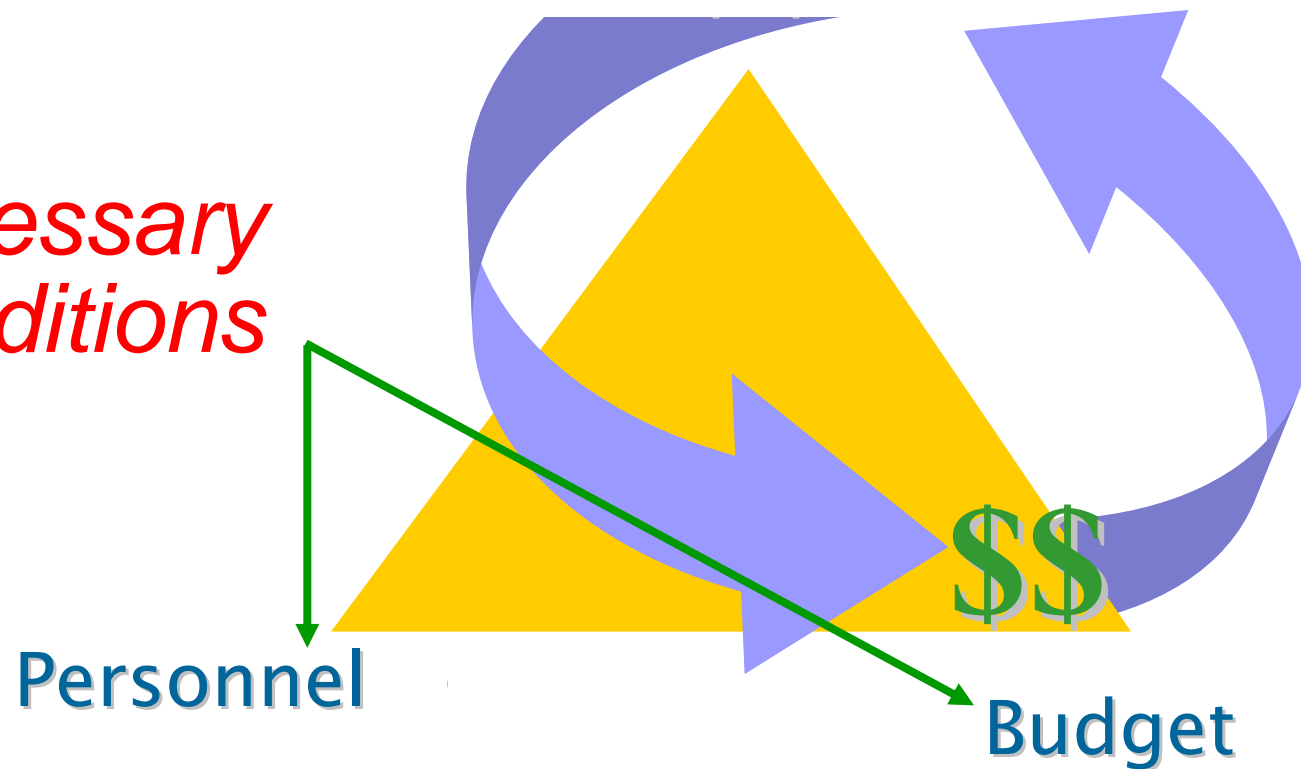
Every organization was created for a Purpose, or *Goal*...



What if the Goal of the organization isn't to make money?

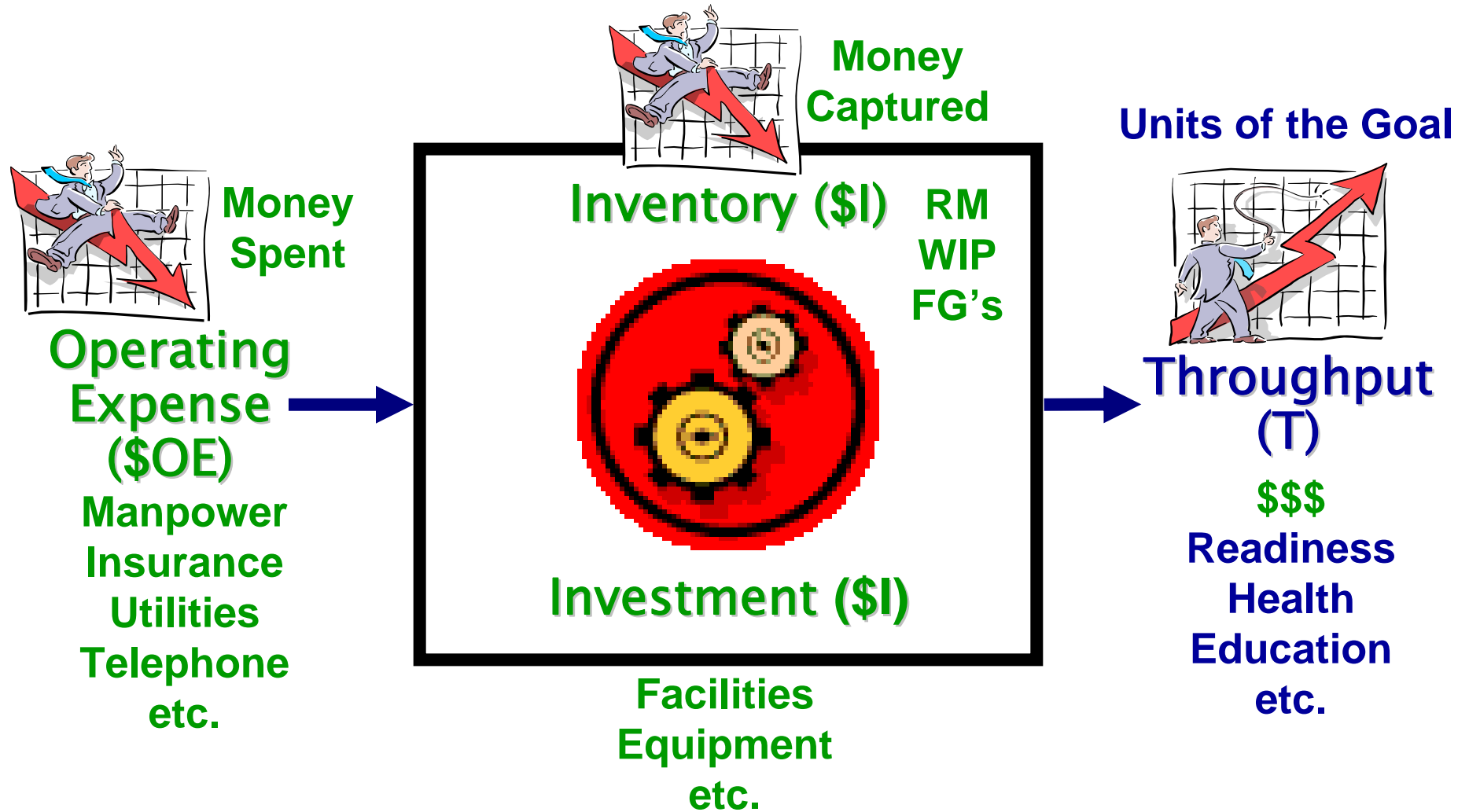
Mission *Goal*

*Necessary
Conditions*



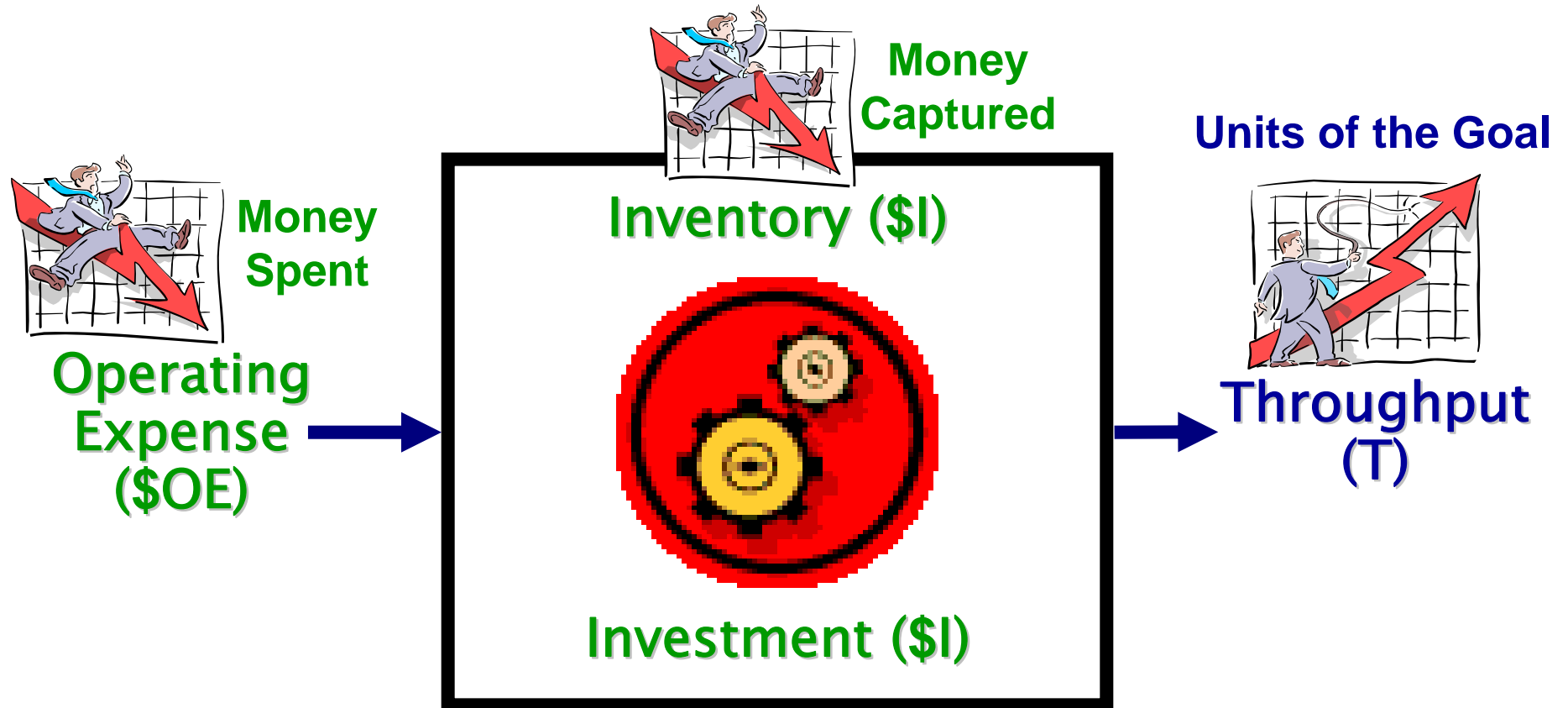
Purpose (Goal)–Driven Machine

“Cost–Wise Performance”



Purpose (Goal)–Driven Machine

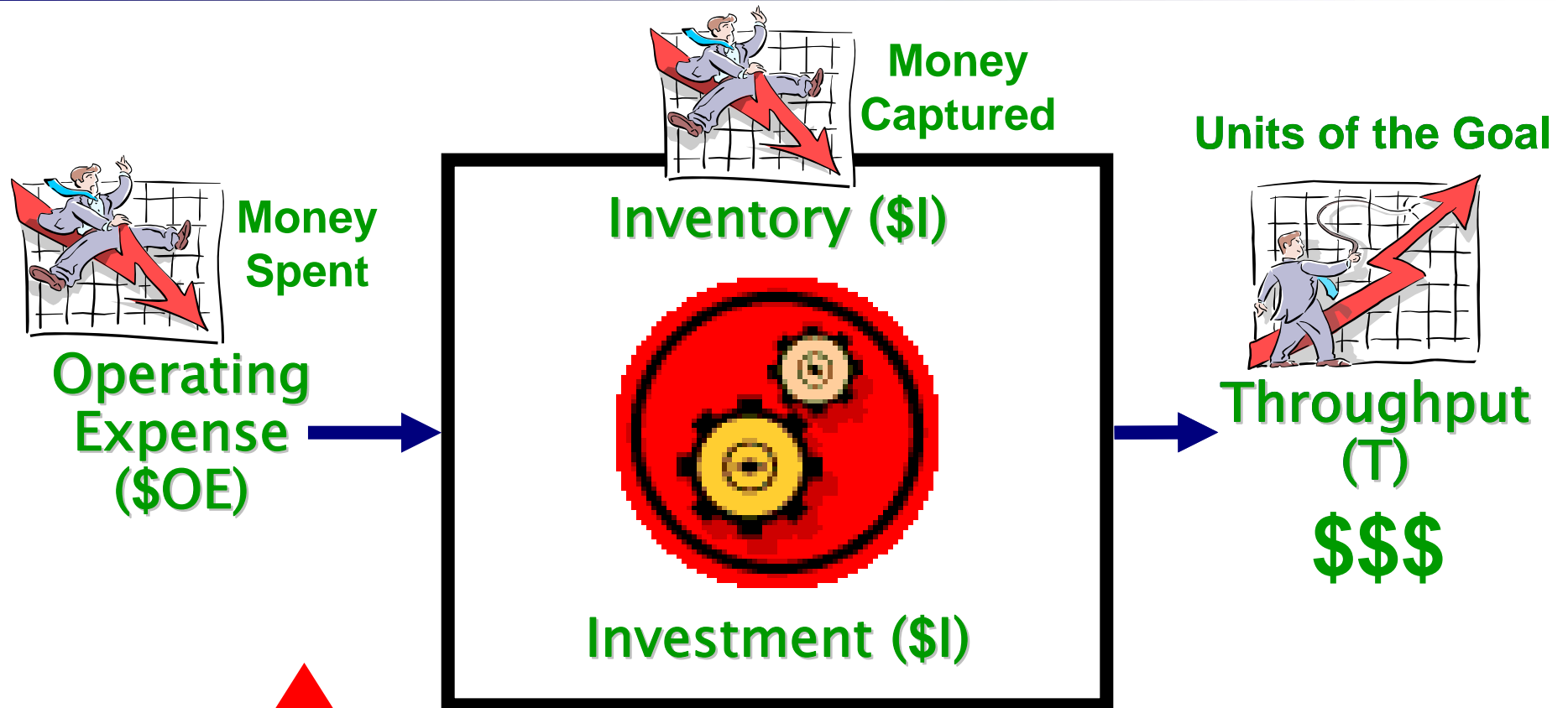
“Cost–Wise Performance”



↑ $T/\$I$ and ↑ $T/\$OE$

Purpose (Goal)–Driven Machine

“Cost–Wise Performance”

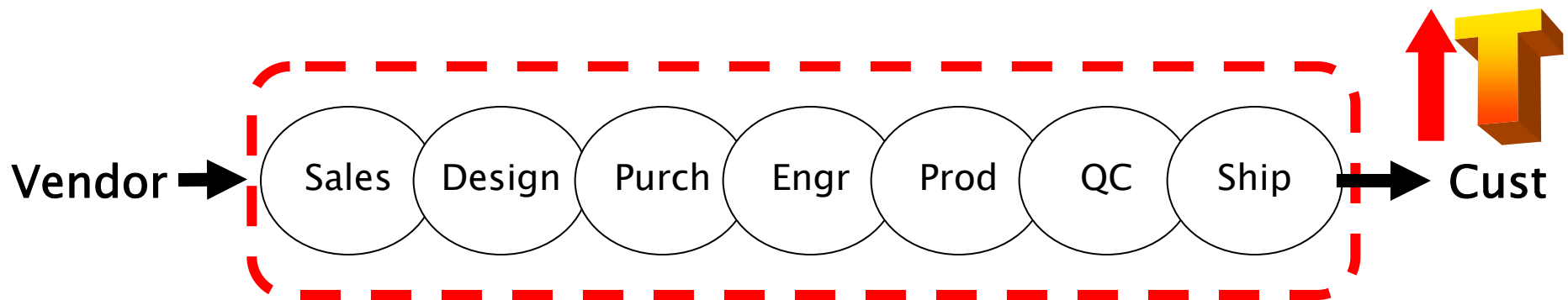


$$\text{Net Profit (NP)} = \$T - \$OE$$

$$\text{Return on Investment (ROI)} = \$NP / \$I$$

Business Processes

Every organization achieves its Goal via a chain(s) of interdependent resources/activities, commonly referred to as a **Business Process(es)**.

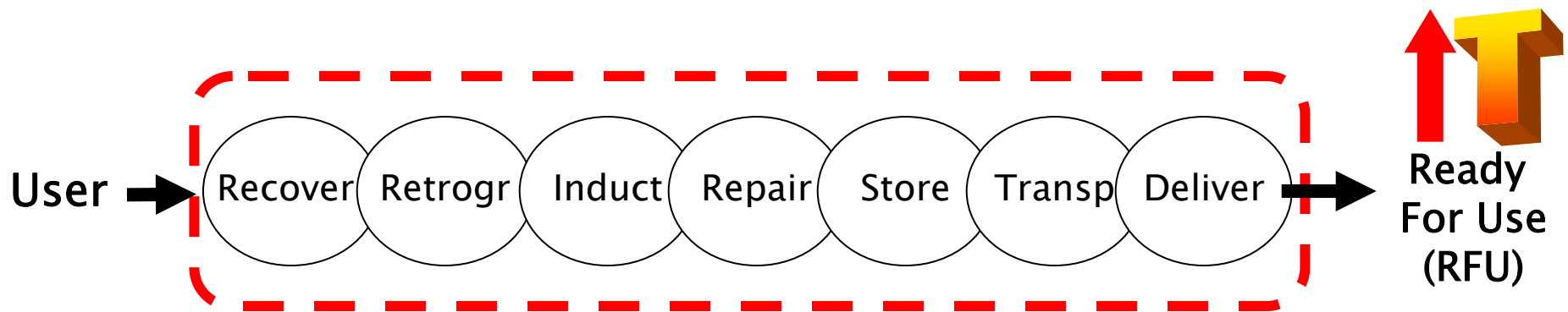


The more *flow* increases consistent with demand, the more successful the organization will be in achieving it's Goal.

For example...

Logistics Process(es)

where the chain of resources / interdependencies looks more like...

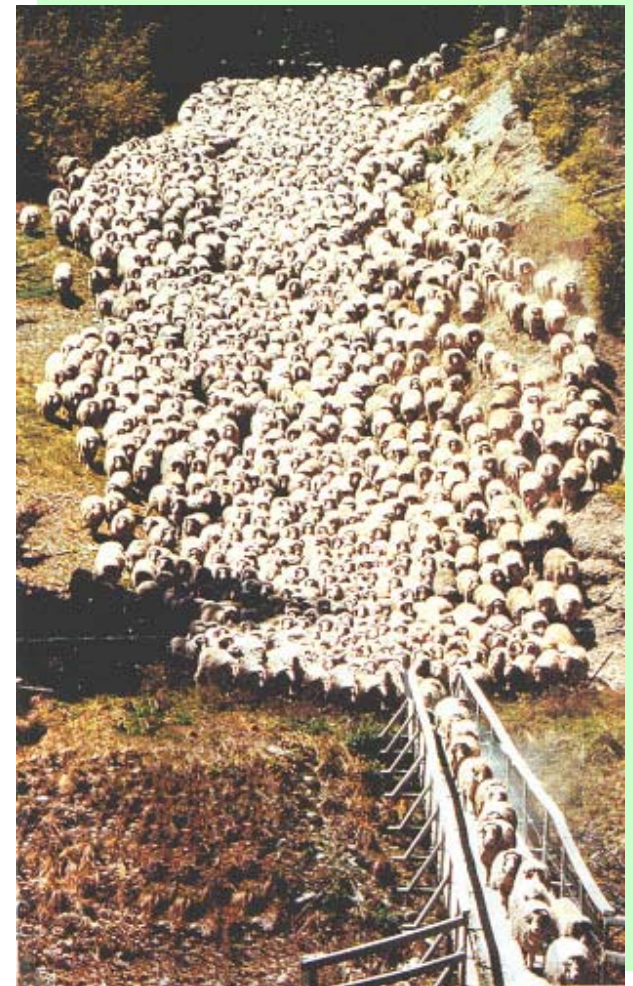


The more *flow* increases consistent with demand, the more successful the organization will be in achieving it's Goal.

As simple as it sounds...
Why is it so challenging in reality?

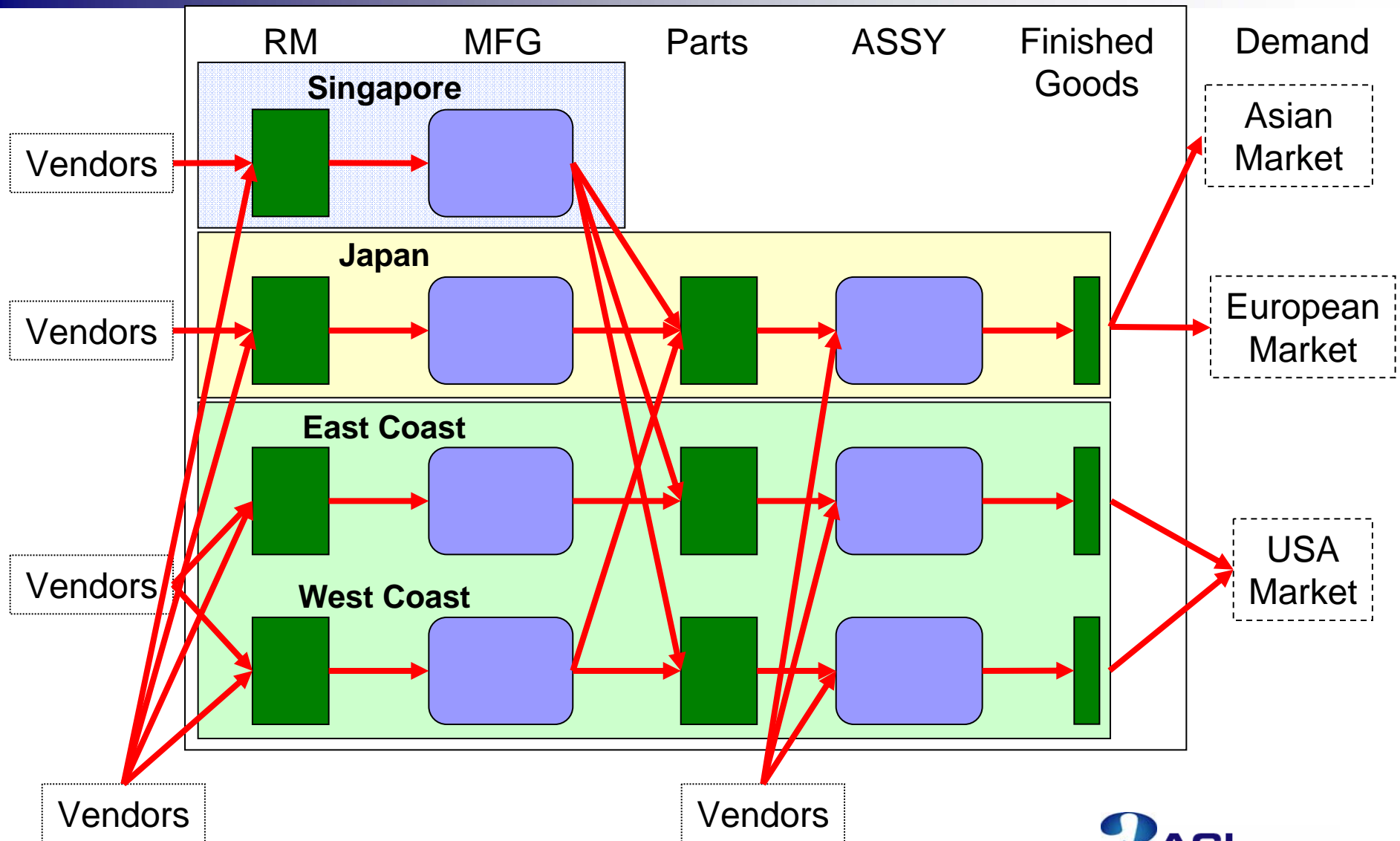
Three things can
significantly impact flow:

1. Interdependencies
2. Variability
3. Constraints (Bottlenecks)



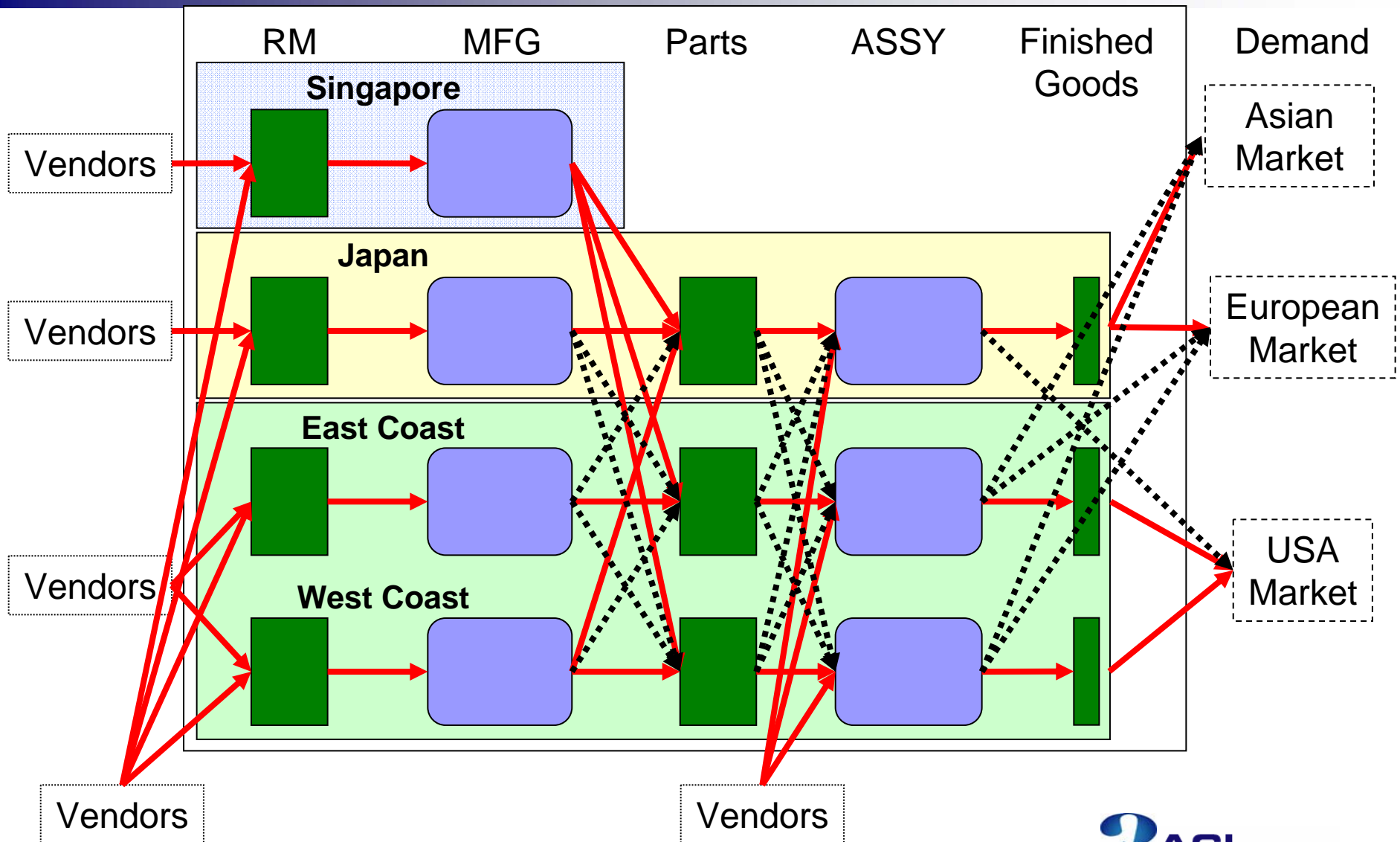
Supply Chain & Manufacturing Processes

Interdependencies – Product/Service Flow



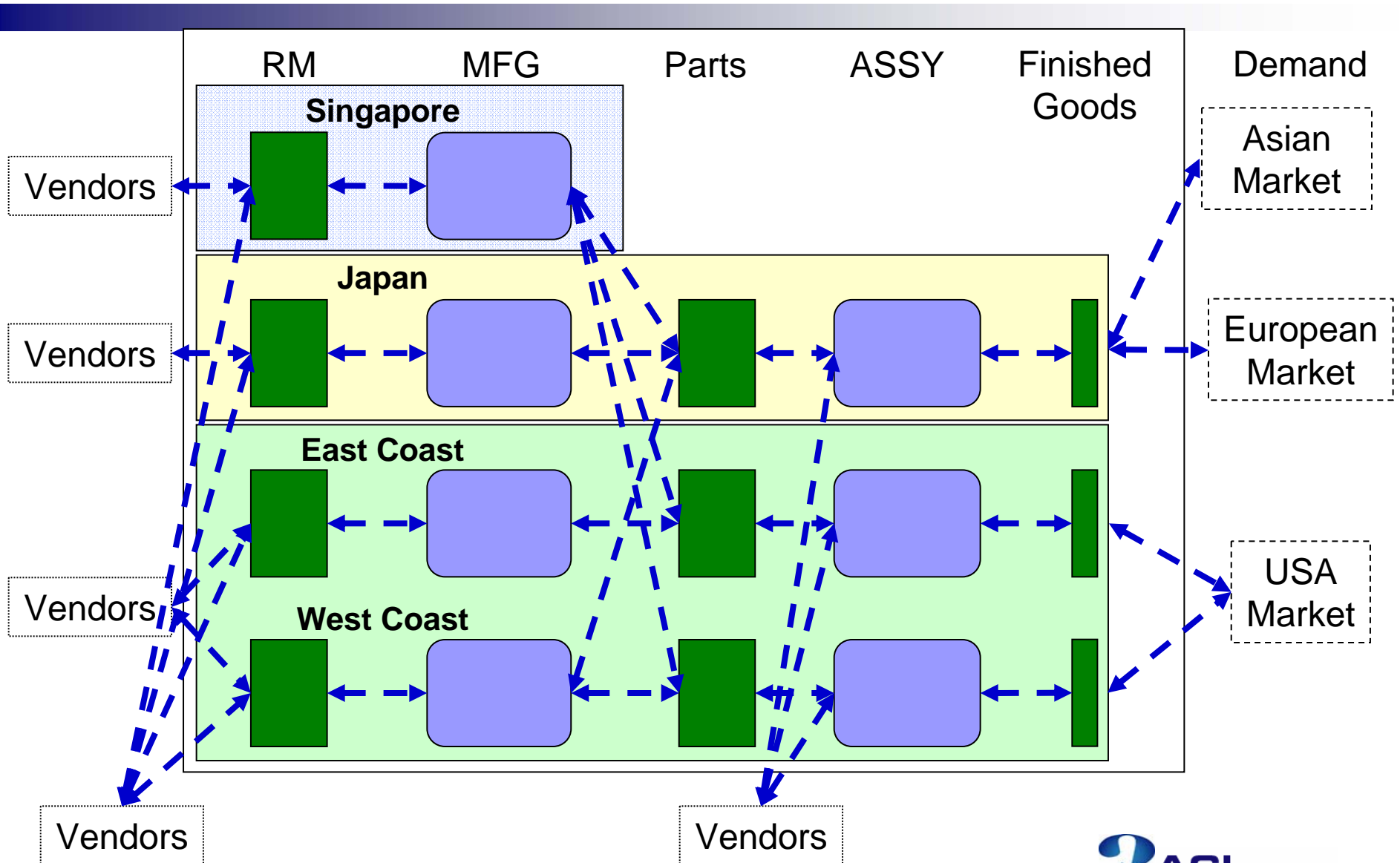
Supply Chain & Manufacturing Processes

Additional Interdependencies–Product/Service Flow



Supply Chain & Manufacturing Processes

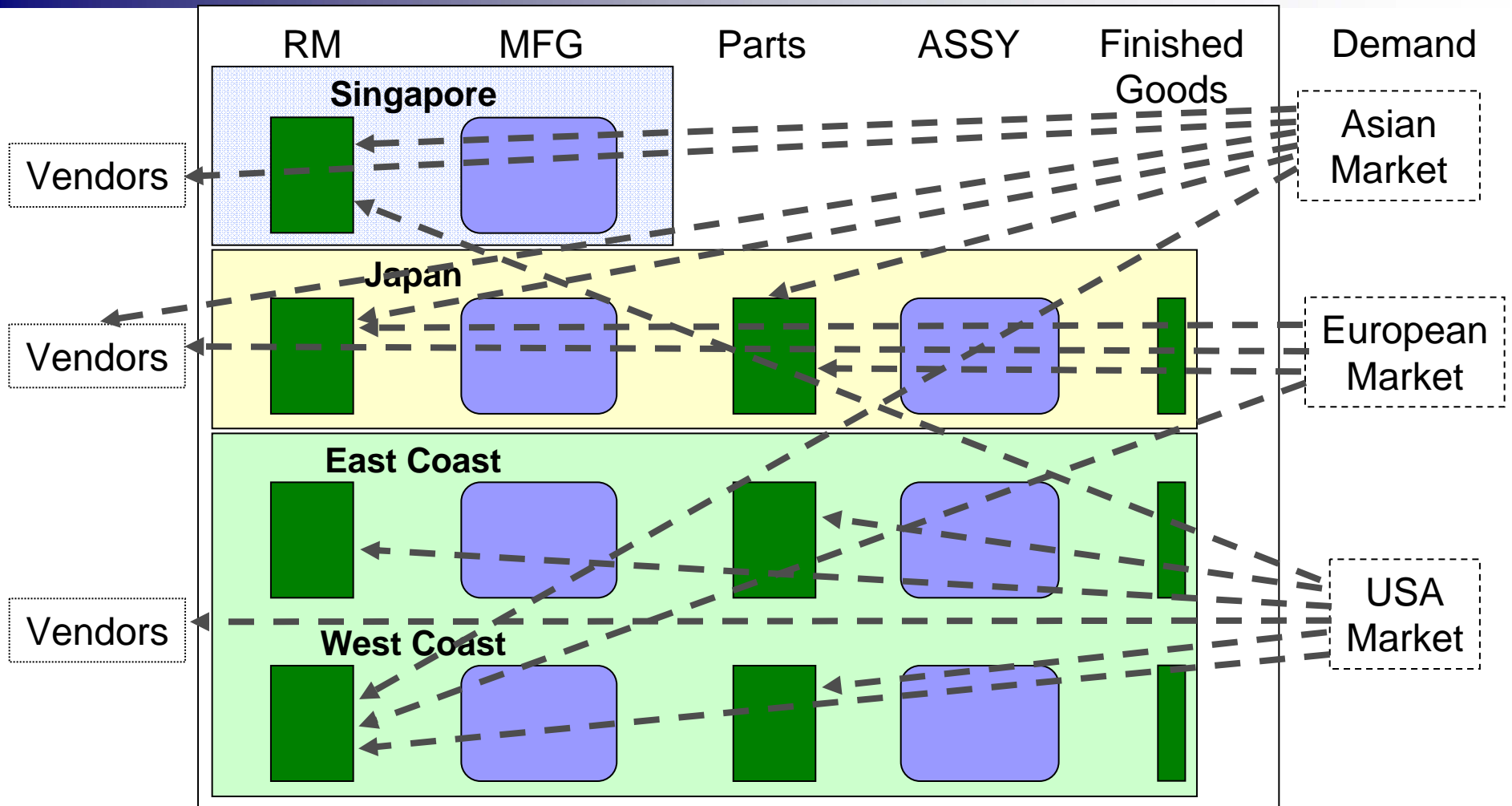
Interdependencies – Information Flow



Supply Chain & Manufacturing Processes

Interdependencies – Maintenance, Repair and Overhaul (MRO)

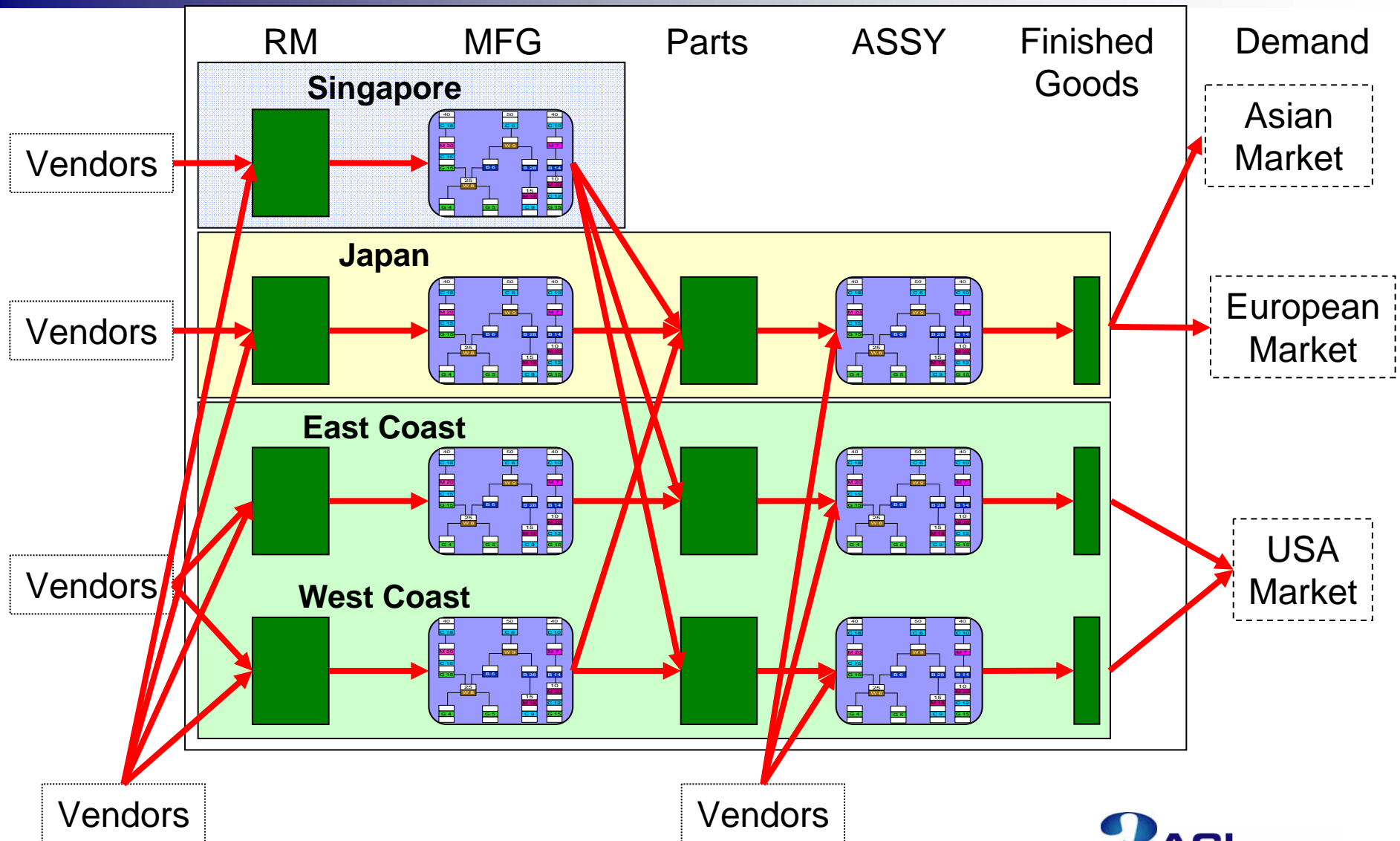
Retrograde Flow



Vendors

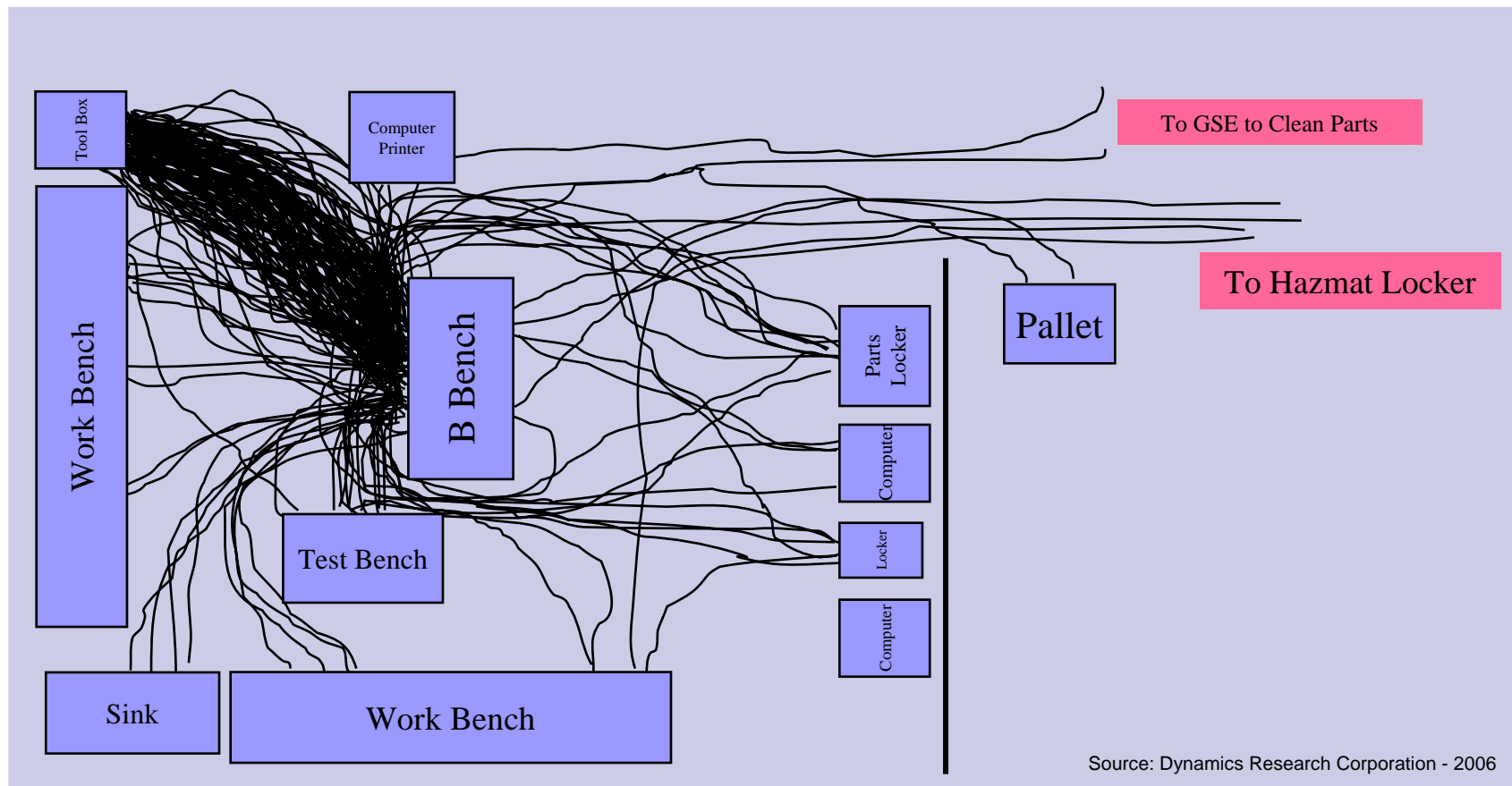
Vendors

Supply Chain & Manufacturing Processes Interdependencies – Detailed Product/Service Flow



Supply Chain & Manufacturing Processes Interdependencies – Spaghetti Chart

Shows the physical area layout, flow of product through a series of process steps, or maps where a person walks to complete their process



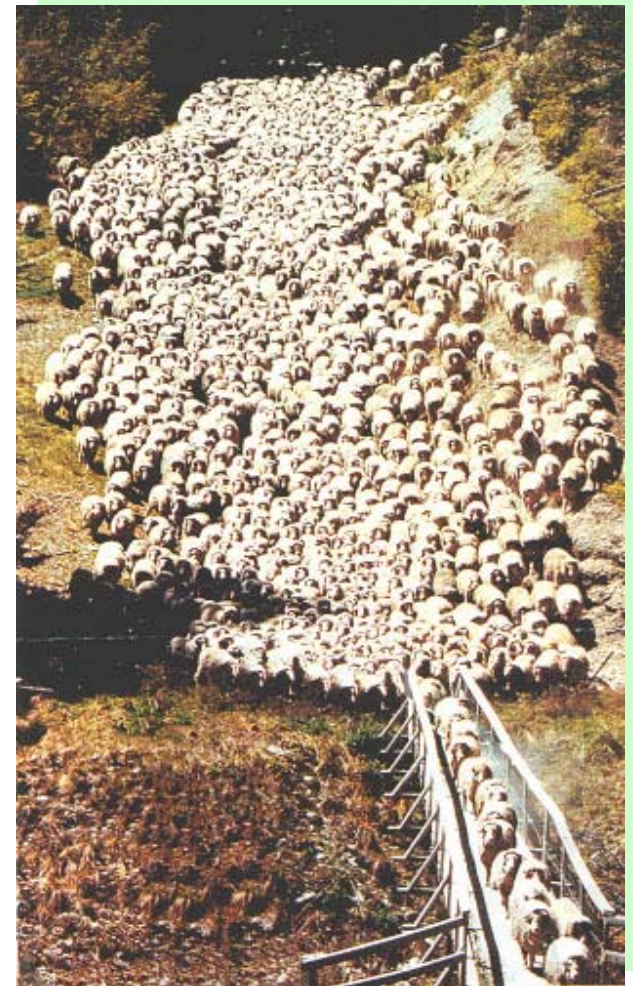
People distance: 2912 feet

Parts distance: 331 feet

As simple as it sounds...
Why is it so challenging in reality?

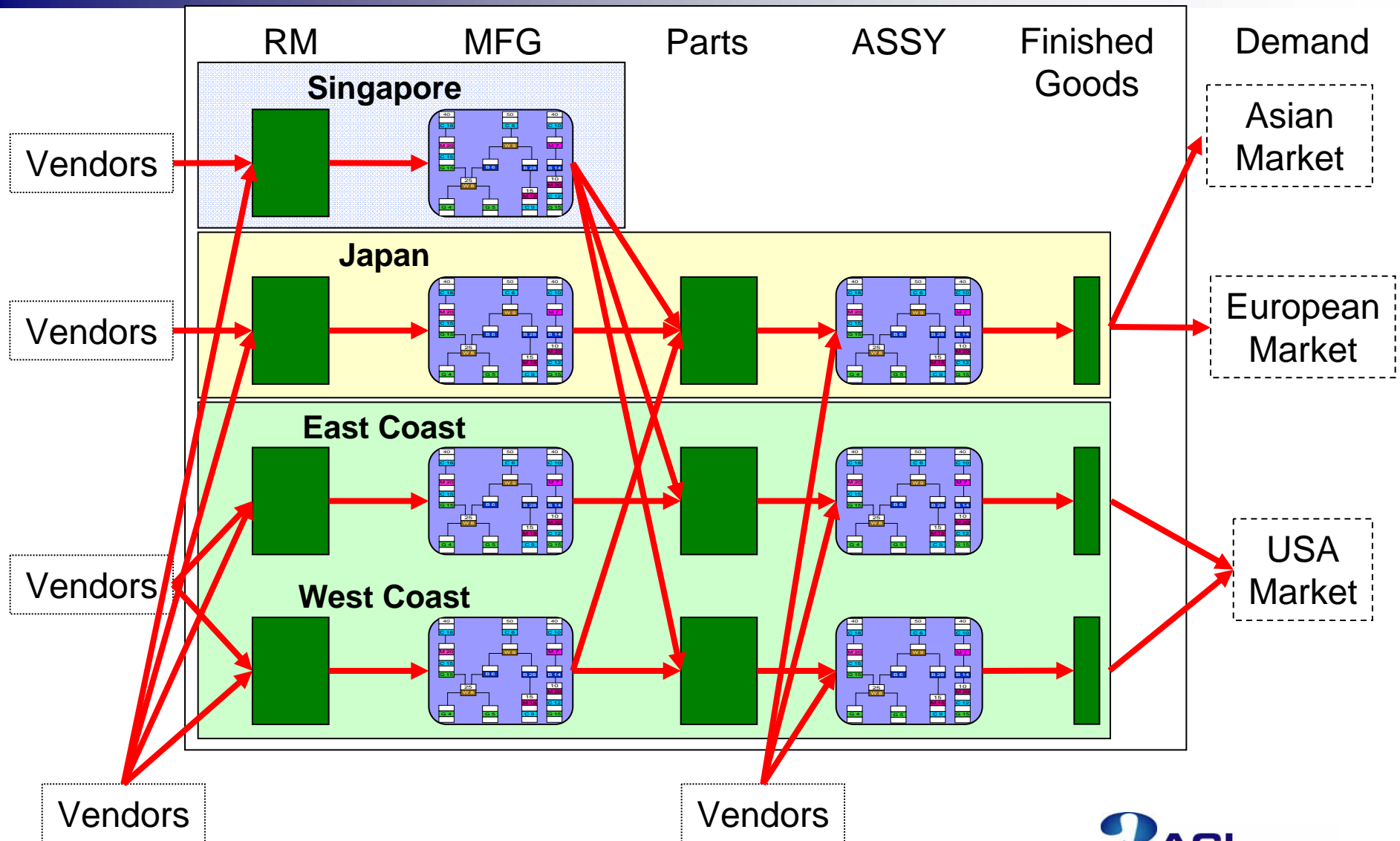
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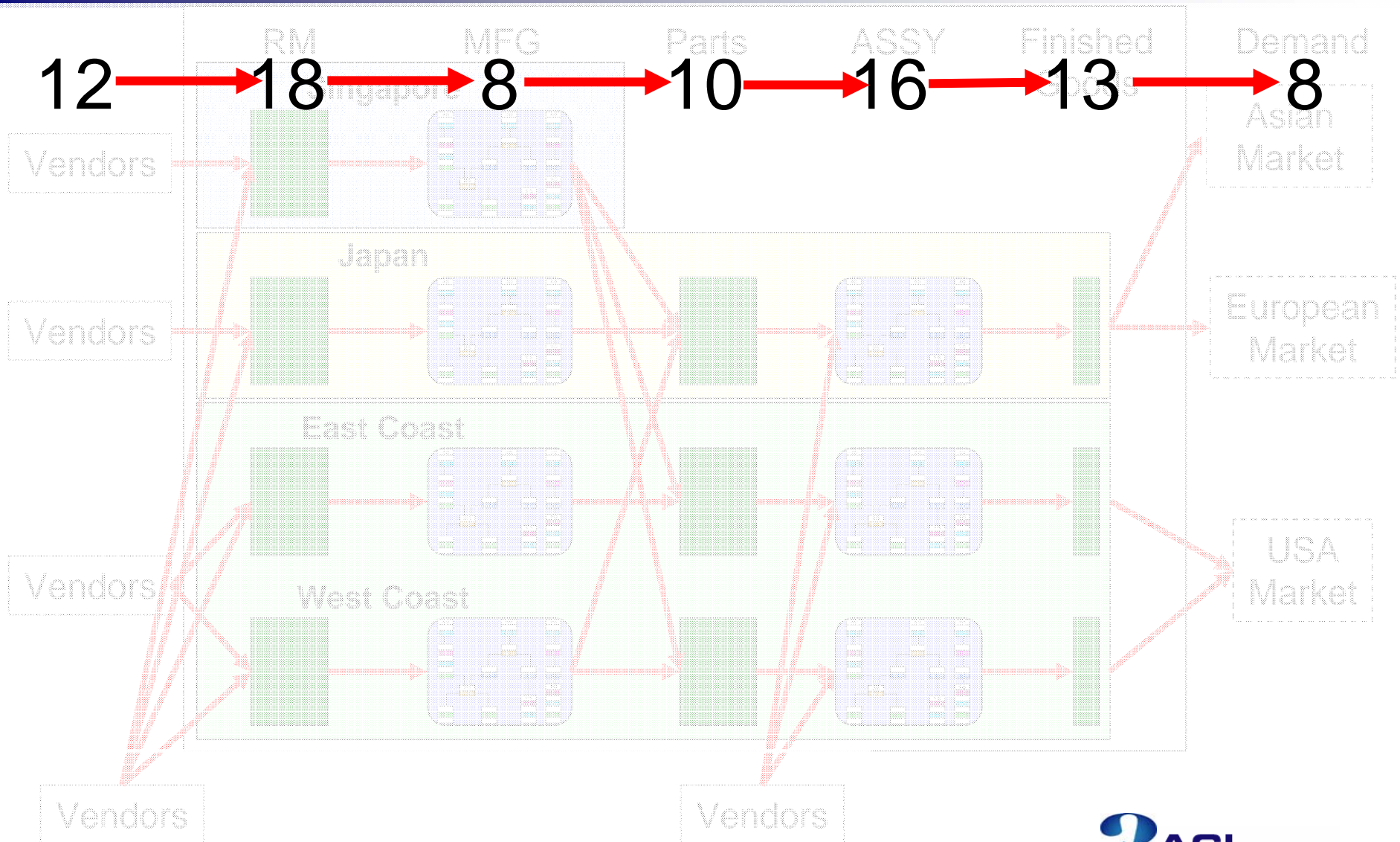
Supply Chain & Manufacturing Processes

Understanding the effects of Variability?



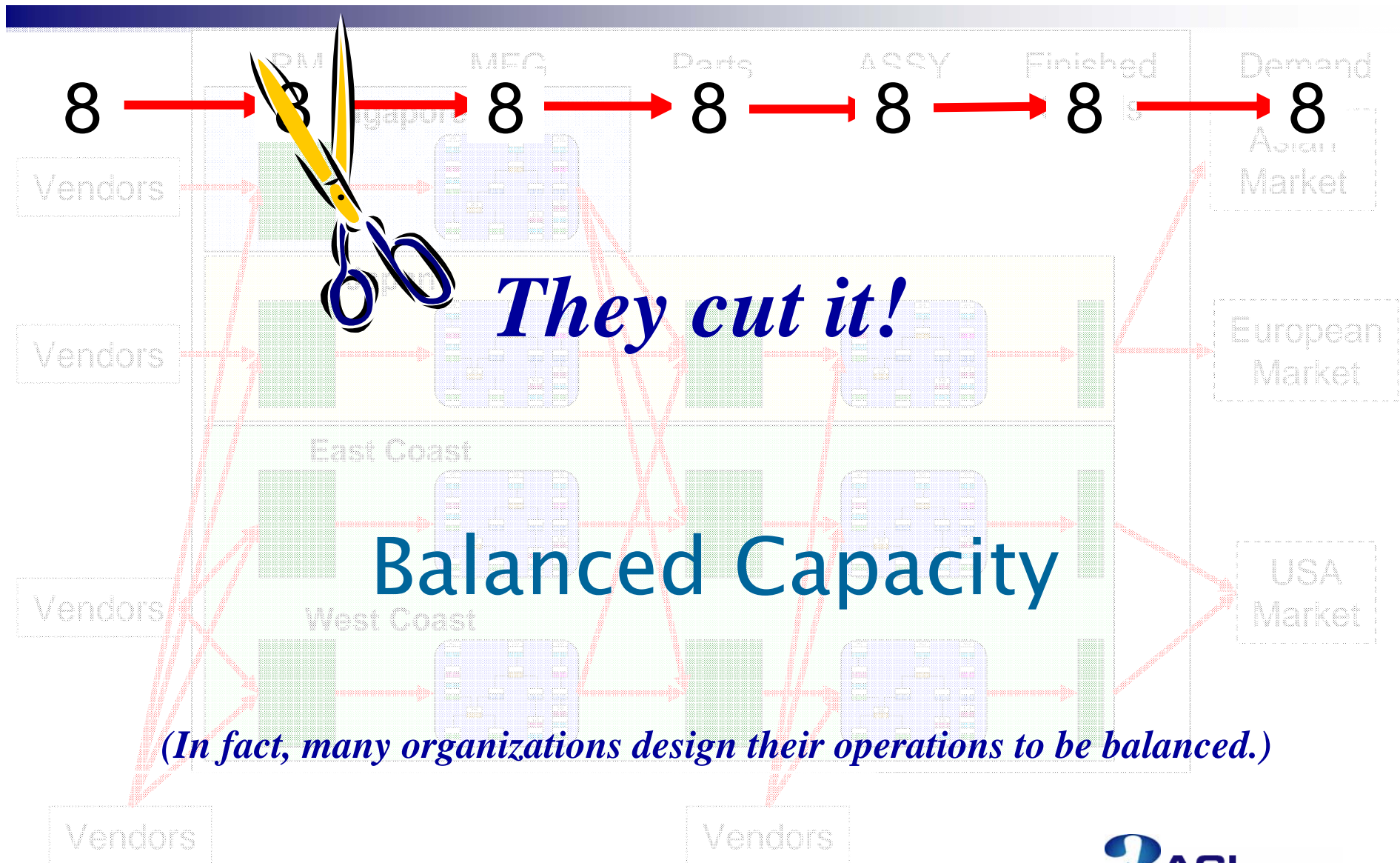
Supply Chain & Manufacturing Processes

What do organizations tend to do with excess capacity?



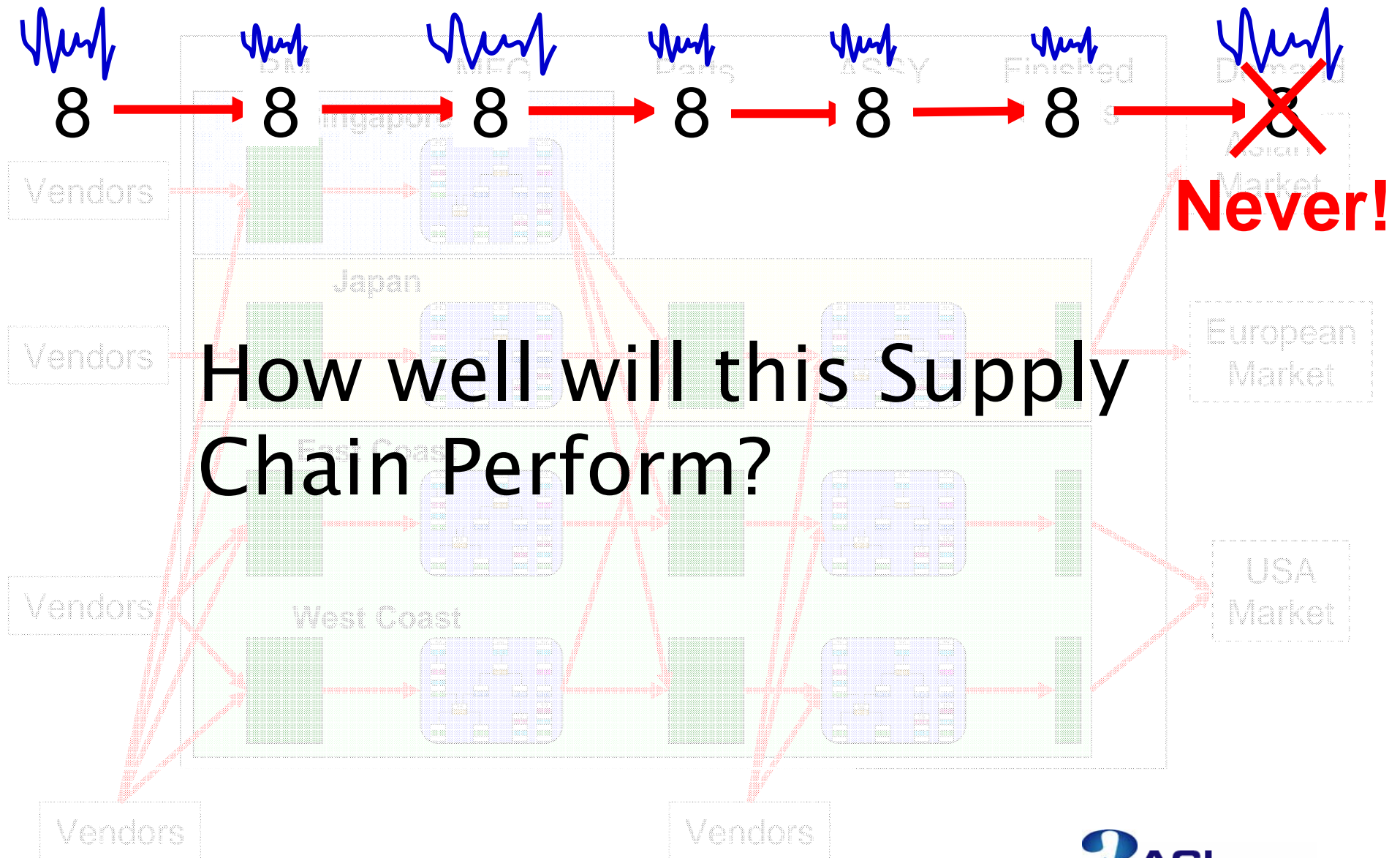
Supply Chain & Manufacturing Processes

What do organizations tend to do with excess capacity?



Supply Chain & Manufacturing Processes

Is there any variability in the processes?



Supply Chain & Manufacturing Processes

Sources of Variability

Vendors

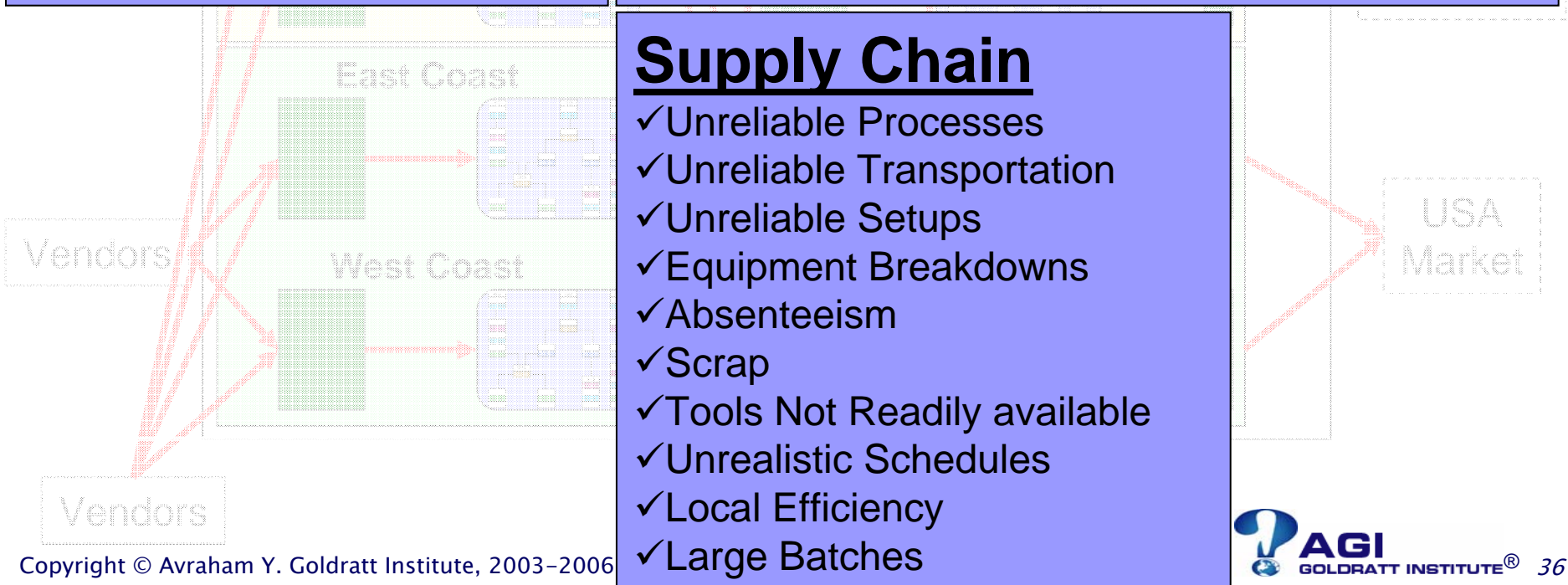
- ✓ Unreliable Lead Times
- ✓ Unreliable Deliveries
- ✓ Unreliable Transportation
- ✓ Poor Quality
- ✓ Unrealistic Schedules
- ✓ Local Efficiency
- ✓ Large Batches

Market

- ✓ Seasonality
- ✓ Customer Needs Are Not Well Understood
- ✓ Customer Needs Are Not Well Addressed – A Poor Value Delivery Process
- ✓ Customer Finds It Difficult To Do Business With The Suppliers
- ✓ Unreliable Sales Process

Supply Chain

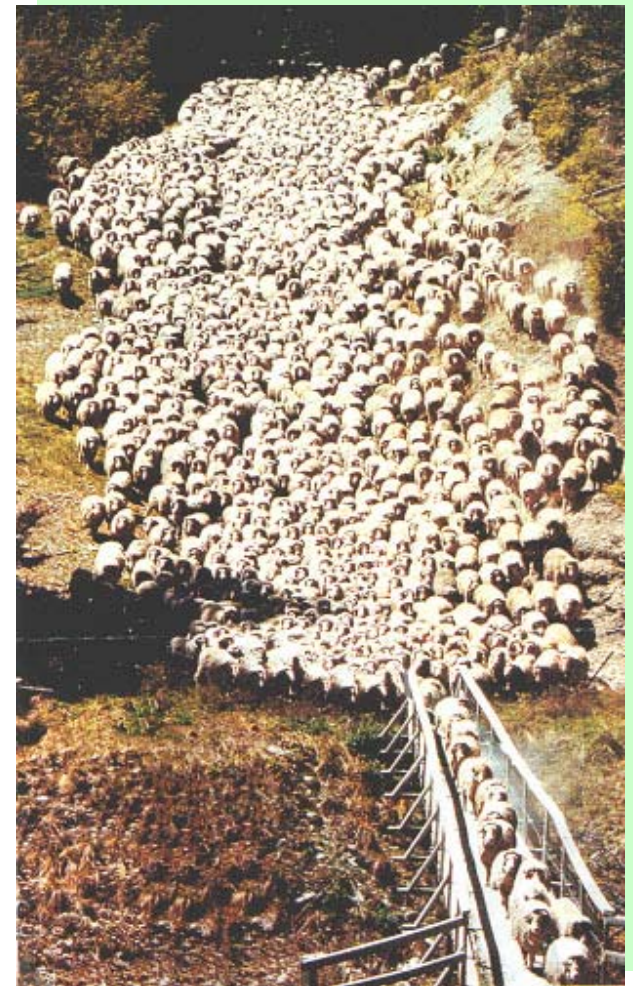
- ✓ Unreliable Processes
- ✓ Unreliable Transportation
- ✓ Unreliable Setups
- ✓ Equipment Breakdowns
- ✓ Absenteeism
- ✓ Scrap
- ✓ Tools Not Readily available
- ✓ Unrealistic Schedules
- ✓ Local Efficiency
- ✓ Large Batches



As simple as it sounds...
Why is it so challenging in reality?

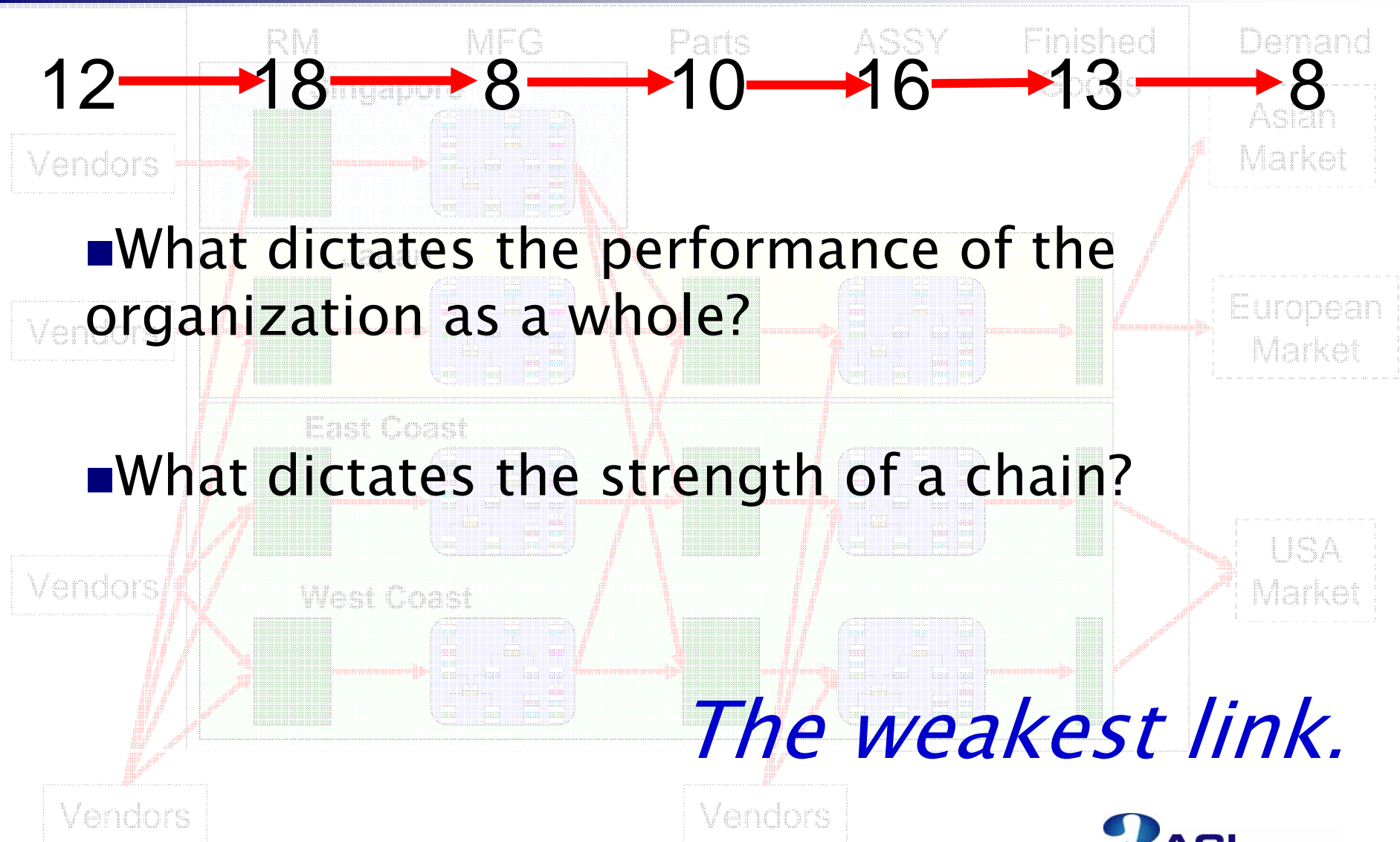
Three things can
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1. Interdependencies
2. Variability
3. Constraints (Bottlenecks)



Supply Chain & Manufacturing Processes

What Determines Overall Performance?

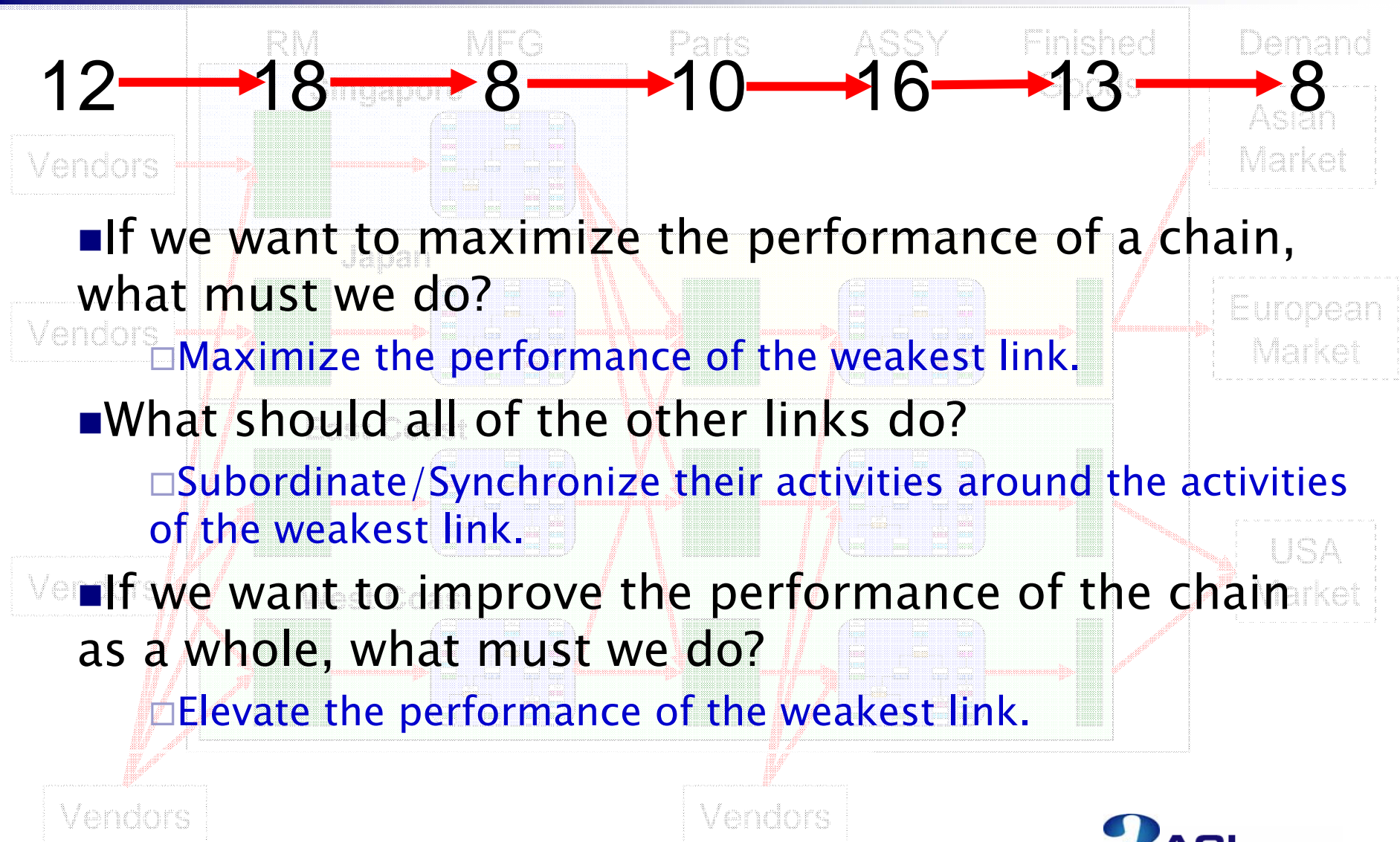


■ What dictates the performance of the organization as a whole?

■ What dictates the strength of a chain?

Supply Chain & Manufacturing Processes

What Determines Overall Performance?



■ If we want to maximize the performance of a chain, what must we do?

□ Maximize the performance of the weakest link.

■ What should all of the other links do?

□ Subordinate/Synchronize their activities around the activities of the weakest link.

■ If we want to improve the performance of the chain as a whole, what must we do?

□ Elevate the performance of the weakest link.

The 5 Focusing Steps of TOC

1. **Identify** the system's constraint. ←
2. Decide how to **exploit** it.
3. **Subordinate/Synchronize** everything else to the above decisions.
4. **Elevate** the system's constraint.
5. If in the above steps the constraint has shifted, **go back to Step 1**. →

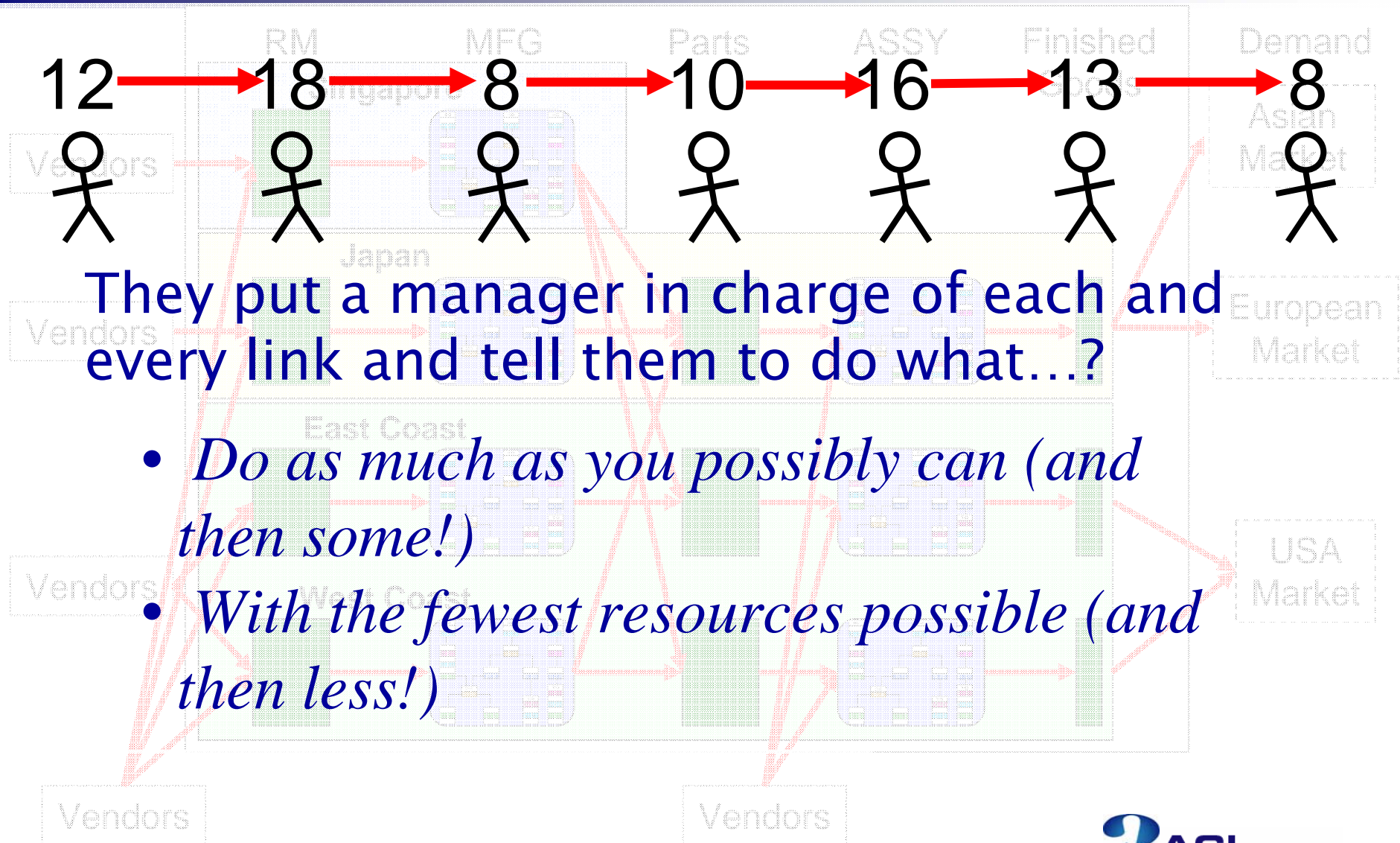
WARNING

Do not allow inertia to become the system's constraint!

A Process Of OnGoing Improvement

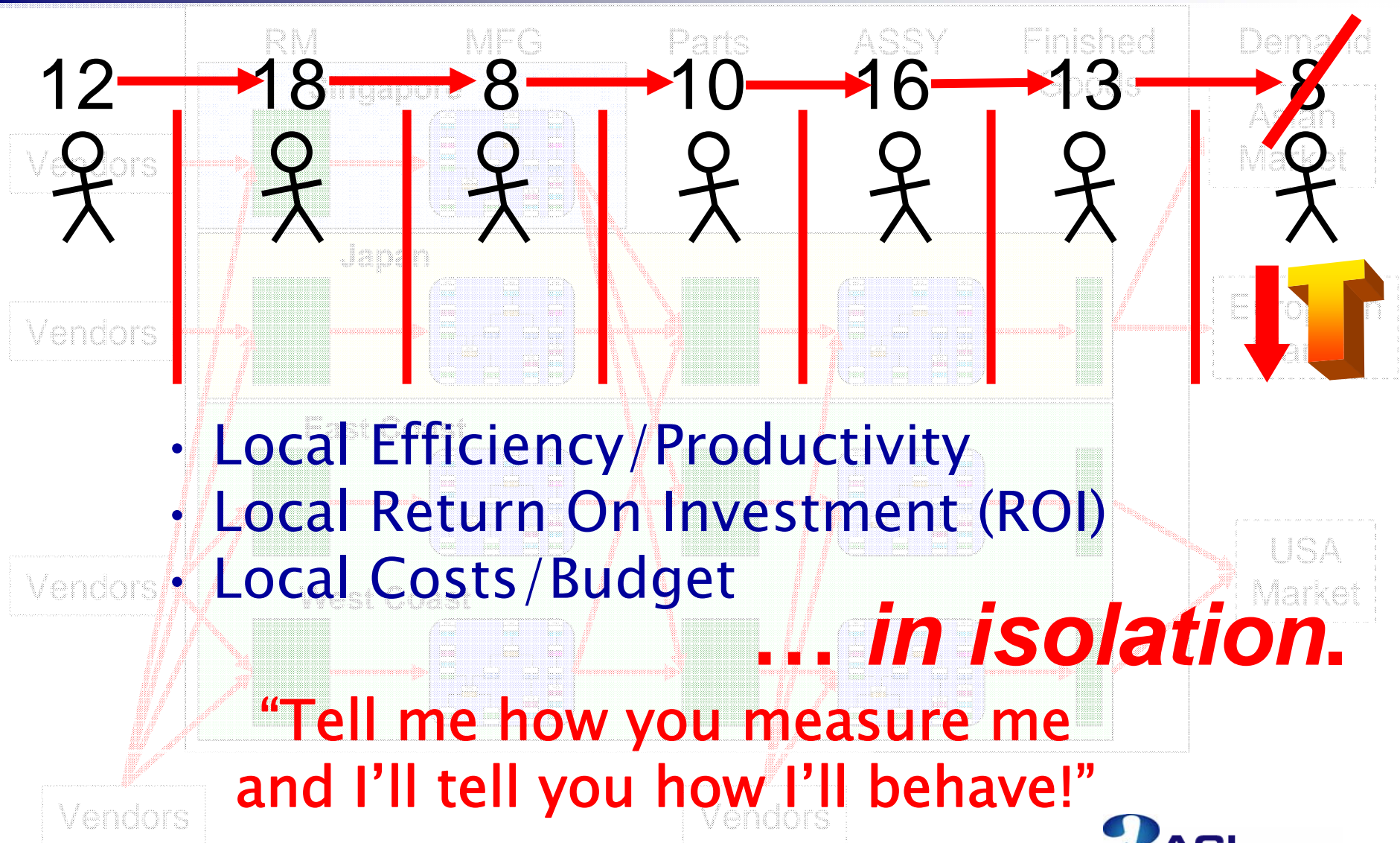
Supply Chain & Manufacturing Processes

How Do Organizations Manage Their Business Process(es)?

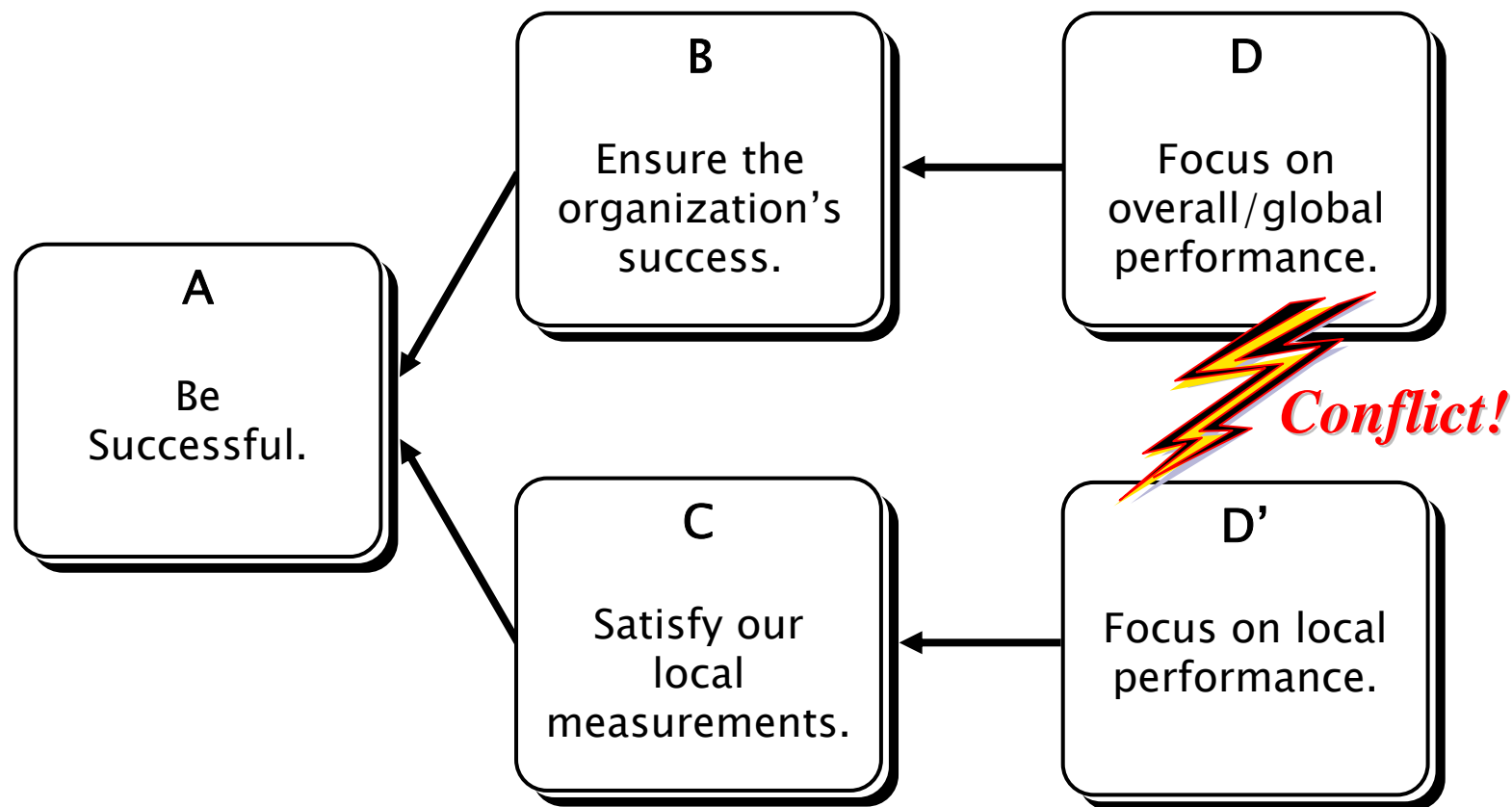


Supply Chain & Manufacturing Processes

How do they *measure, reward* and *incent* their people?

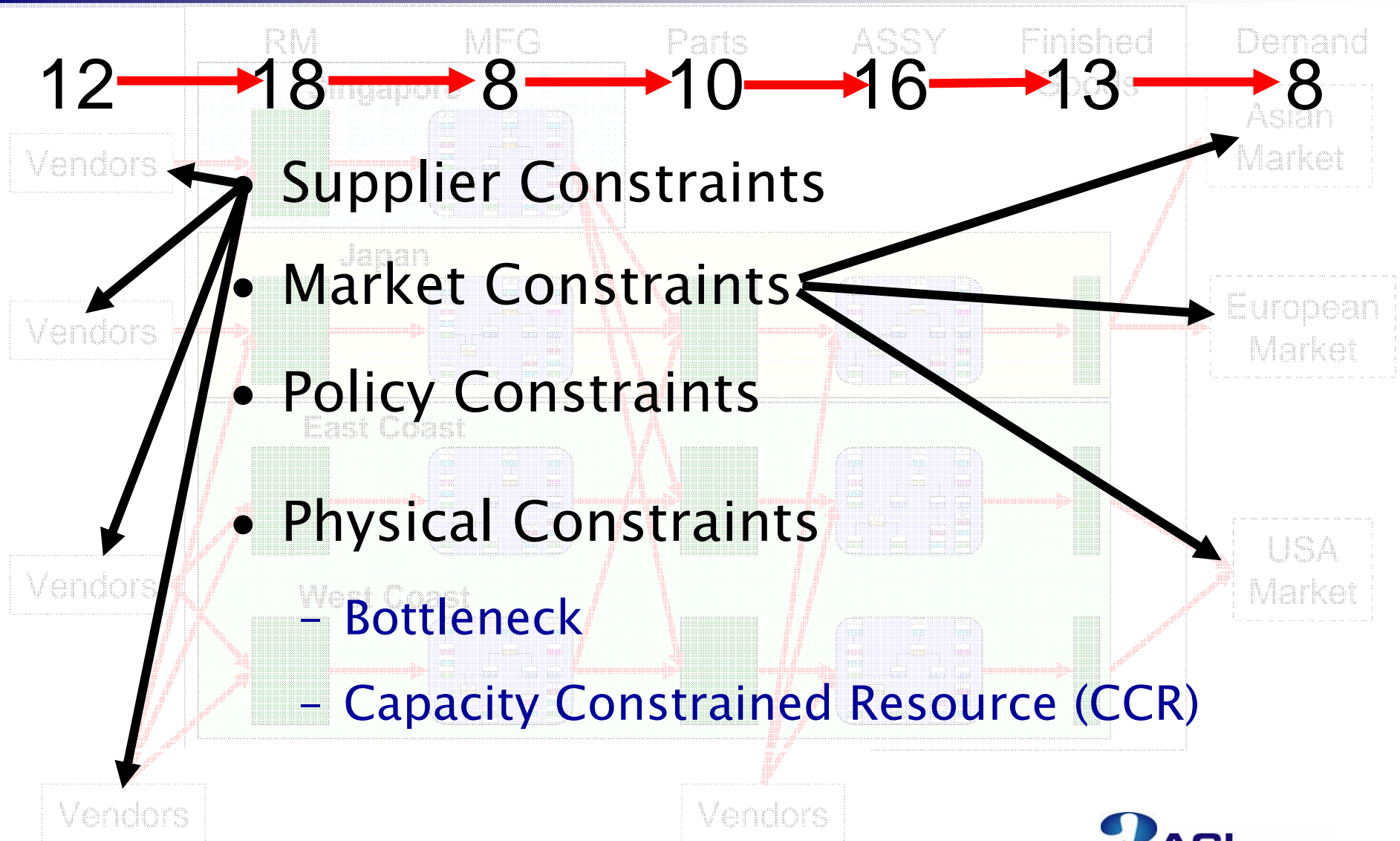


The battle for results in virtually *every* organization comes from a *single conflict*...



Supply Chain & Manufacturing Processes

Constraints Determine Overall Performance?



Supply Chain & Manufacturing Processes

Maximizing the Return on our Improvement Dollars

So, how do we maximize the return on our improvement dollars?

Where should we focus our improvement efforts?

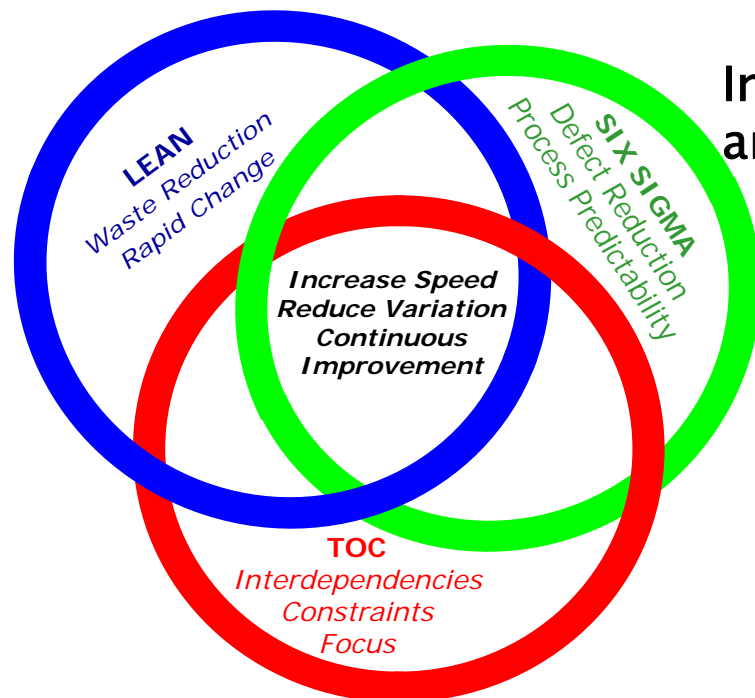
- ✓ Interdependencies
- ✓ Variability
- ✓ Constraints
- ✓ Waste

Enterprise Focused CPI Tools and Methods

TOC–Lean–Six Sigma Integration (TLS)

- “Theory of Constraints (TOC) is a body of knowledge on the effective management of organizations as systems.”
- “Lean Manufacturing is a management philosophy focusing on reduction of the 7 wastes in manufactured products. By eliminating waste, quality is improved, production time is reduced, and cost is reduced.”
- “Six Sigma can be defined as a methodology to manage process variations that cause defects, defined as unacceptable deviation from the mean or target; and to systematically work towards managing variation to eliminate those defects.”

Source: Wikipedia Encyclopedia



Integrated Application of *TOC*, *Lean* and *Six Sigma* Methodologies

Aligns doctrine, policy, decision rules, measurements and behavioral changes with the physical reconfiguration of space, resources and assets

IN ORDER TO ACHIEVE ENTERPRISE LEVEL RESULTS

- Increased Throughput
- Reduced Operating Expense
- Reduced Investment/Inventory

Supply Chain & Manufacturing Processes

Maximizing The Return On Our Improvement Dollars

Applying TOC, Lean and Six Sigma as an Integrated Approach to Continuous Process Improvement starts with:

- 1) Defining, to an appropriate level of detail, the decision rules (i.e., doctrine, policy, measurements and instructions) that will be used to guide and direct the required actions, and
- 2) Reconfiguring the environment (i.e., buffers, buffer management, information systems, physical layout, tool location, supplies, kitting, etc.) to support the effective execution of those required actions

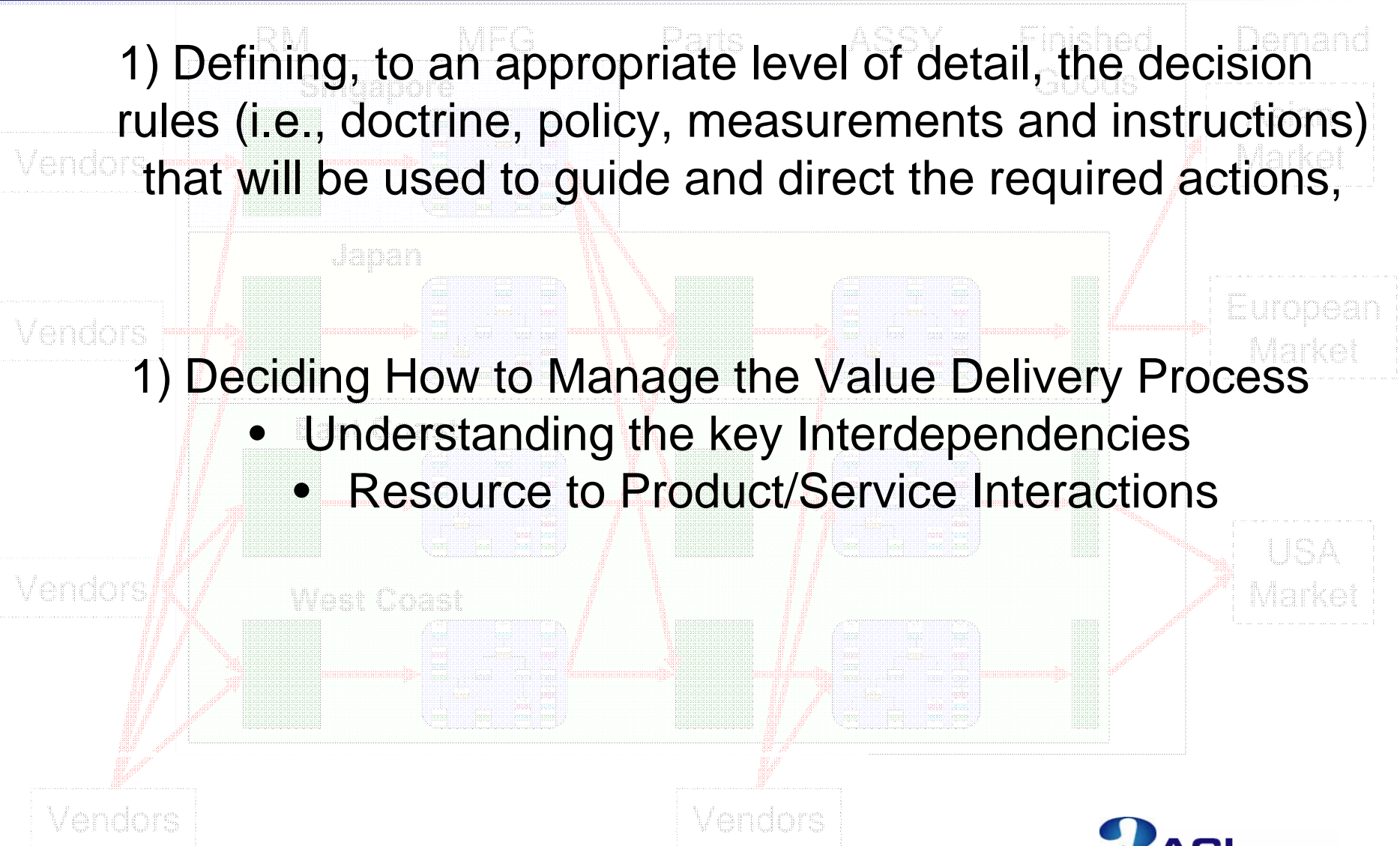
Supply Chain & Manufacturing Processes

Maximizing The Return On Our Improvement Dollars

1) Defining, to an appropriate level of detail, the decision rules (i.e., doctrine, policy, measurements and instructions) that will be used to guide and direct the required actions,

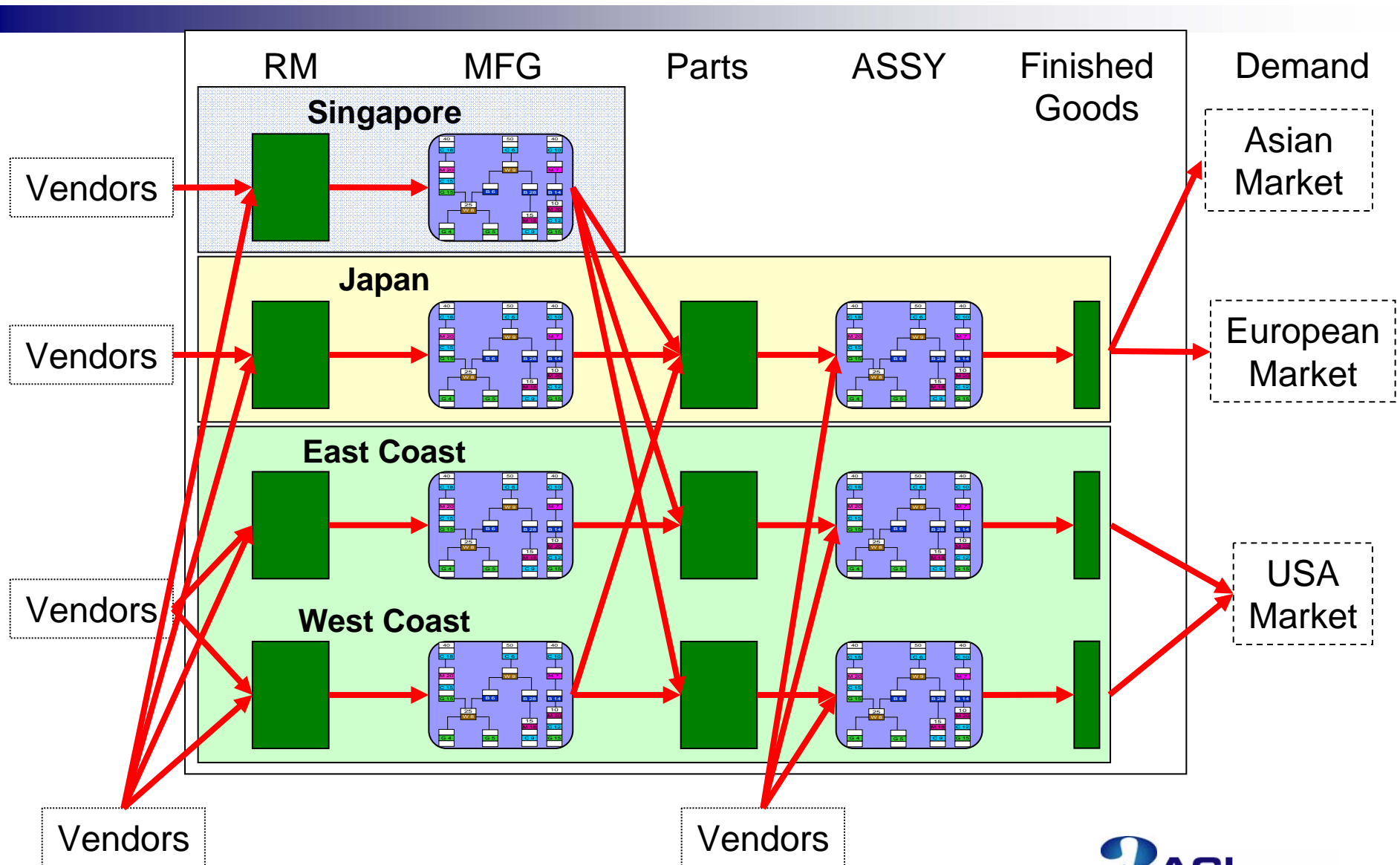
1) Deciding How to Manage the Value Delivery Process

- Understanding the key Interdependencies
- Resource to Product/Service Interactions



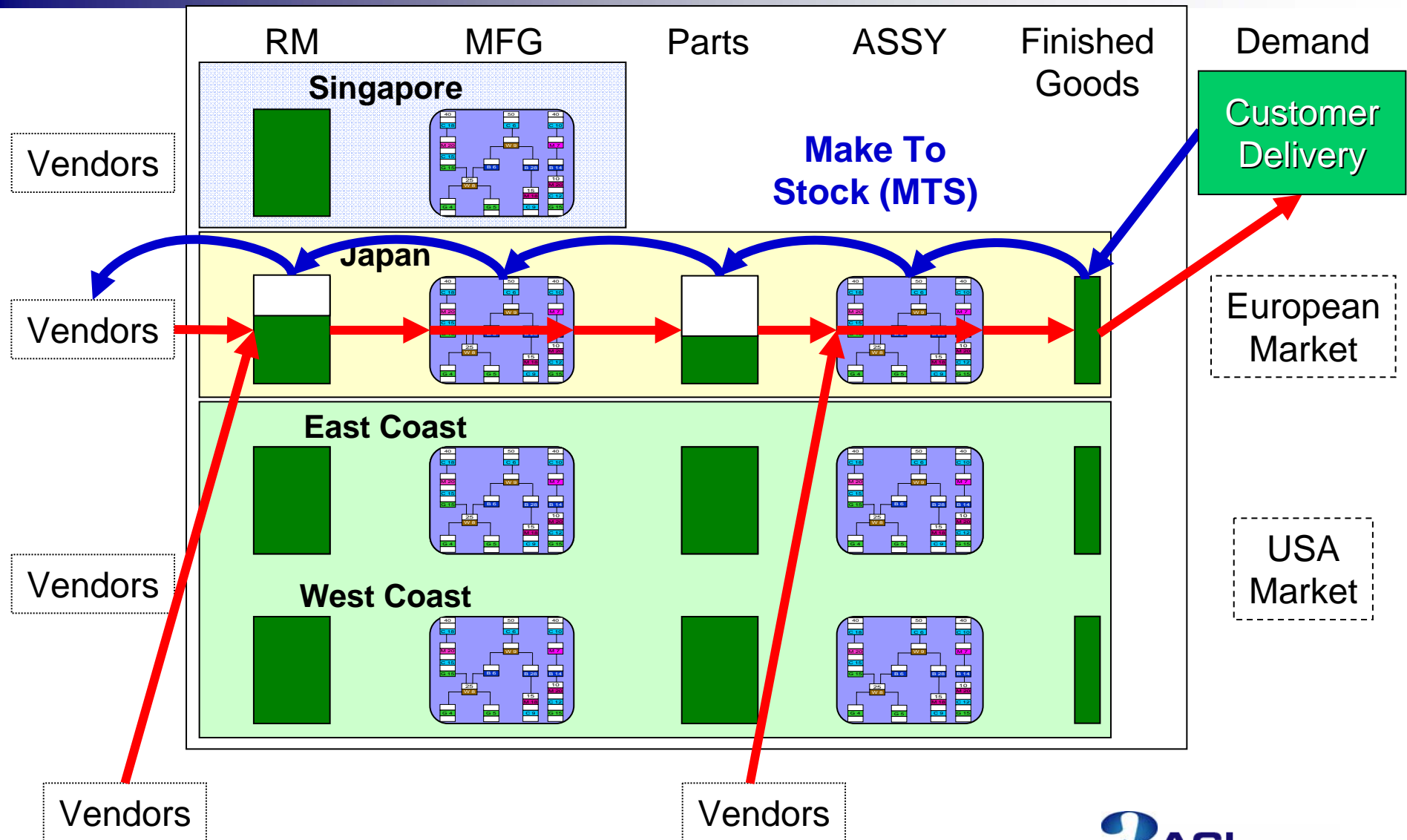
Deciding How to Manage the Value Delivery Process

Key Interdependencies – Resource to Product/Service Interactions



Deciding How to Manage the Value Delivery Process

Defining the Decision Rules - Pull means Production/Repair and Replenish processes are only activated by Customer Demand



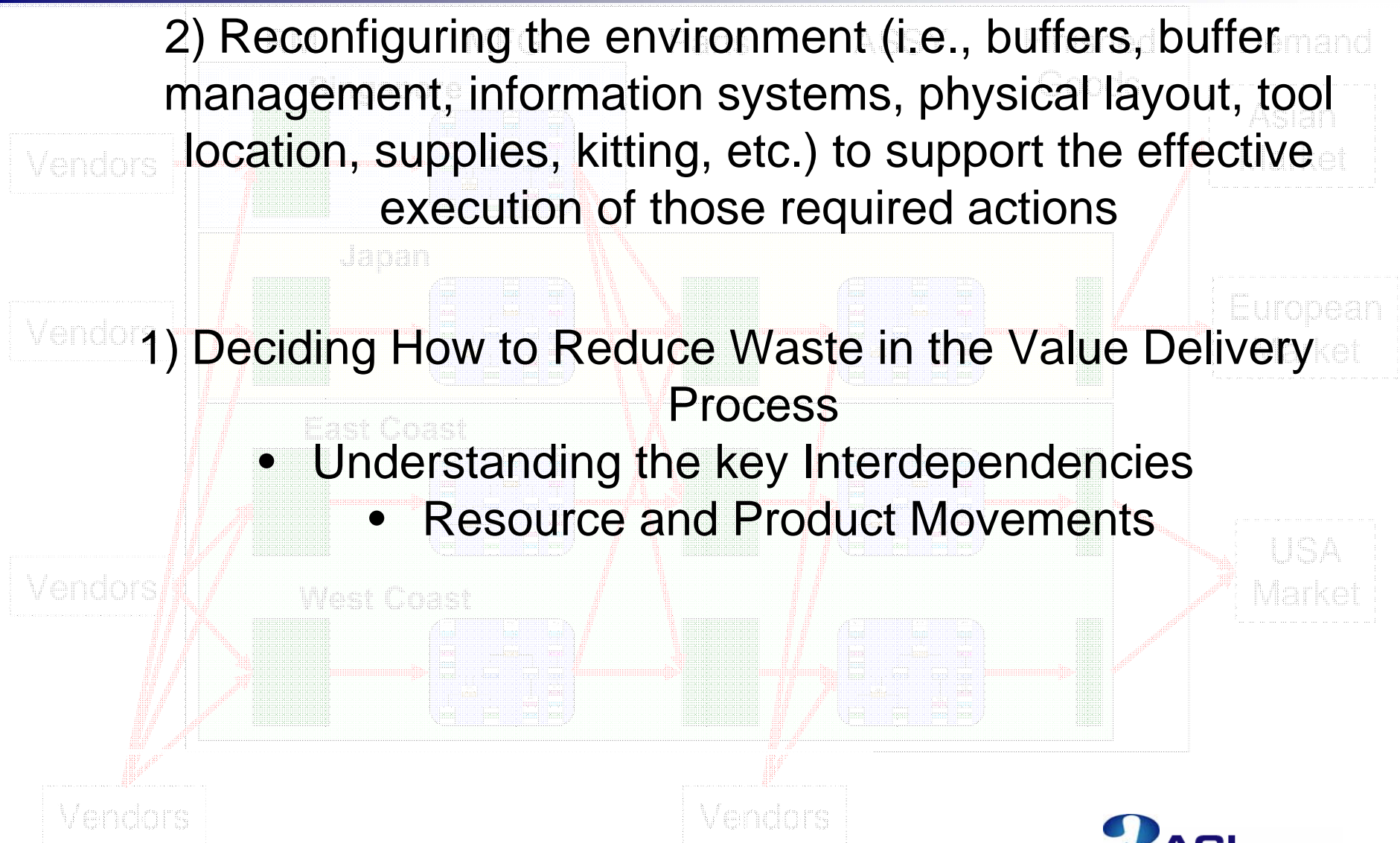
Supply Chain & Manufacturing Processes

Maximizing The Return On Our Improvement Dollars

2) Reconfiguring the environment (i.e., buffers, buffer management, information systems, physical layout, tool location, supplies, kitting, etc.) to support the effective execution of those required actions

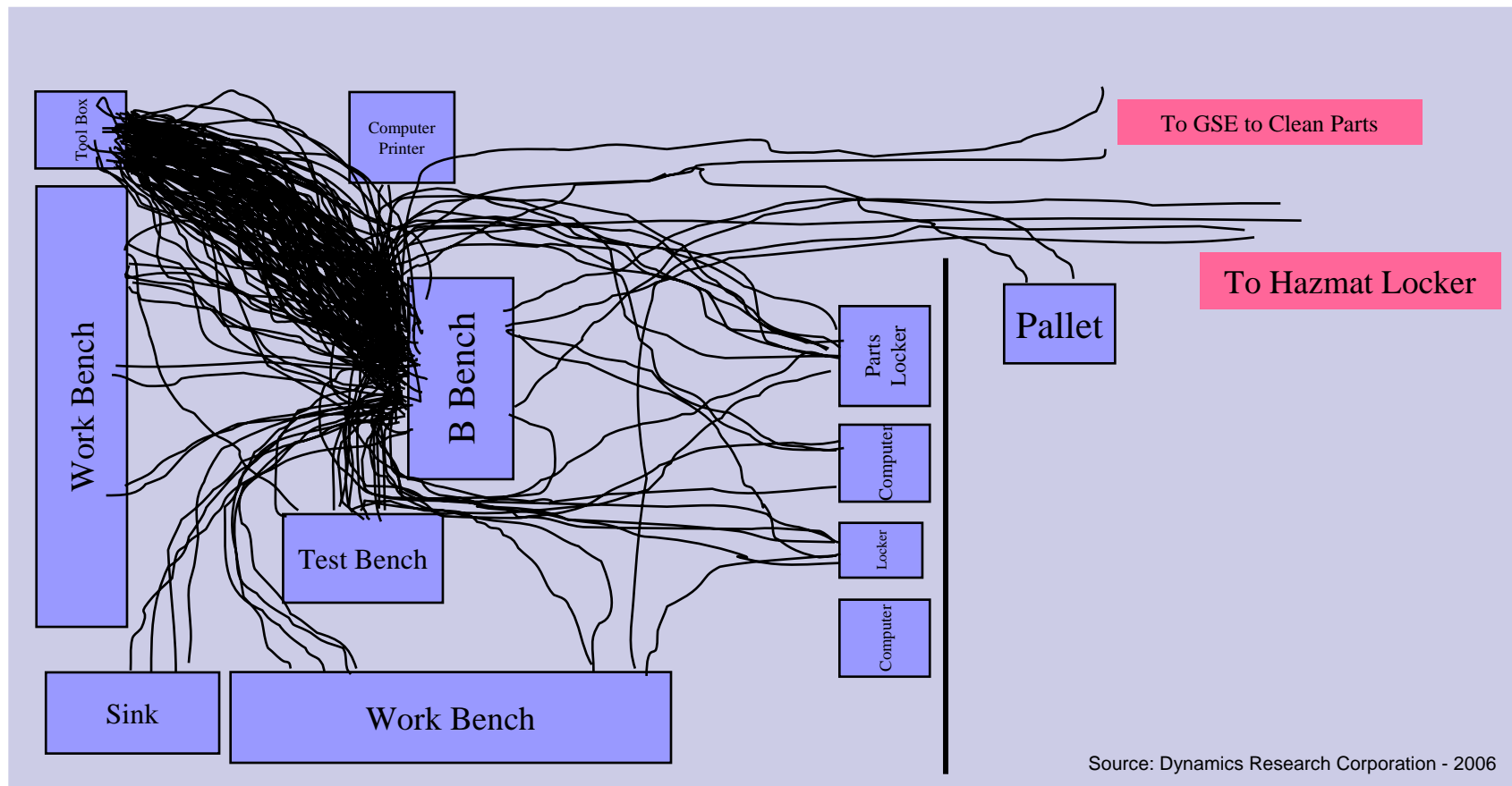
1) Deciding How to Reduce Waste in the Value Delivery Process

- Understanding the key Interdependencies
 - Resource and Product Movements



Supply Chain & Manufacturing Processes Interdependencies – Spaghetti Chart

Shows the physical area layout, flow of product through a series of process steps, or maps where a person walks to complete their process

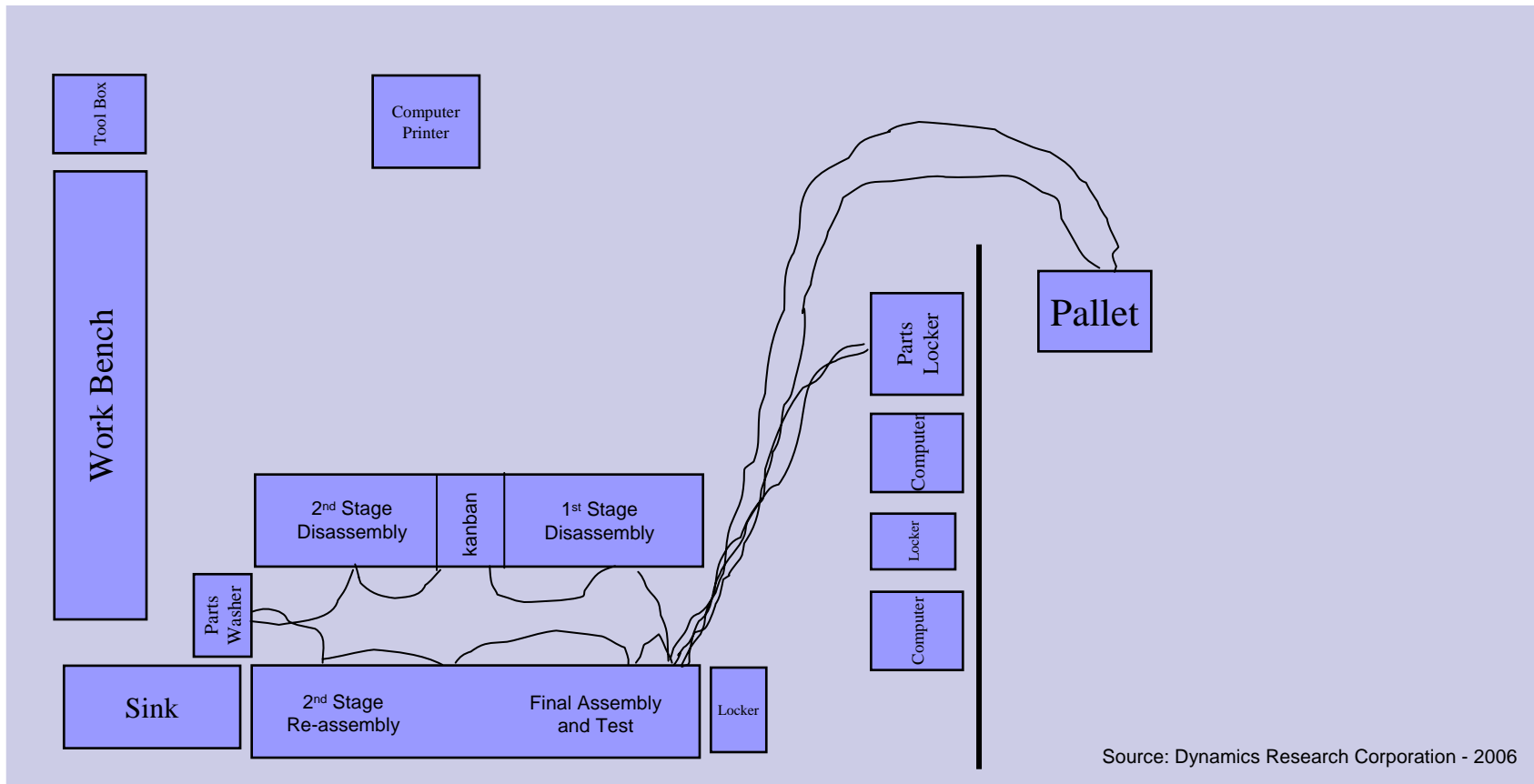


People distance: 2912 feet

Parts distance: 331 feet

Deciding How to Manage the Value Delivery Process

Reconfiguring the Environment to Support the Required Actions and to Reduce Waste in terms of Distance Traveled



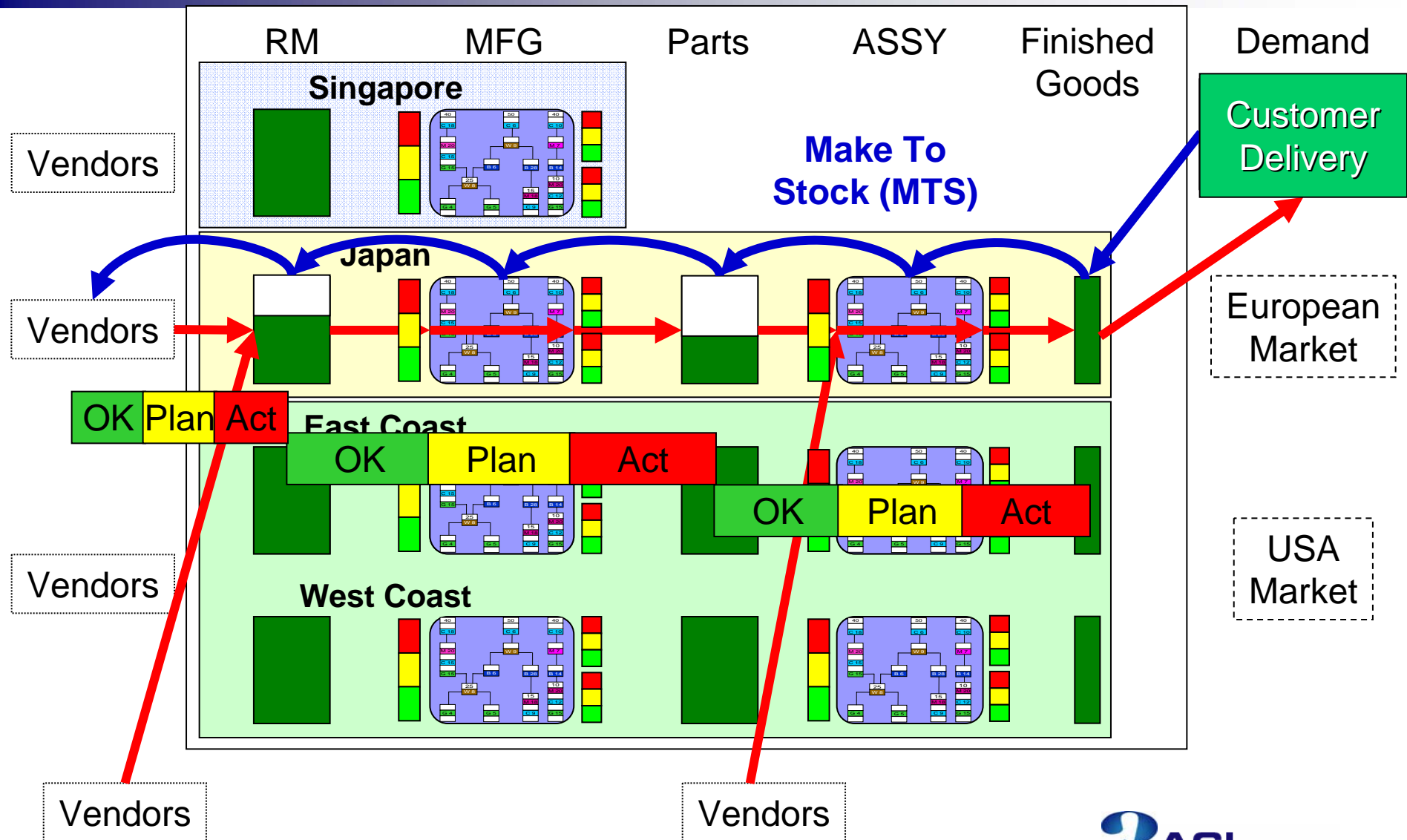
People distance: 86 feet

Parts distance: 64 feet

Deciding How to Manage the Value Delivery Process

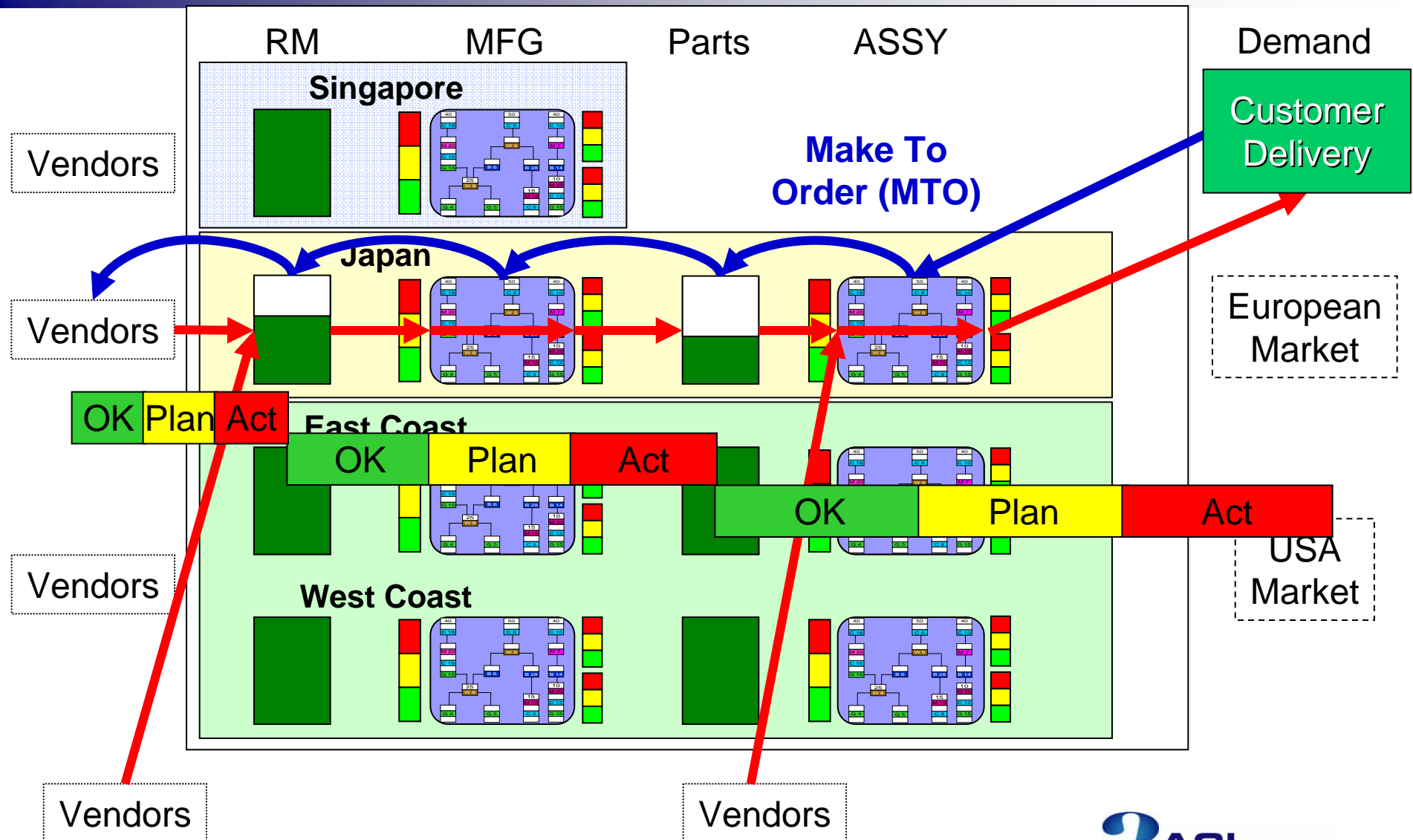
Reconfiguring the Environment to Support the Required Actions

- Buffer Management to Manage the Effects of Variability



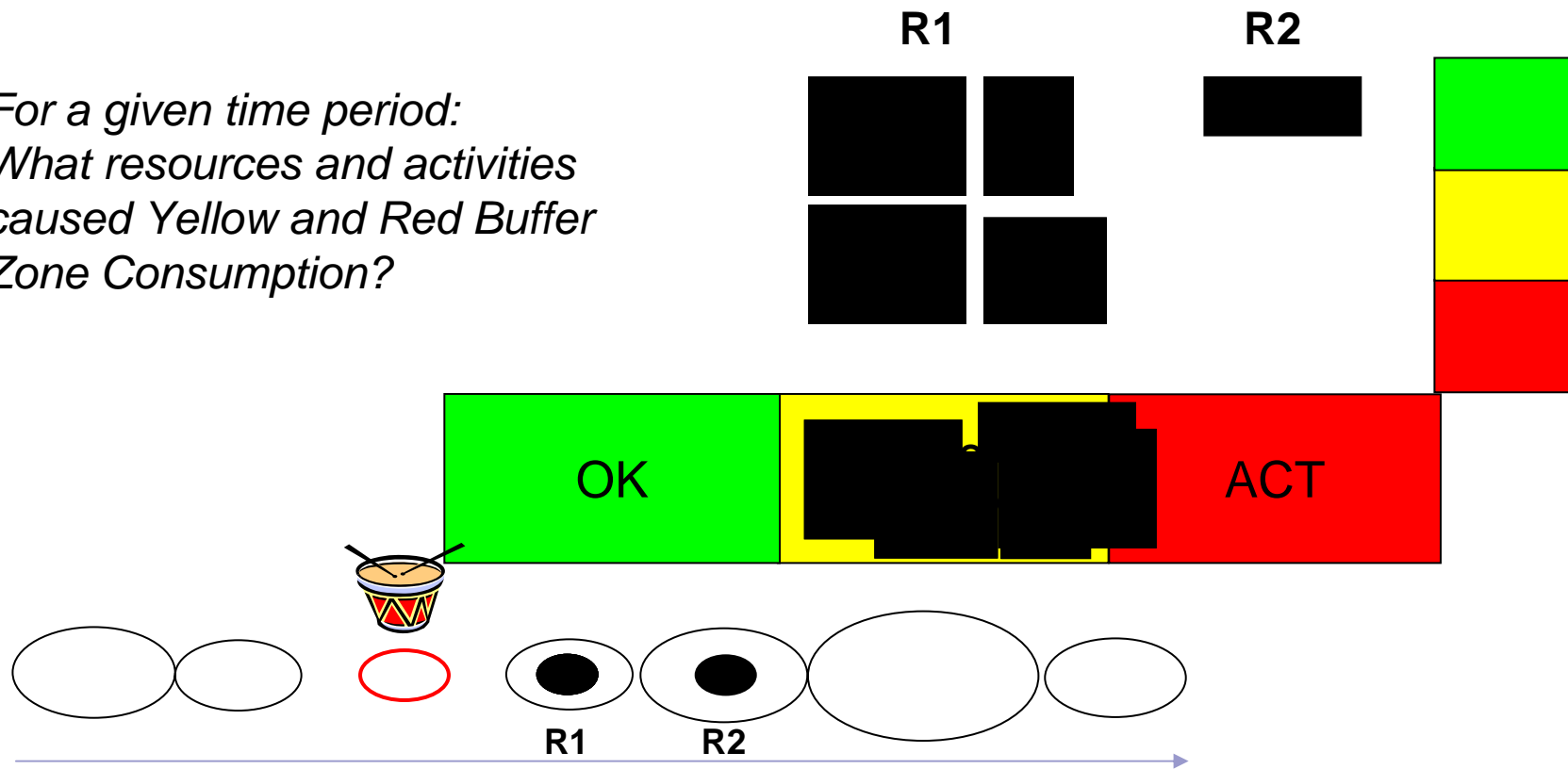
How to Manage the Value Delivery Process

Defining the Decision Rules – Pull means Production/Repair and Replenish processes are only activated by Customer Demand



Using Trend Information from Buffer Management to Focus Continuous Process Improvement Events

*For a given time period:
What resources and activities
caused Yellow and Red Buffer
Zone Consumption?*



We use Buffer Consumption Analysis to direct where other improvement efforts should be focused to increase “T”, and reduce “I” and “OE”.

How do we maximize
performance in the face of
interdependencies,
variability and constraints?

The TOC Approach

The 5 Focusing Steps of TOC

1. **Identify** the system's constraint. ←
2. Decide how to **exploit** it.
3. **Subordinate/Synchronize** everything else to the above decisions.
4. **Elevate** the system's constraint.
5. If in the above steps the constraint has shifted, **go back to Step 1**. →

WARNING

Do not allow inertia to become the system's constraint!

A Process Of OnGoing Improvement

The 5 Focusing Steps of TOC

1. **Identify** the system's constraint. ←
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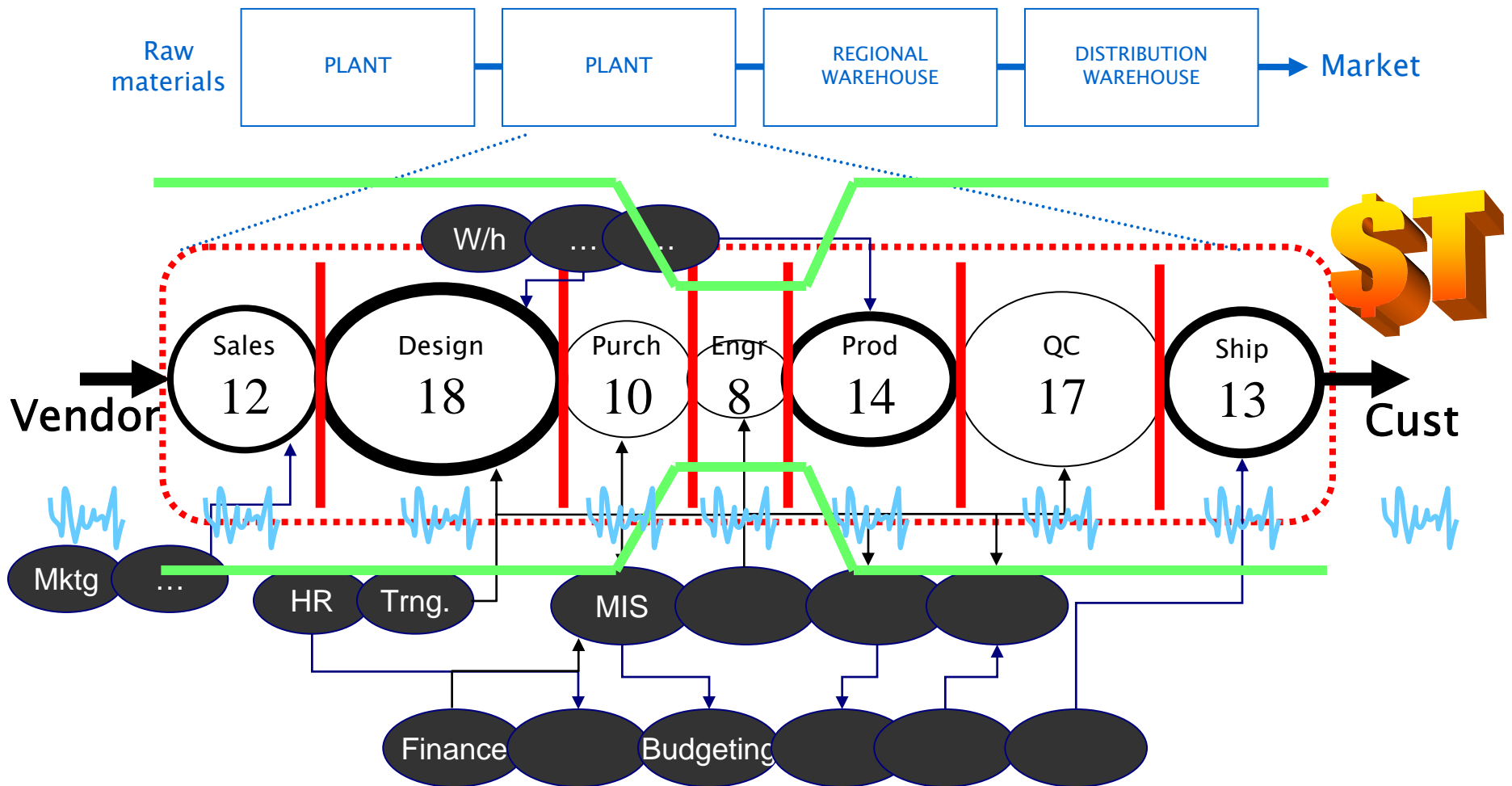
Do not allow inertia to become the system's constraint!

A Process Of OnGoing Improvement

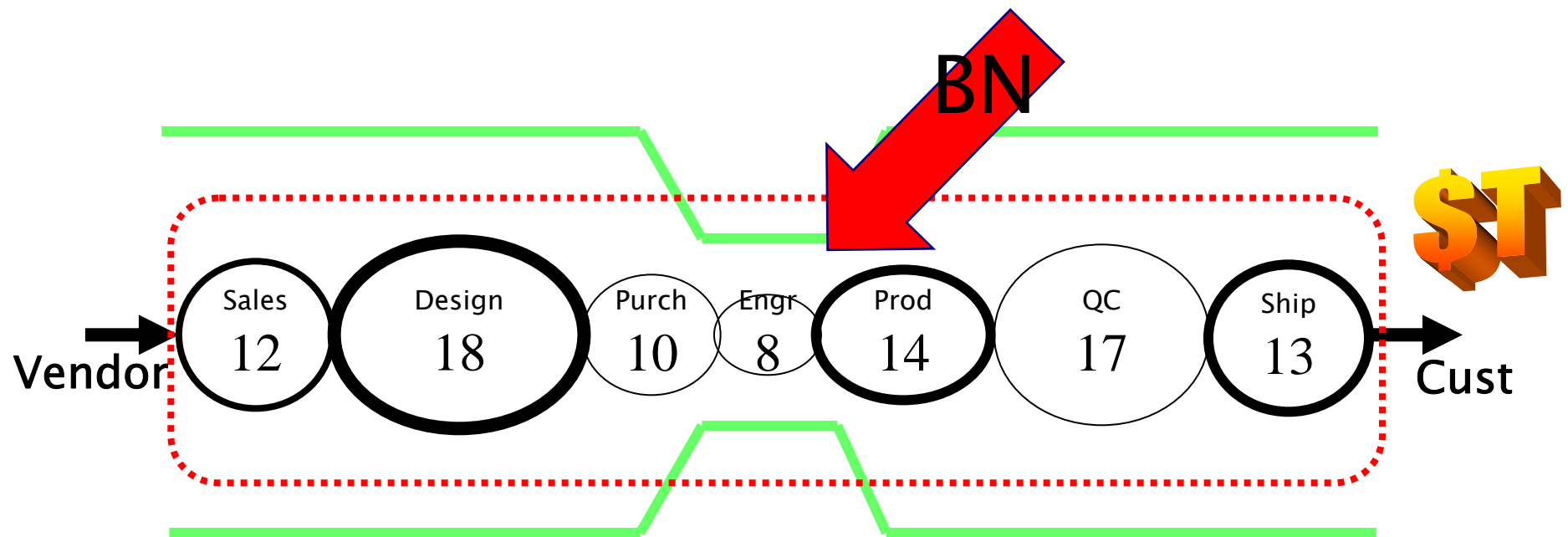


How are these steps applied in a very simple environment?

First, we must understand the system, i.e., its Goal, Necessary Conditions and the relevant *interdependencies*.



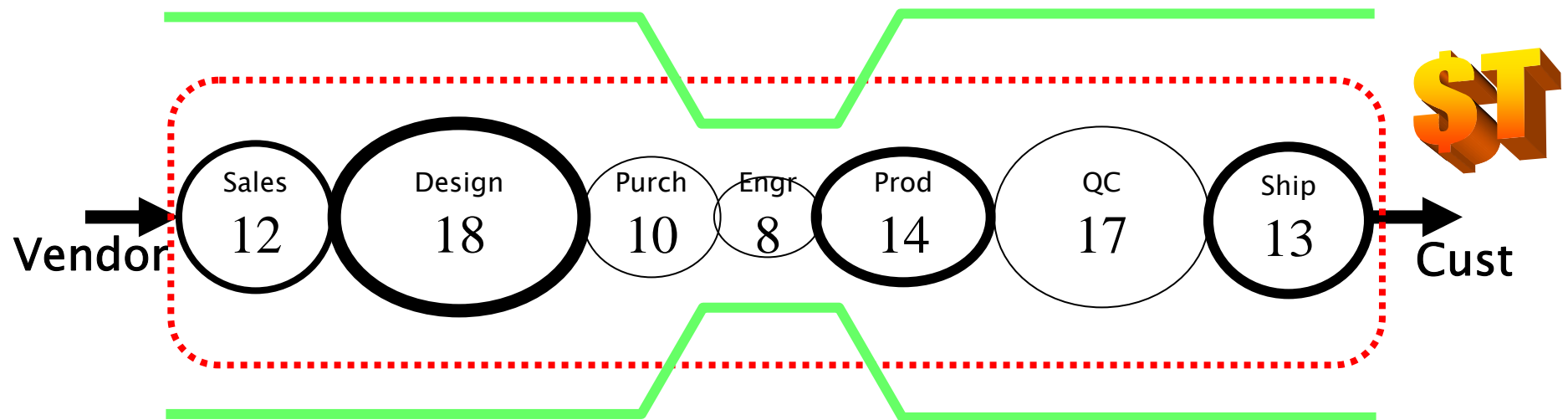
Step 1: **Identify** the system's constraint (e.g., bottleneck).



A “bottleneck” is but one example of a type of constraint:

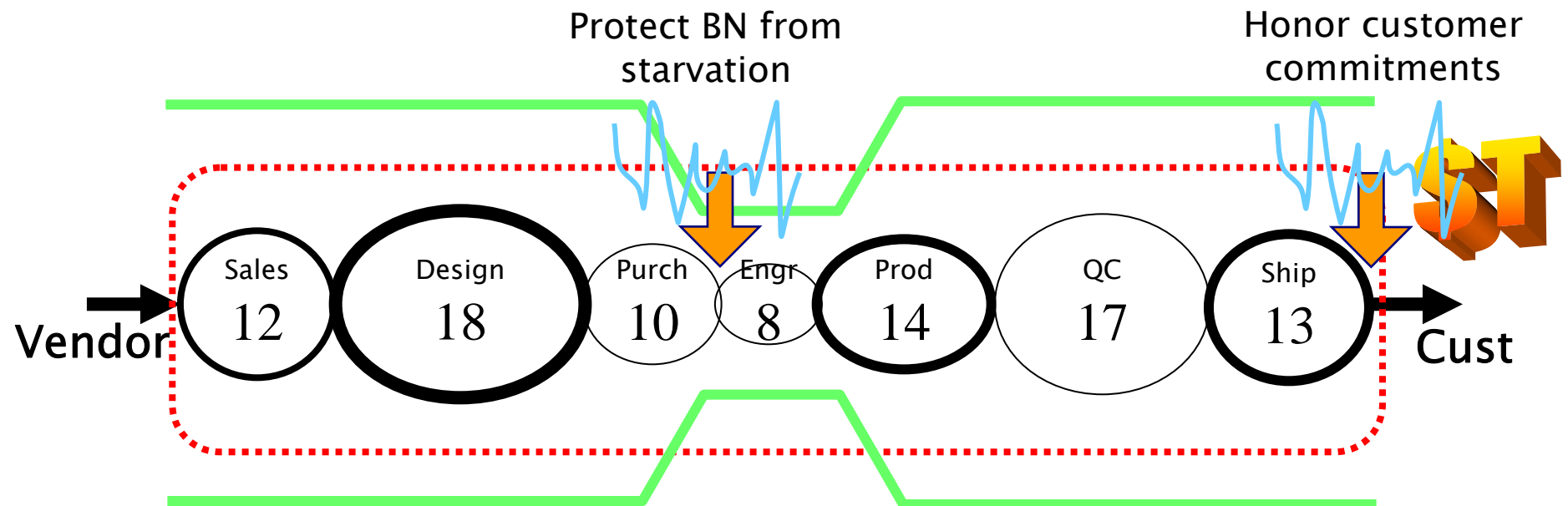
- Physical Constraints
 - Bottleneck
 - Capacity Constrained Resource (CCR)
- Market Constraints
- Supplier Constraints
- Policy Constraints

Step 2: Decide how to **exploit** the system's constraint.



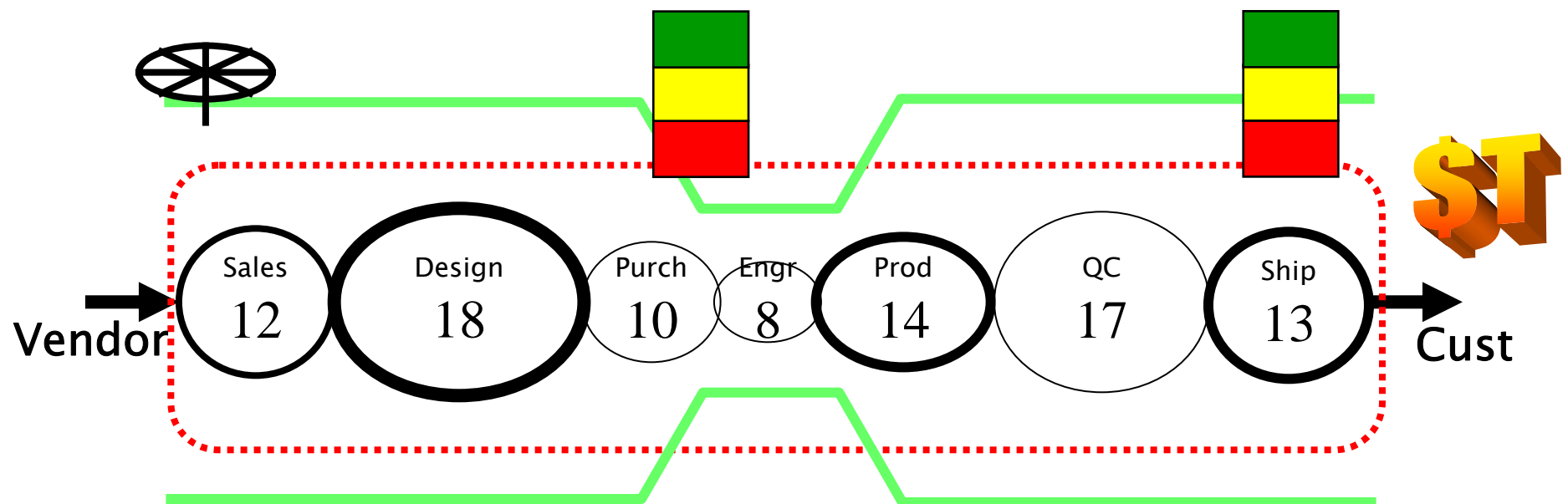
Substantial \uparrow in **T**

Step 3: **Subordinate/Synchronize** everything else to the above decisions.



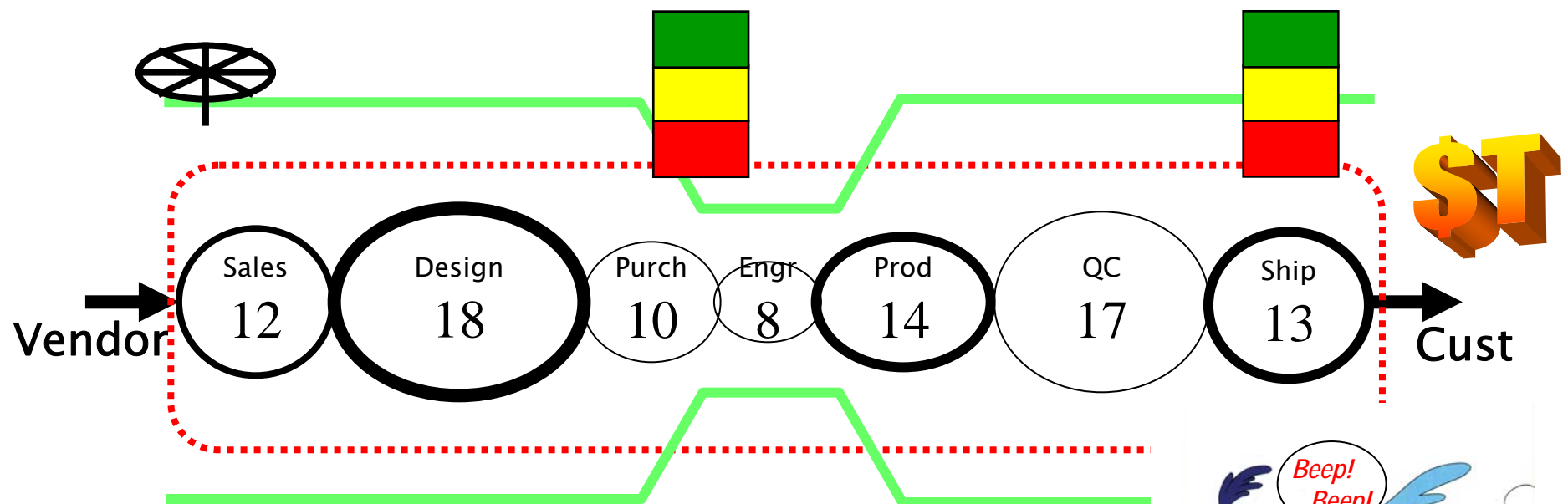
Strategically place **buffers** *only* where needed to protect **T** from **variation**.

Step 3: **Subordinate/Synchronize** everything else to the above decisions.

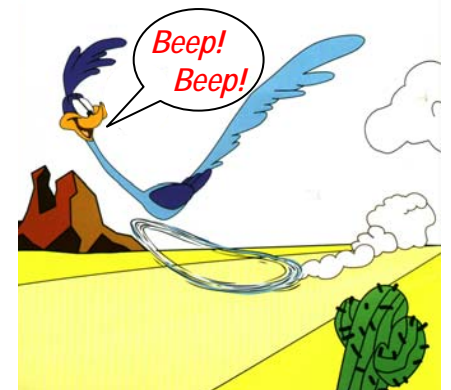


Gate the release of work to be in line with the consumption rate of the constraint.

Step 3: **Subordinate/Synchronize** everything else to the above decisions.



“Road Runner” Work Ethic for all non-constraints:
Work as fast as possible when you have material available, otherwise, don't produce!



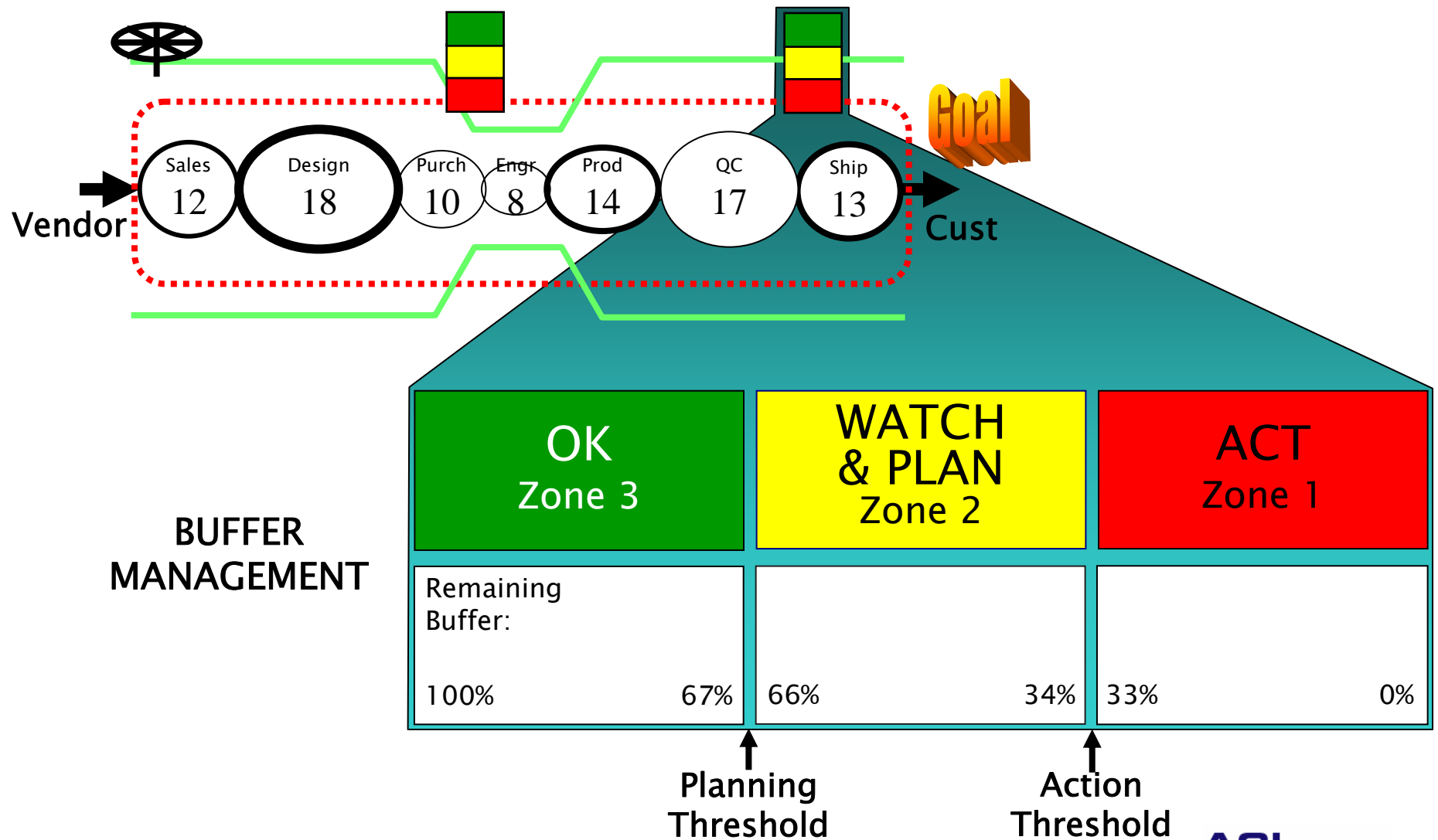
By:

1. Identifying the system's constraint;
2. Exploiting the system's constraint;
3. Subordinating/synchronizing everything else to the above decisions;
4. Gating the release of work to be in line with the consumption rate of the constraint; and
5. "Roadrunner" work ethic for all non-constraints

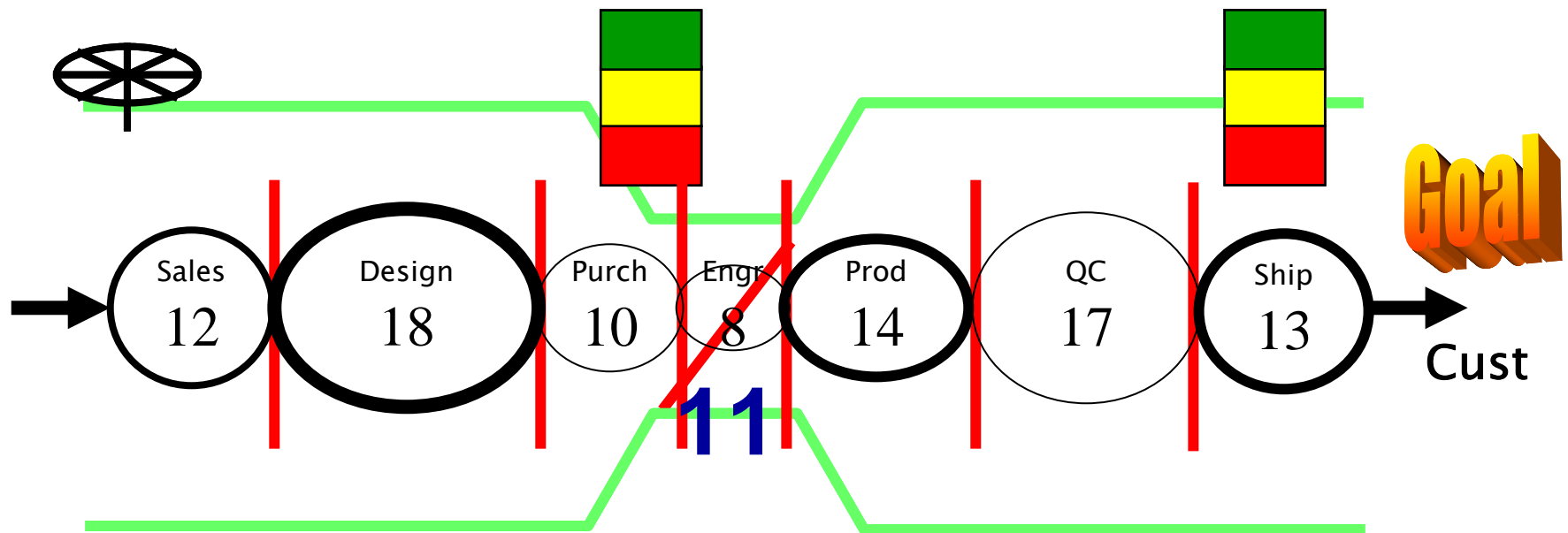
Expect:

Substantial \uparrow in **T** & \downarrow in **\$I** and **\$OE**

Buffers Used Correctly can Provide Focus and an Early Warning System to Protect \$T

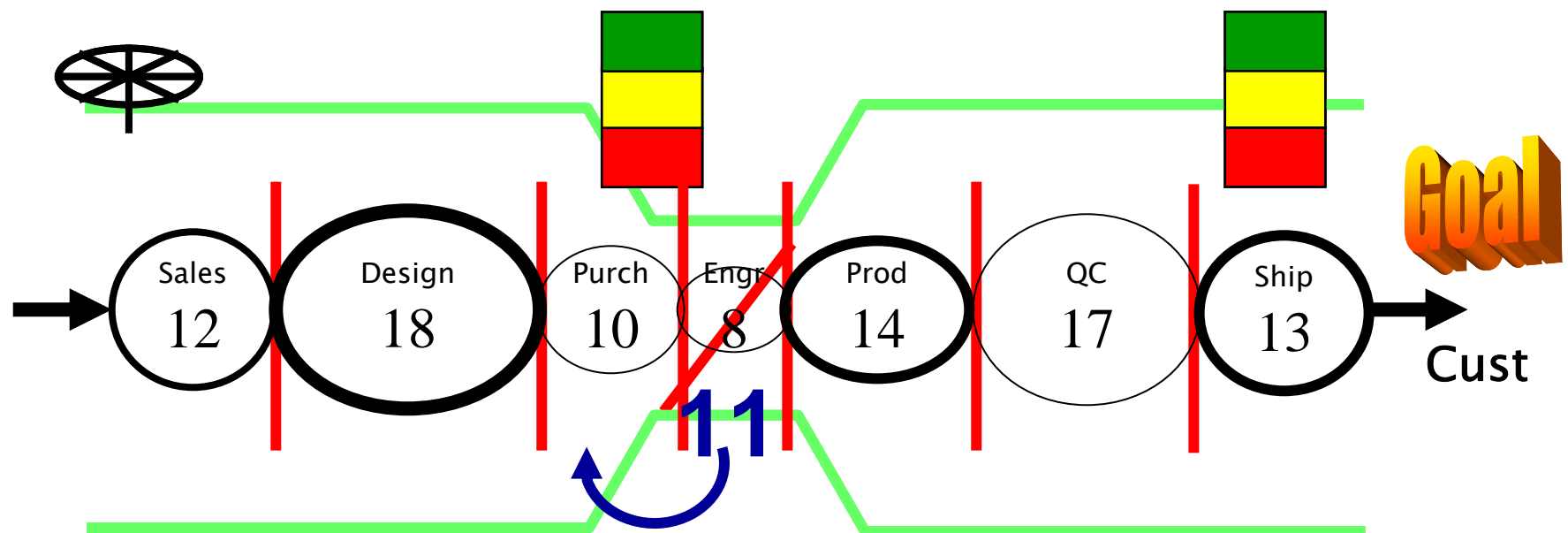


Step 4: Elevate the system's constraints.



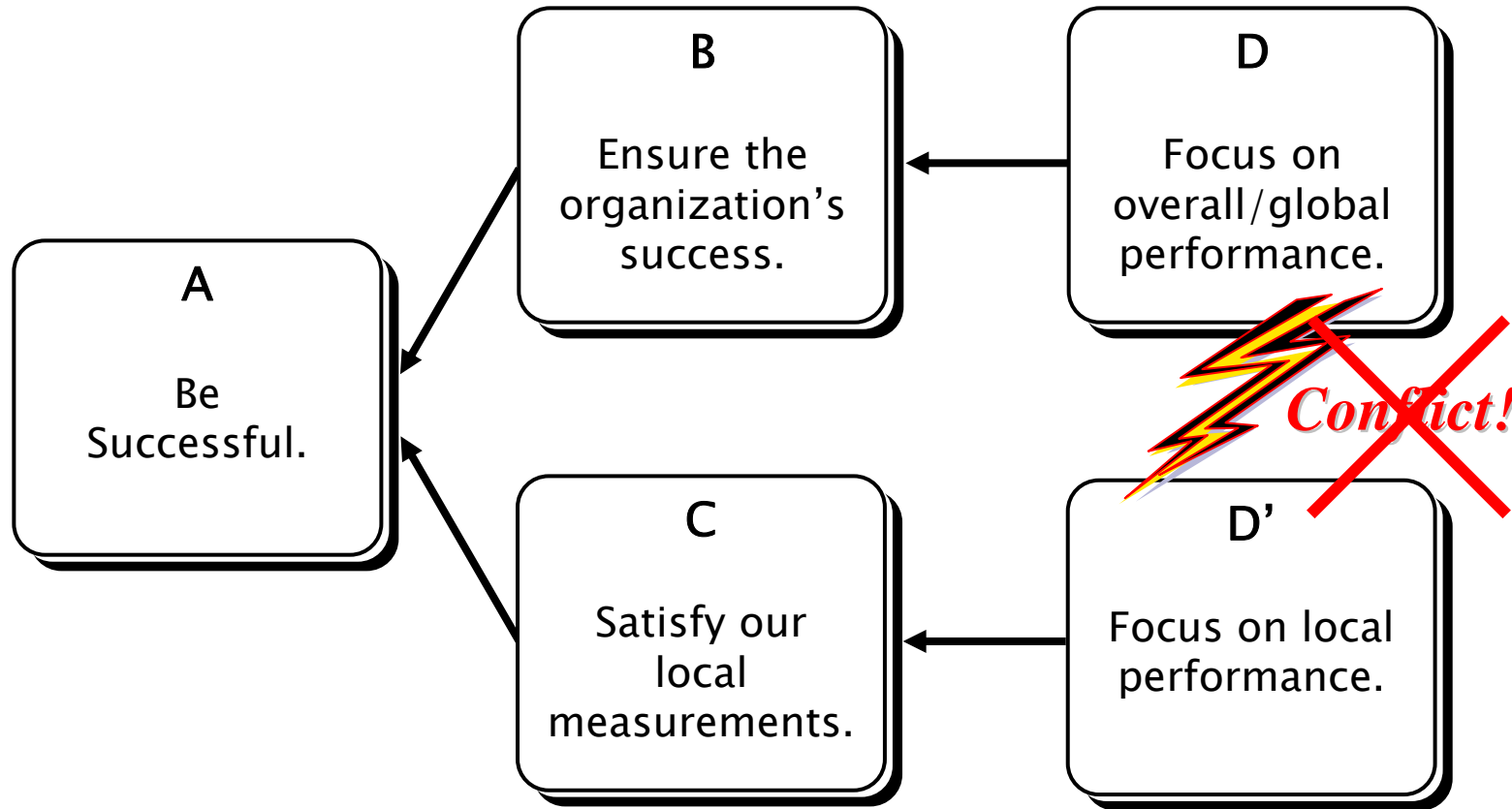
Substantial \uparrow in T

Step 5: If in the above steps the constraint has shifted, **go back to Step 1**.



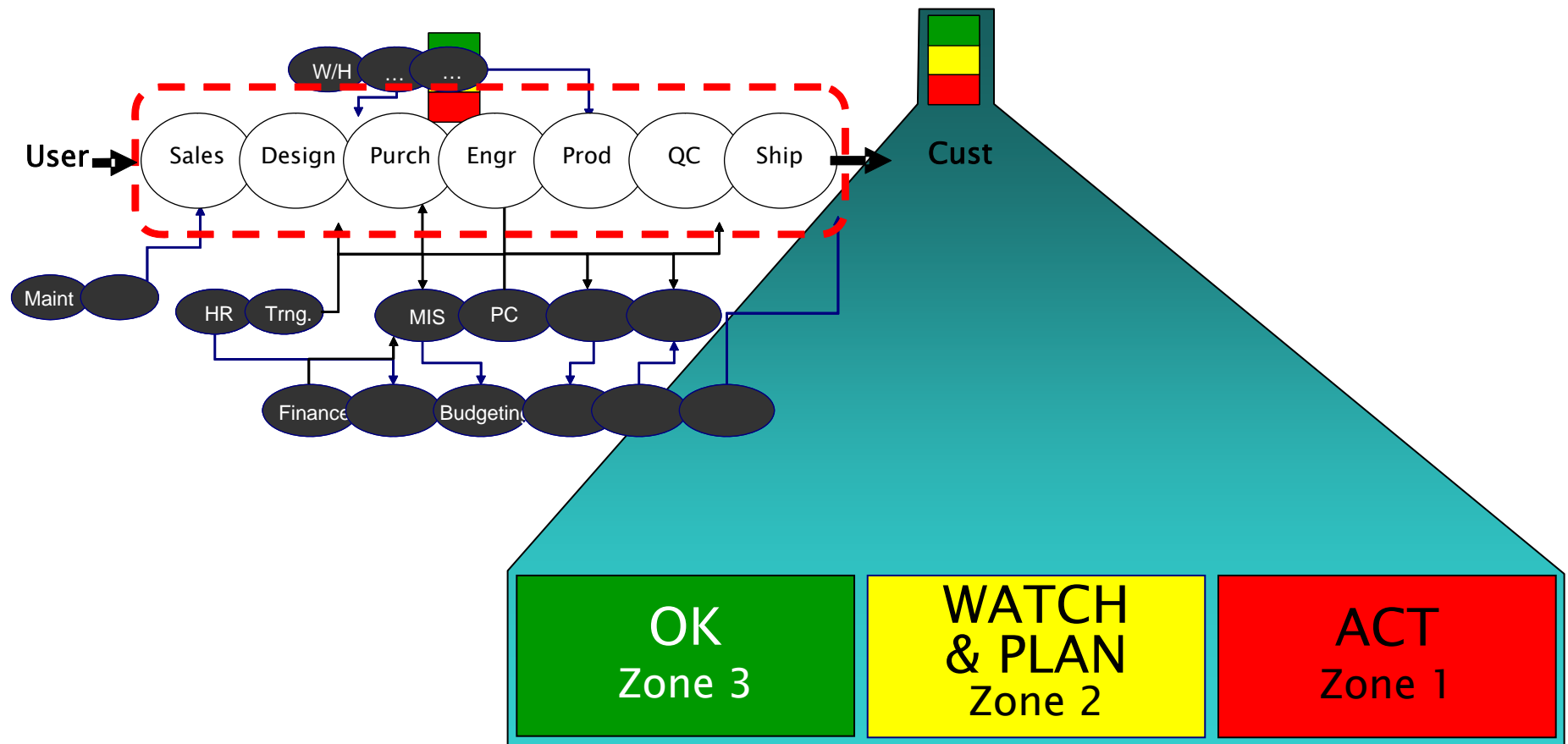
Process of Ongoing Improvement

TOC's 5 Focusing Steps enable Organizations to Break this Core Conflict...



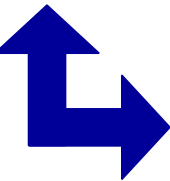
...by "Aligning Local Performance with Global Performance"

Resulting in a system that is significantly more manageable, easier to navigate, more responsive to important opportunities...



And resolving its many resulting effects...

- Unpredictable, unreliable delivery performance
- Unpredictable, erratic queue times, cycle times and lead times
- Bottlenecks jumping all over the place depending upon product mix, material release policies, batching policies, etc.
- Constantly shuffling priorities
- Inventory blockages and hold-ups
- Escalating costs
- Chronic resource insufficiencies...

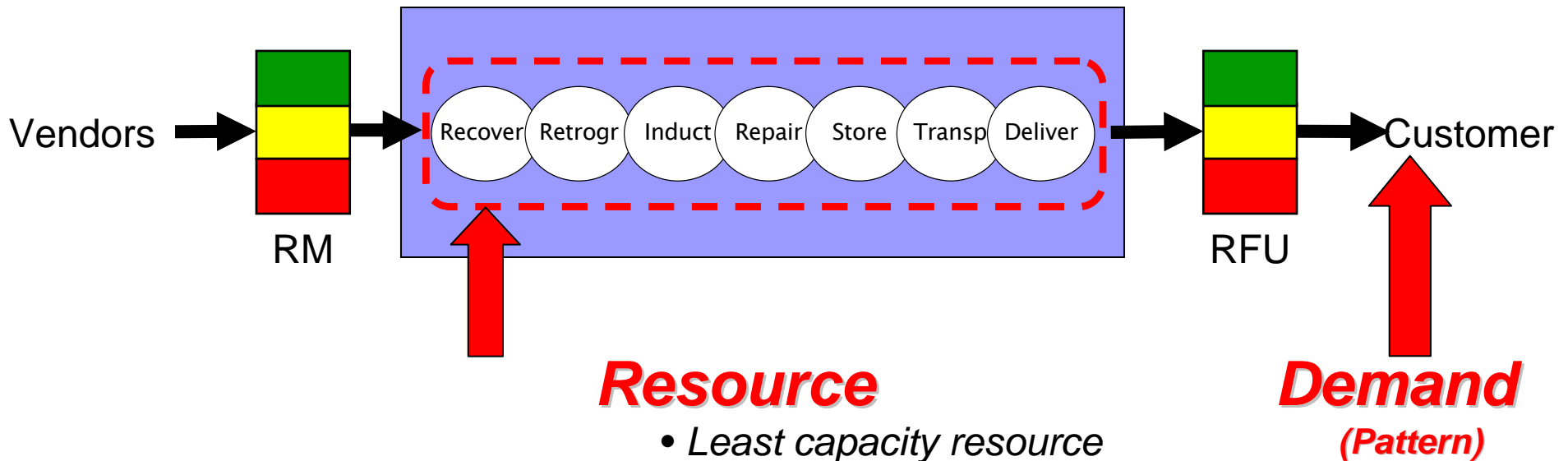
T 

\$I 

\$OE 

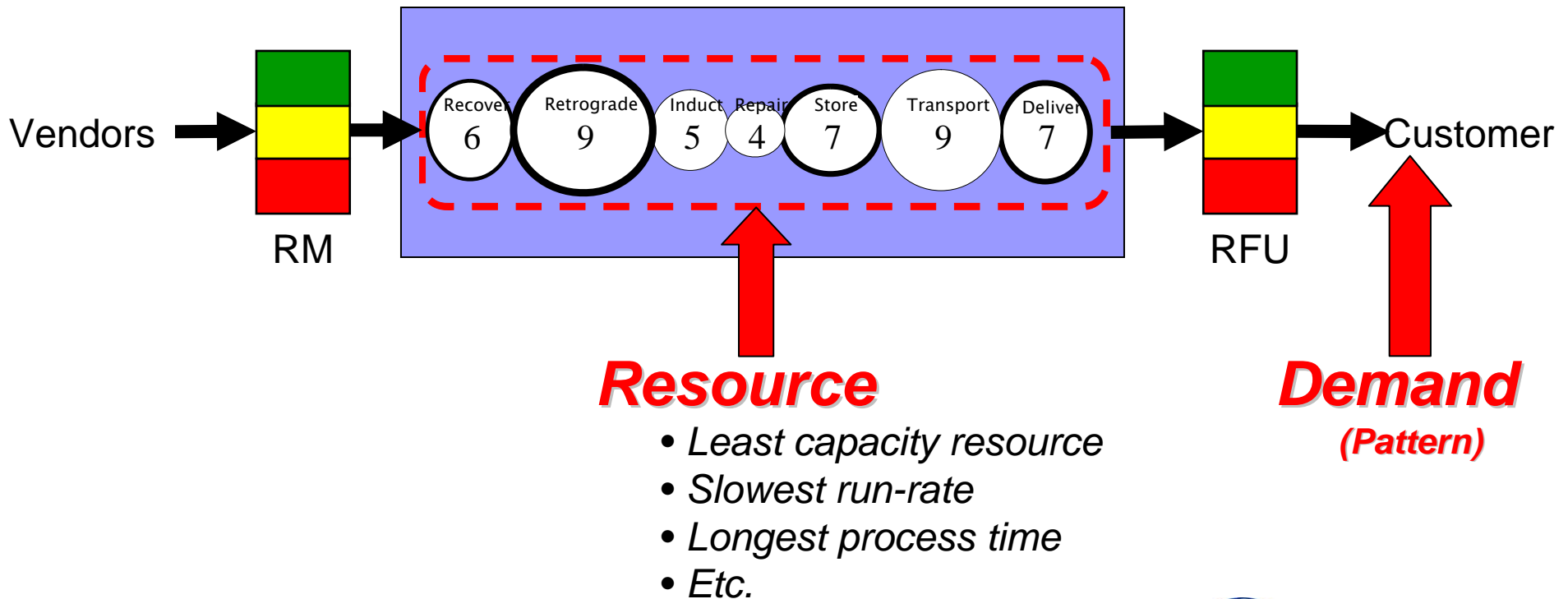
Re-applying TOC's 5 Steps to a Different System

Step 1: Identify the system's constraint(s).



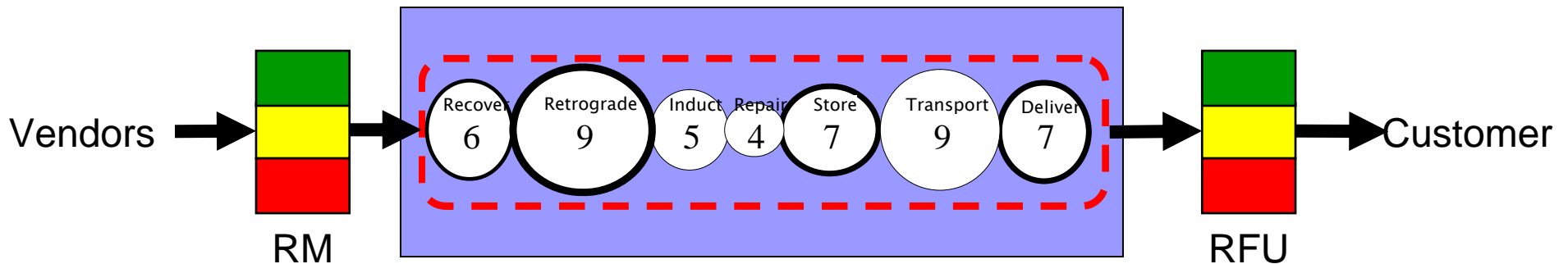
Re-applying TOC's 5 Steps to a Different System

Step 1: Identify the system's constraint(s).



Re-applying TOC's 5 Steps to a Different System

Step 1: Identify the system's constraint(s).

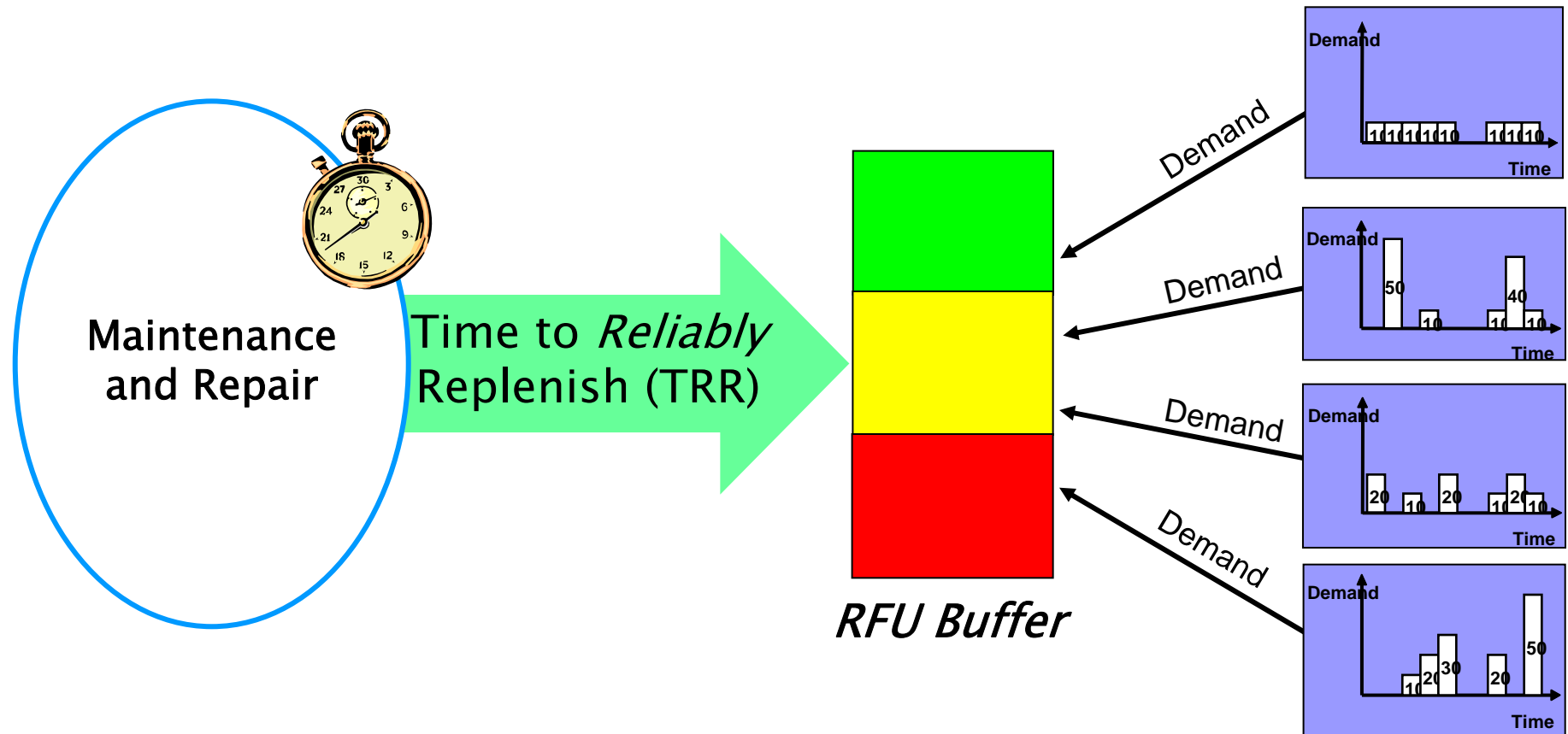


**Can the constraint resource meet system demand?
In what time frame?**

...without becoming a BOTTLENECK!

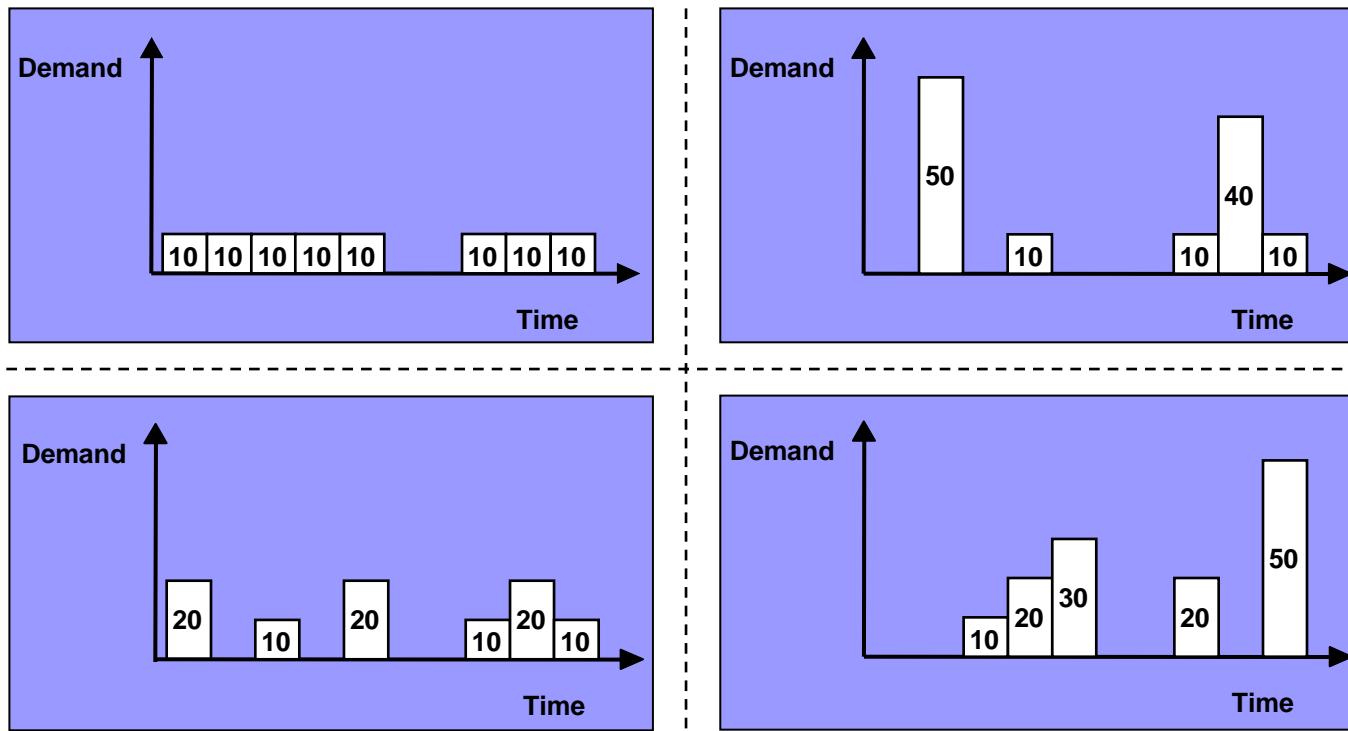
That time frame is the ***“Time to Reliably Replenish”***.

Sizing Inventory Buffers Using TOC



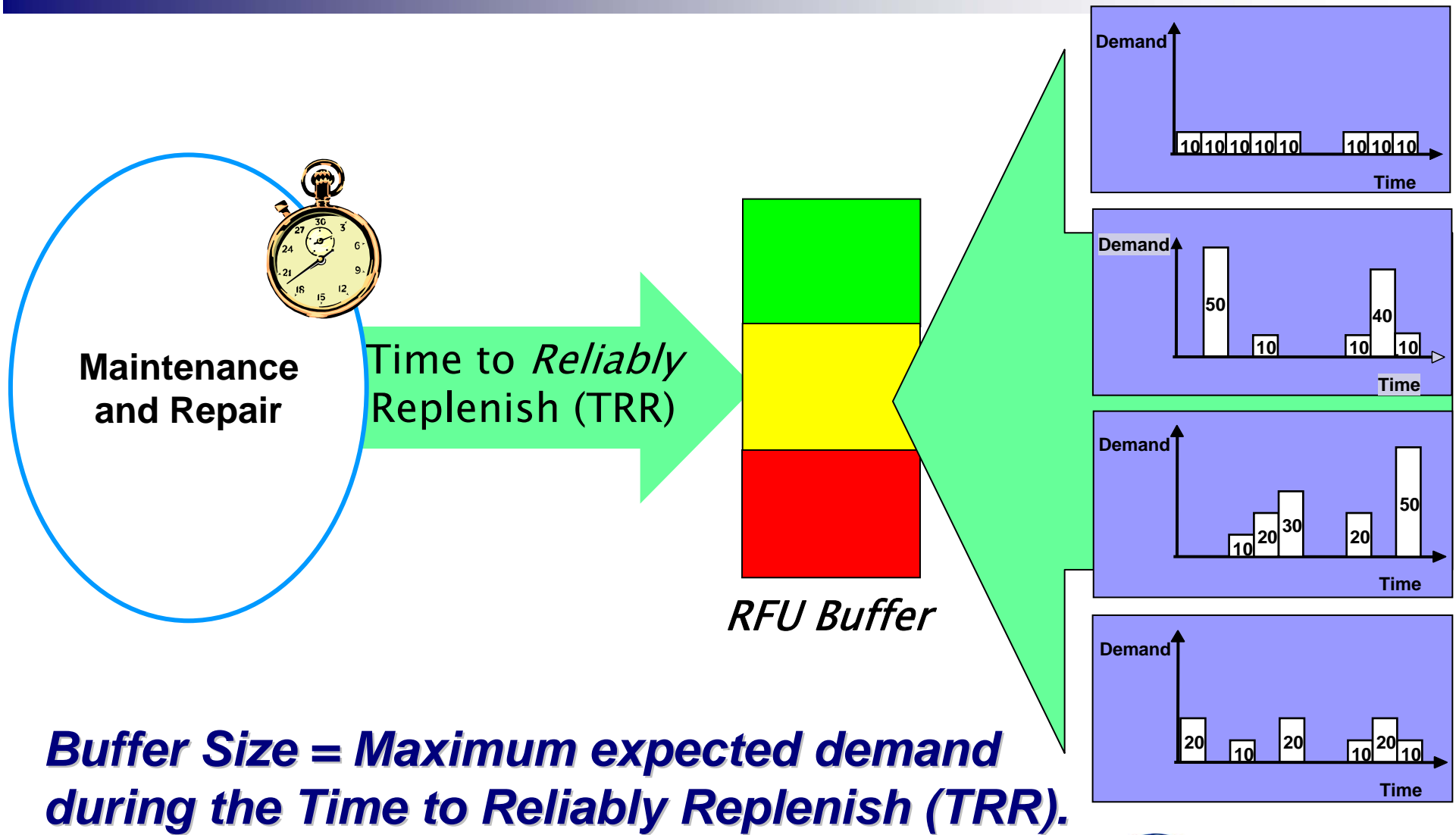
“Hold enough stock to cover maximum demand during the TRR”

Average demand shouldn't be the primary factor in setting inventory levels...

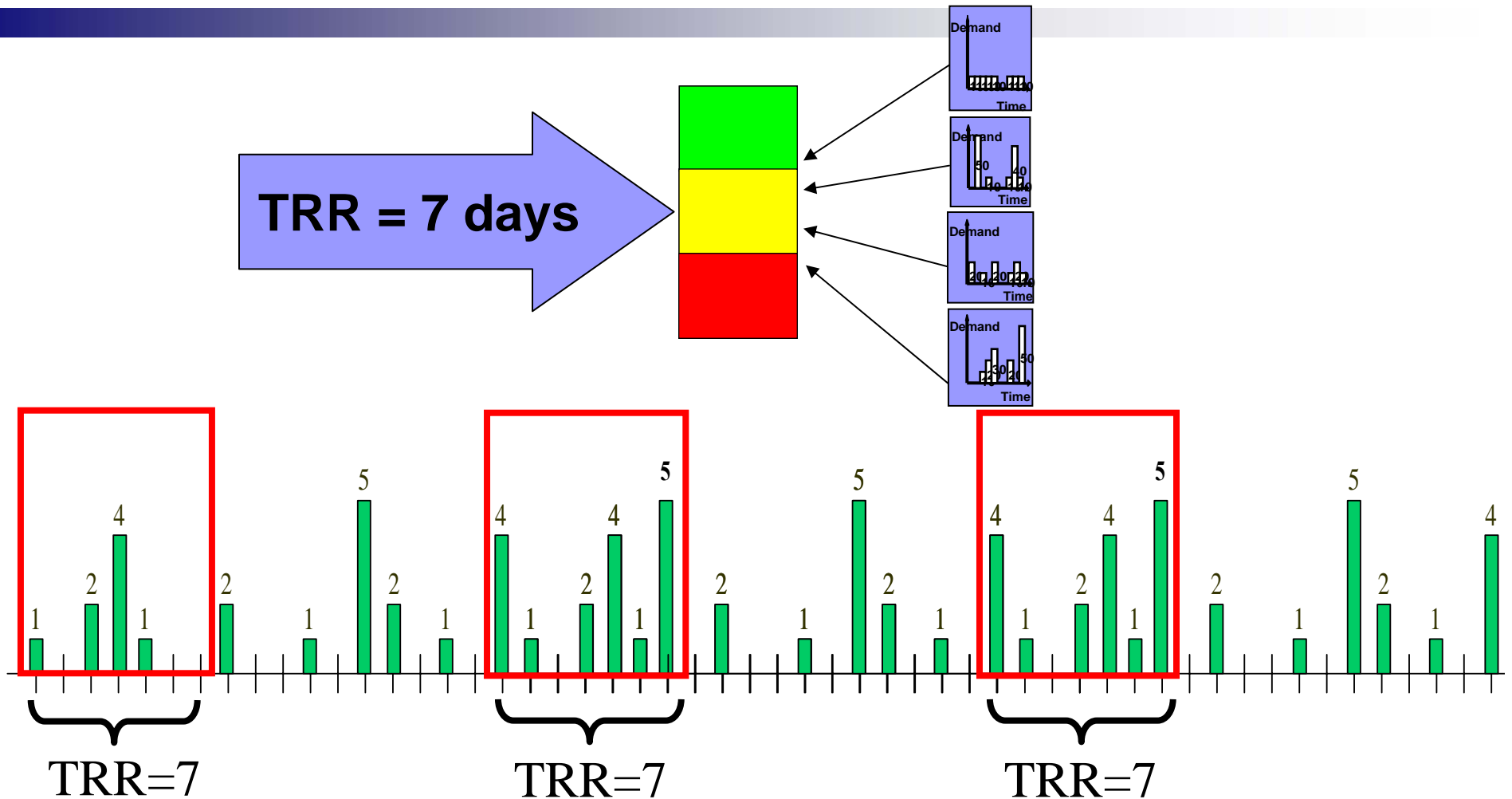


... actual customer demand patterns should be.

Sizing Inventory Buffers Using TOC



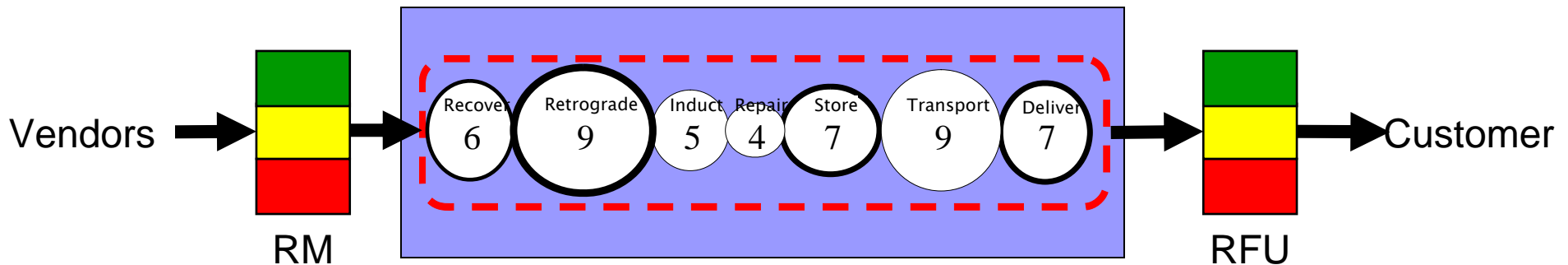
What should the buffer size be?



Buffer Size = 17 (4+1+2+4+1+5)

Re-applying TOC's 5 Steps to a Different System

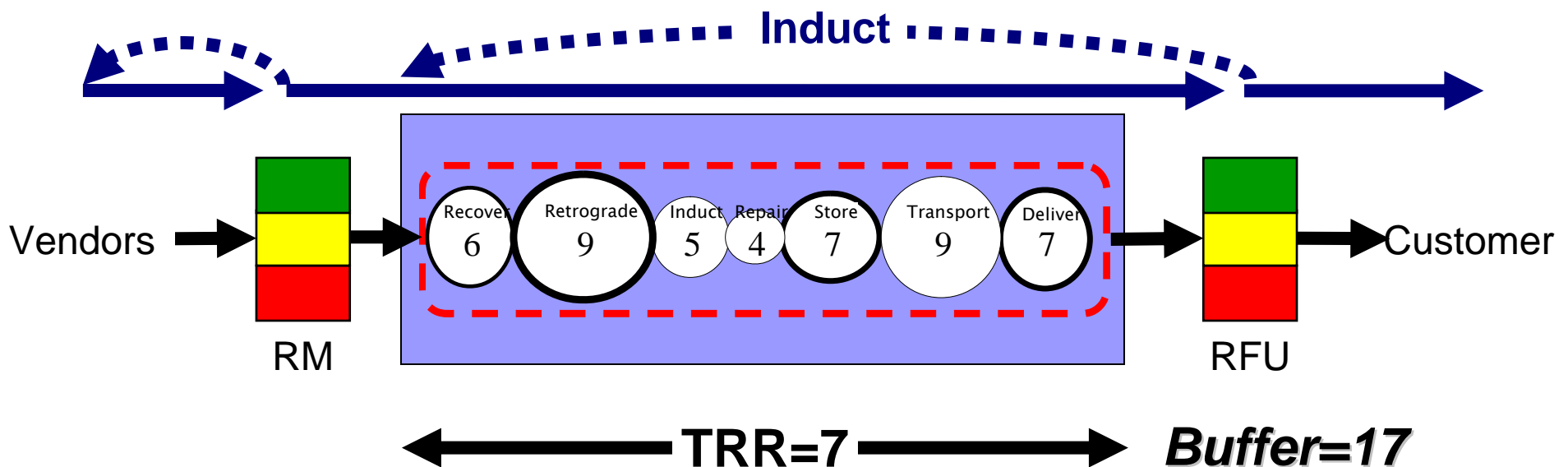
*Step 2: Decide how to **exploit** the system's constraint(s).*



Determine how to schedule the resource constraint to meet system demand, i.e. consistently meet the TRR to maintain the Buffer.

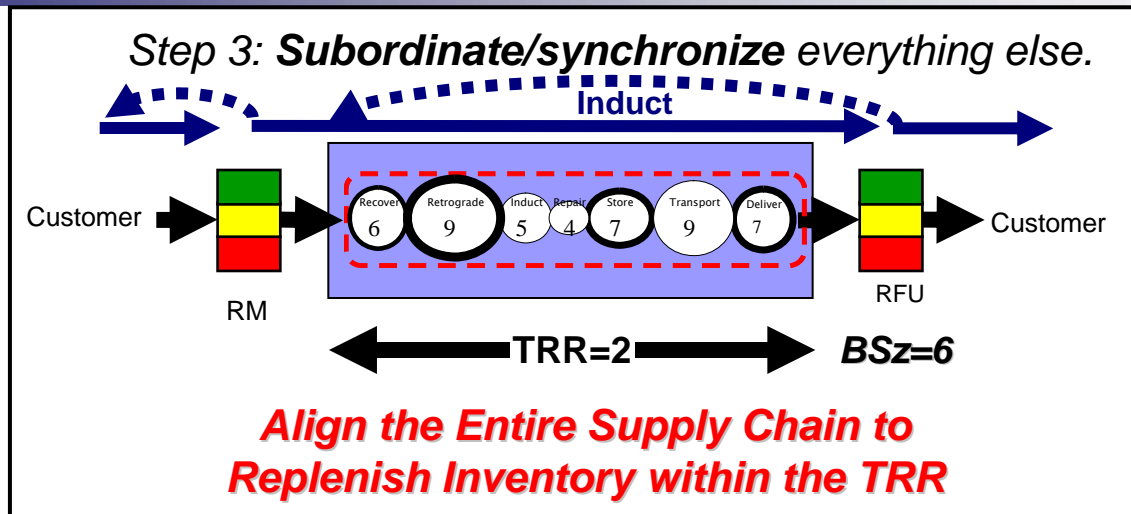
Re-applying TOC's 5 Steps to a Different System

Step 3: Subordinate/Synchronize everything else to the above decision.



Align the Entire Supply Chain to Replenish Inventory within the TRR

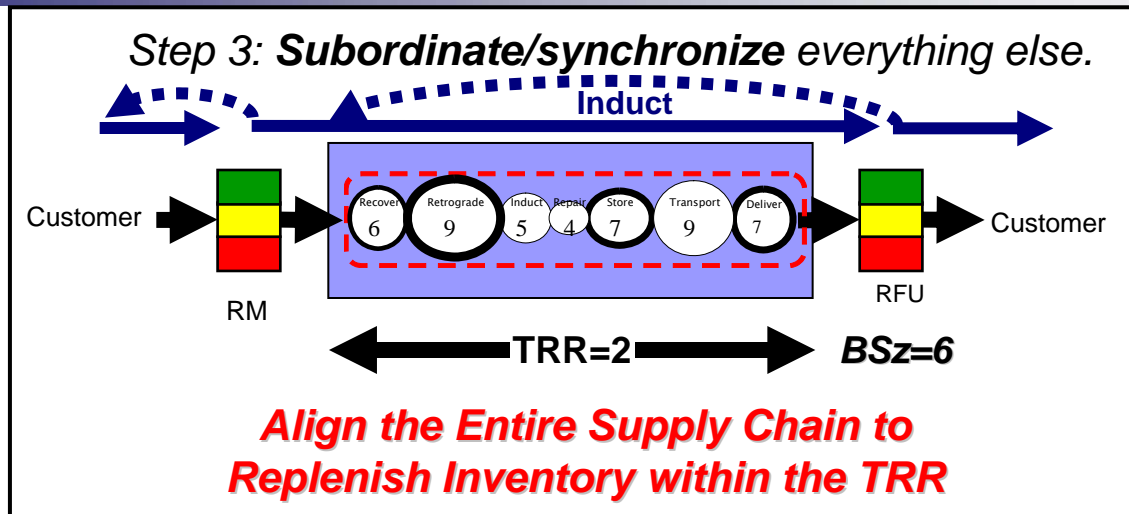
Re-applying TOC's 5 Steps to a Different System



... which, in this case, means doing things such as:

- Ensuring the production facility produces only what's needed to replenish the buffer,
- Sizing all other buffers based on their actual demand and the TRRs feeding them,
- Contracting transportation to support the defined TRRs and quantities,
- Putting the triggers in place to initiate replenishment at each link,
- *Instituting local measures and rewards that induce behaviors supporting global performance, i.e., \$T, \$I and \$OE...*

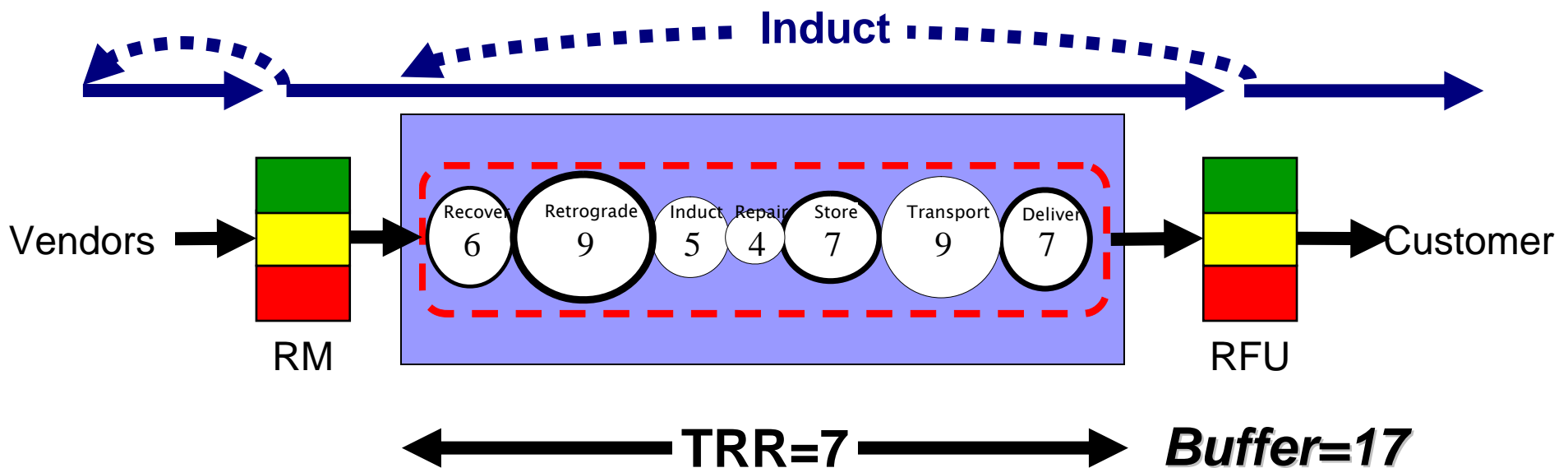
Re-applying TOC's 5 Steps to a Different System



- *A cultural change*, requiring the re-evaluation of:
 - Policies
 - Procedures
 - Practices
 - Measurements
 - Communications and Handshakes
 - Decision-Making
 - Planning...

Re-applying TOC's 5 Steps to a Different System

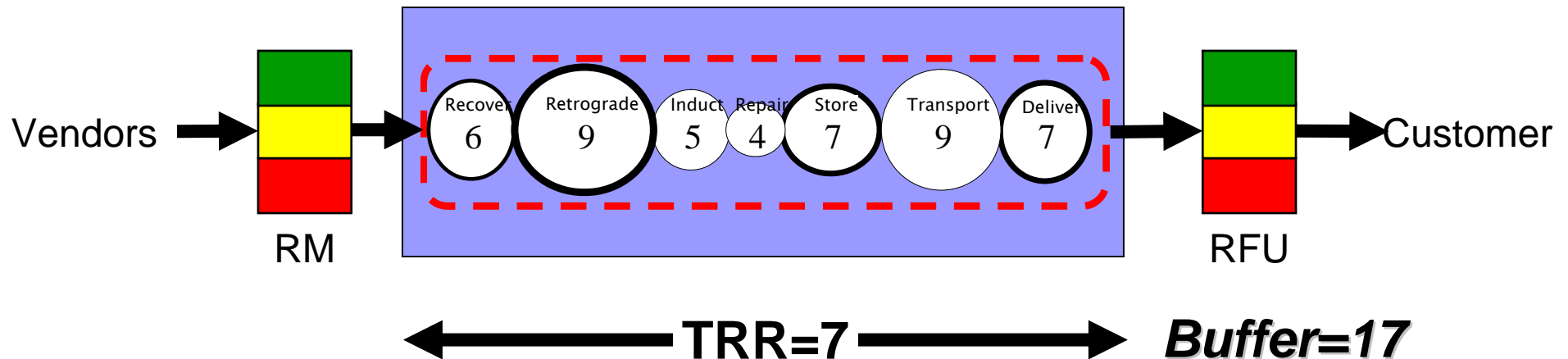
Step 3: Subordinate/Synchronize everything else to the above decision.



The system operation is then monitored using Buffer Management...

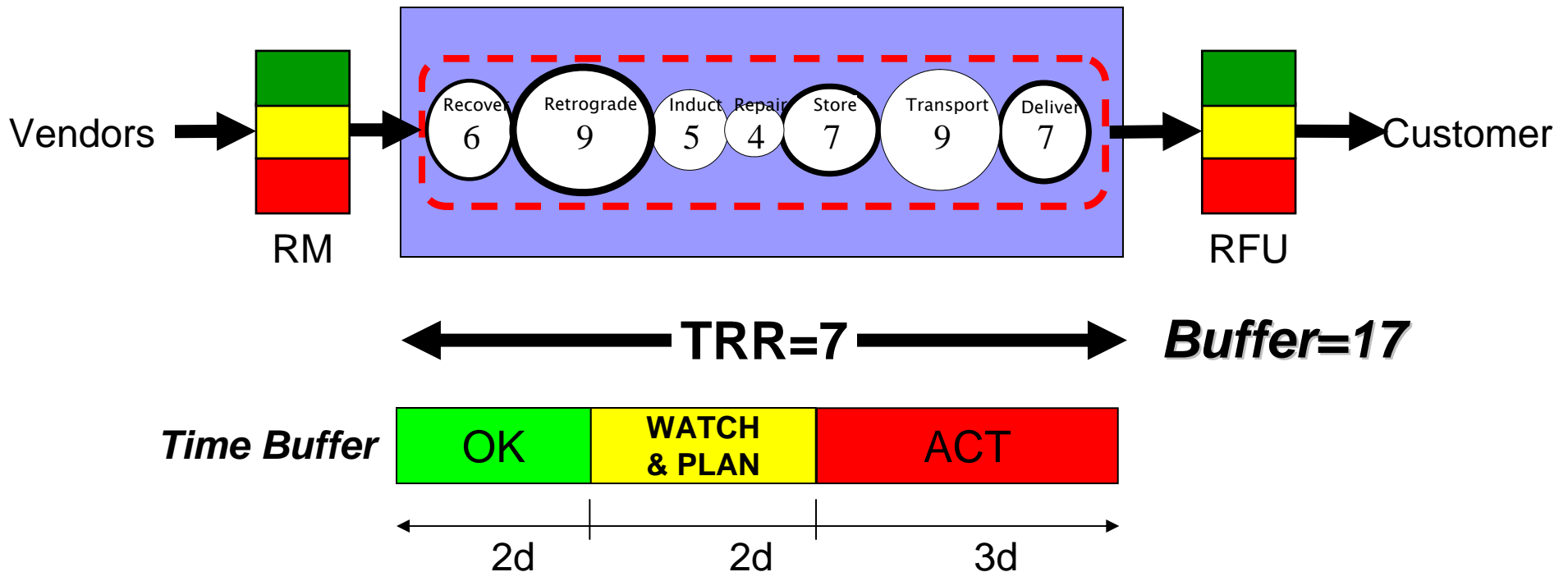
Buffer Management

The primary difference between Inventory Management and Buffer Management is the FOCUS.



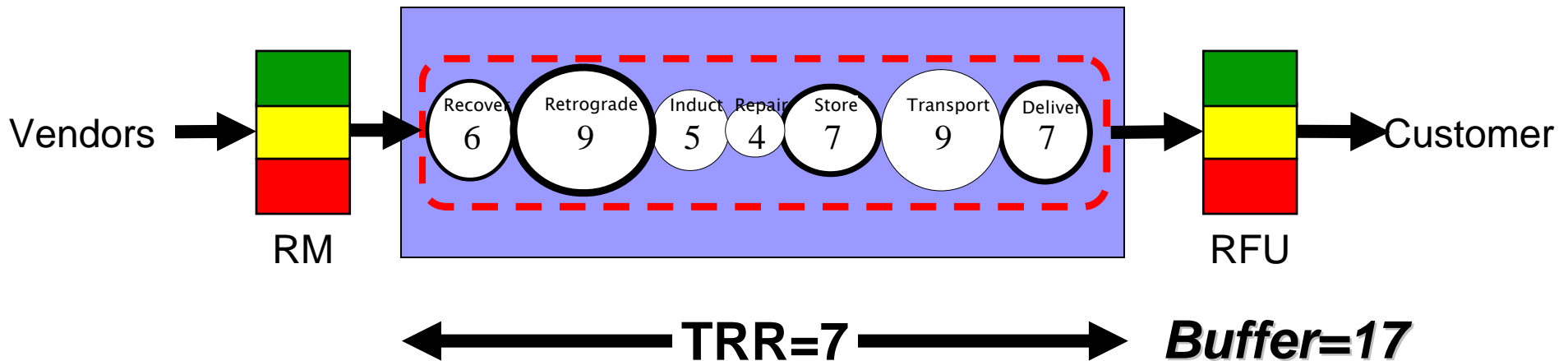
Buffer Management

Buffer Management's primary focus is the movement of inventory in time, not on parts on the shelf.



Re-applying TOC's 5 Steps to a Different System

Step 4: Elevate the system's constraint(s).



***How do we elevate the system's constraint ?
What outcomes are we working to achieve?***

Re-applying TOC's 5 Steps to a Different System

How do we elevate the system's constraint ?

“Elevate” means to get more Throughput from the system's constraint(s).

There are several possibilities:

- Reduce the time to get to – and through – the resource constraint and back to the shelf
- Ensure that the resource constraint is working only on what is needed to satisfy Demand
- Reduce variability in the system on the TRR side
- Reduce variability in the system on the Demand side
- Reposition or get more of the resource constraint

Re-applying TOC's 5 Steps to a Different System

What outcomes are we working to achieve ?

↑T/\$I and **↑**T/\$OE

*More Throughput per \$ Invested and
per \$ of Operating Expense*

↑Net Profit (NP) = \$T - \$OE
↑Return on Investment (ROI) = \$NP/\$I

*More Throughput per \$ Invested and
per \$ of Operating Expense*

$\$OE + \$I \leq \$Budget$

- *Operate within or below Budget*

Re-applying TOC's 5 Steps to a Different System

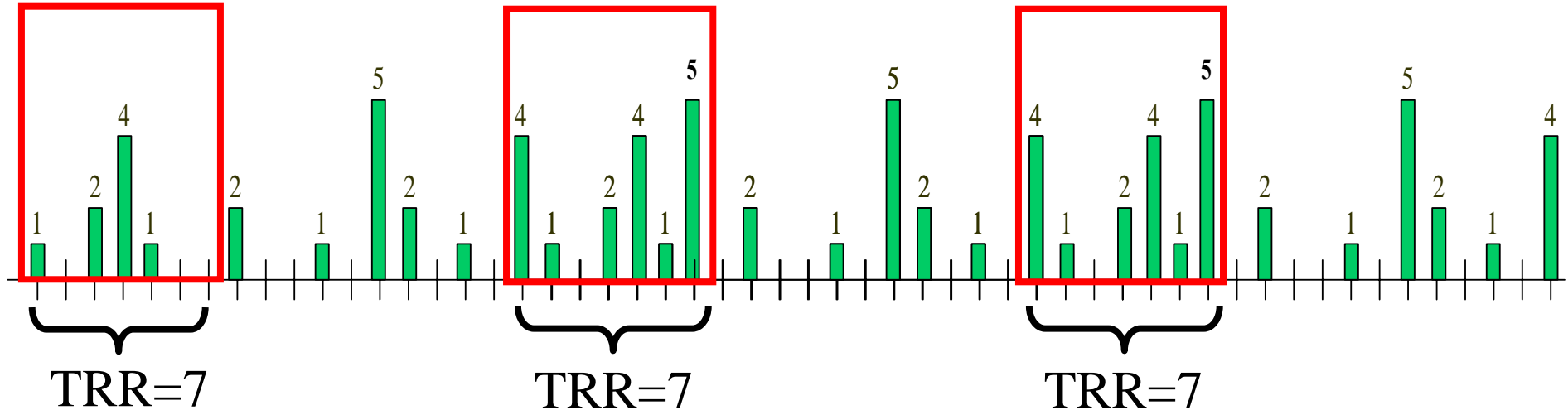
How do we elevate the system's constraint ?

- ◆ Reduction of time (resources) – \$\$
- ◆ Reduction of inventory (investment) – \$\$

...while increasing or maintaining Throughput

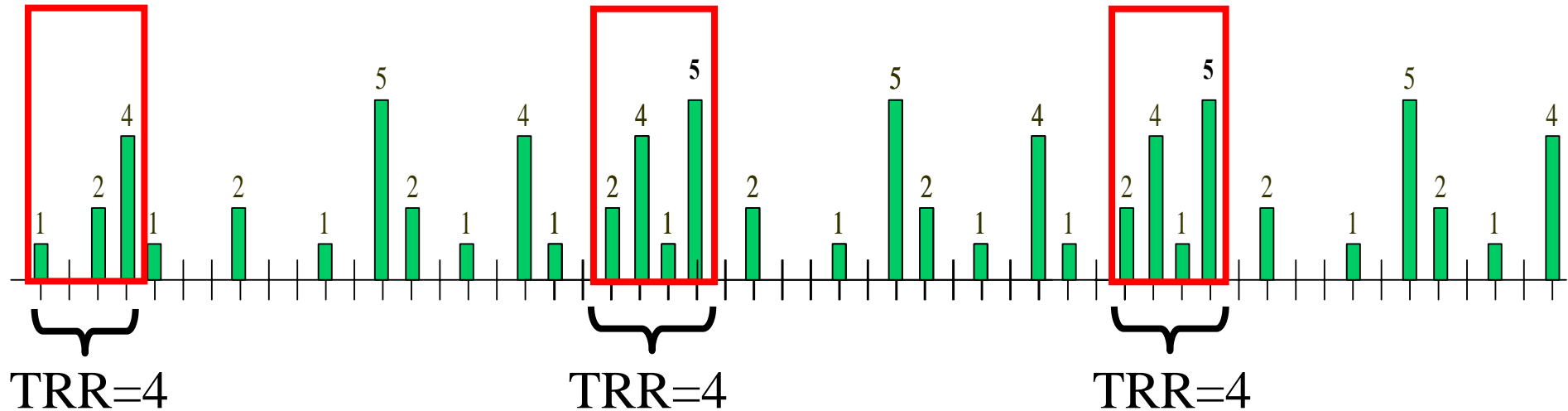
Impact of reducing time...

Our Baseline



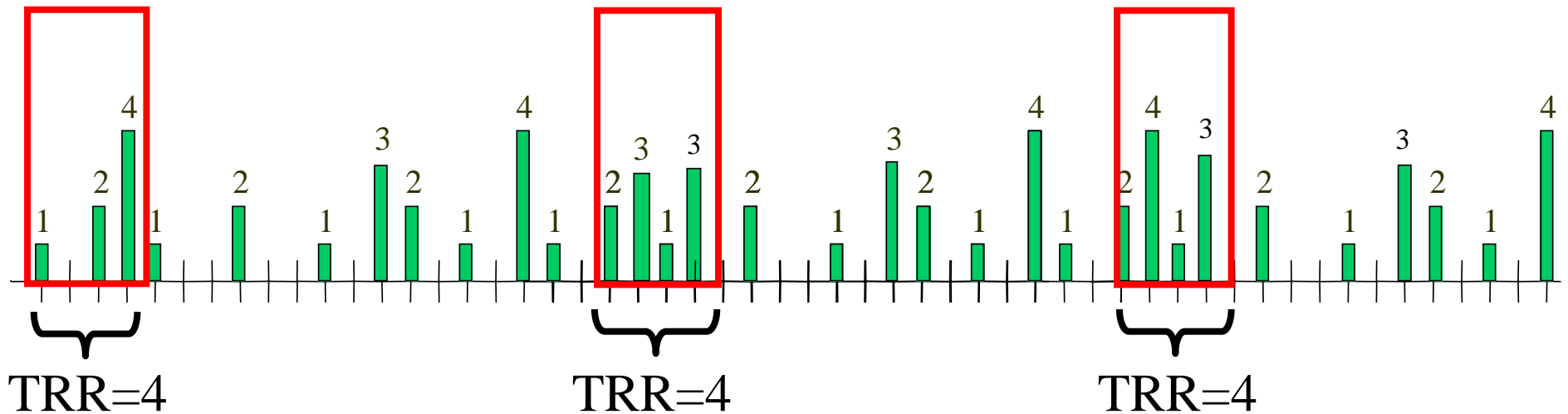
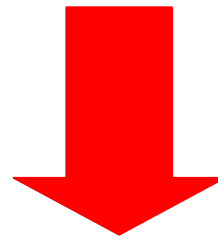
Buffer Size = 17 (4+1+2+4+1+5)

Impact of reducing time...



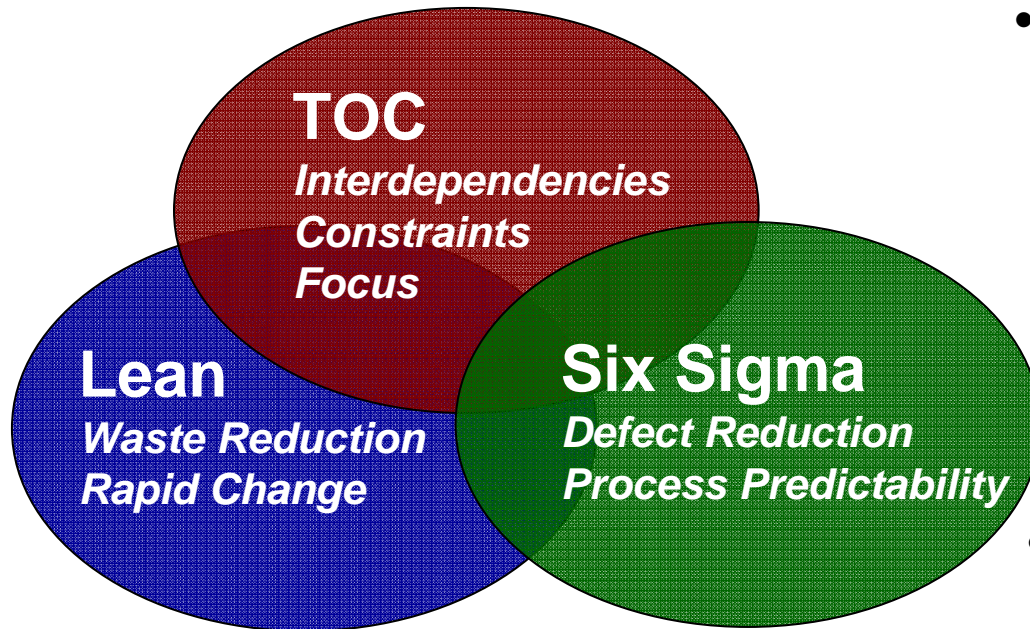
Buffer Size = 12 (2+4+1+5)

Impact of reducing variability of demand...



Buffer Size = 10 (2+3+1+3) or (2+4+1+3)

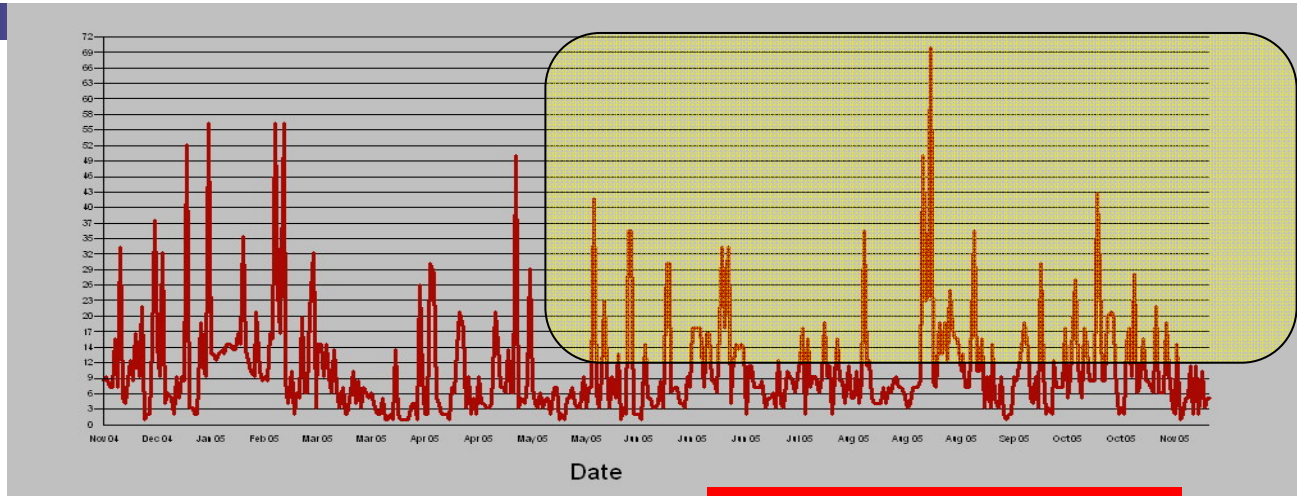
How Does Enterprise Focused CPI Achieve Improved Results?



- Eliminate waste and reduce cycle time where the impact increases Throughput and decreases Operational Expense and Investment.

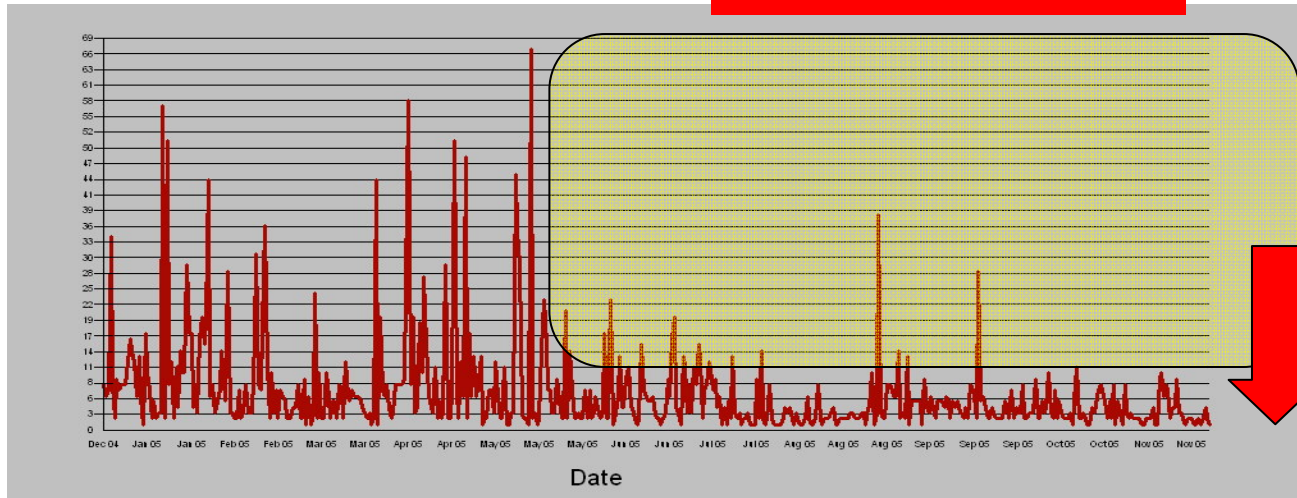
- Design and establish a stable operational system to maximize Throughput and link it to time - considering the interdependencies, variability and constraints of the system.
- Reduce variation and defects and increase process predictability where the impact increases Throughput and decreases Operational Expense and Investment.

Why the Operational System First?



Causes??

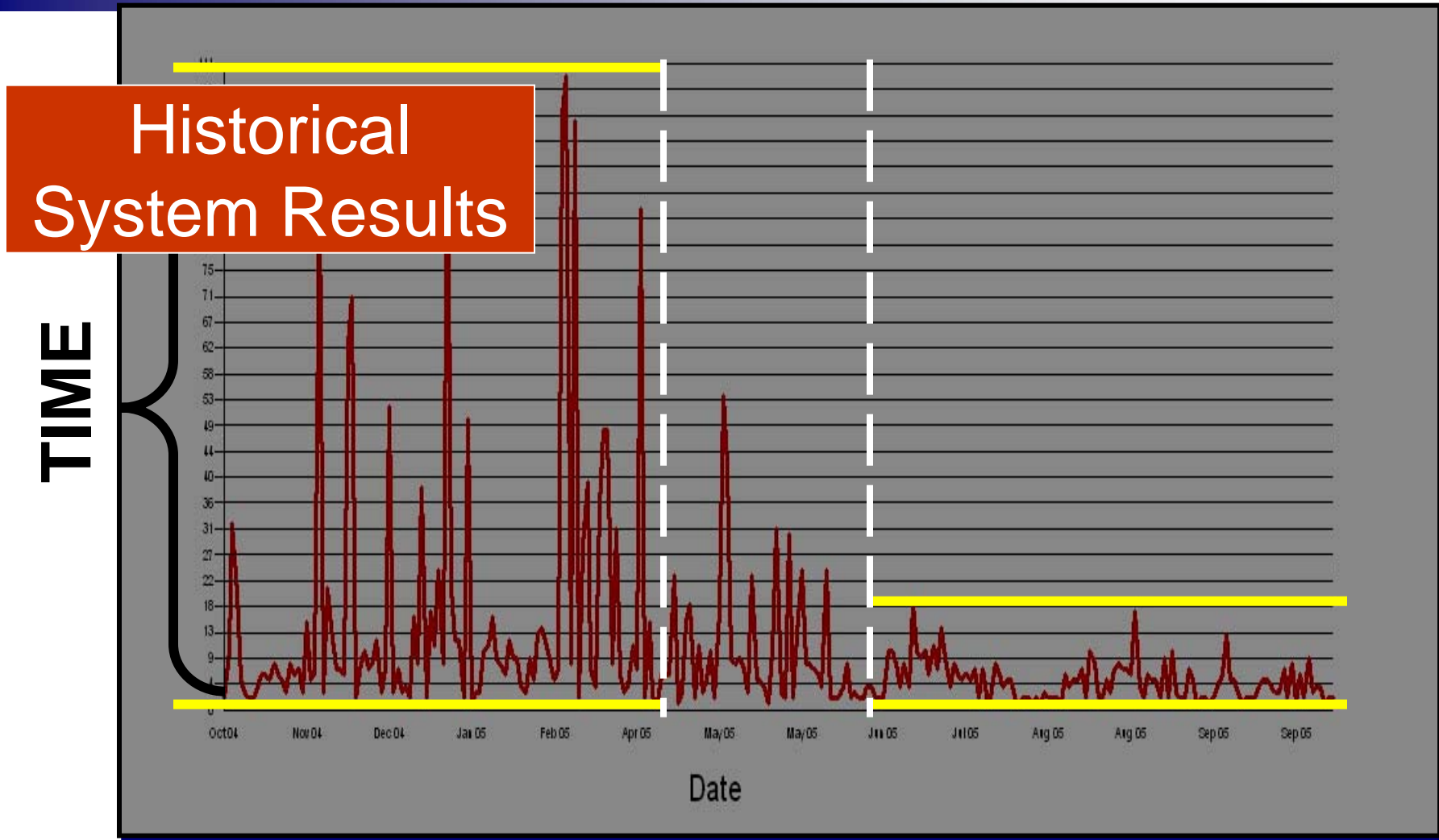
STABILITY!!



Causes??

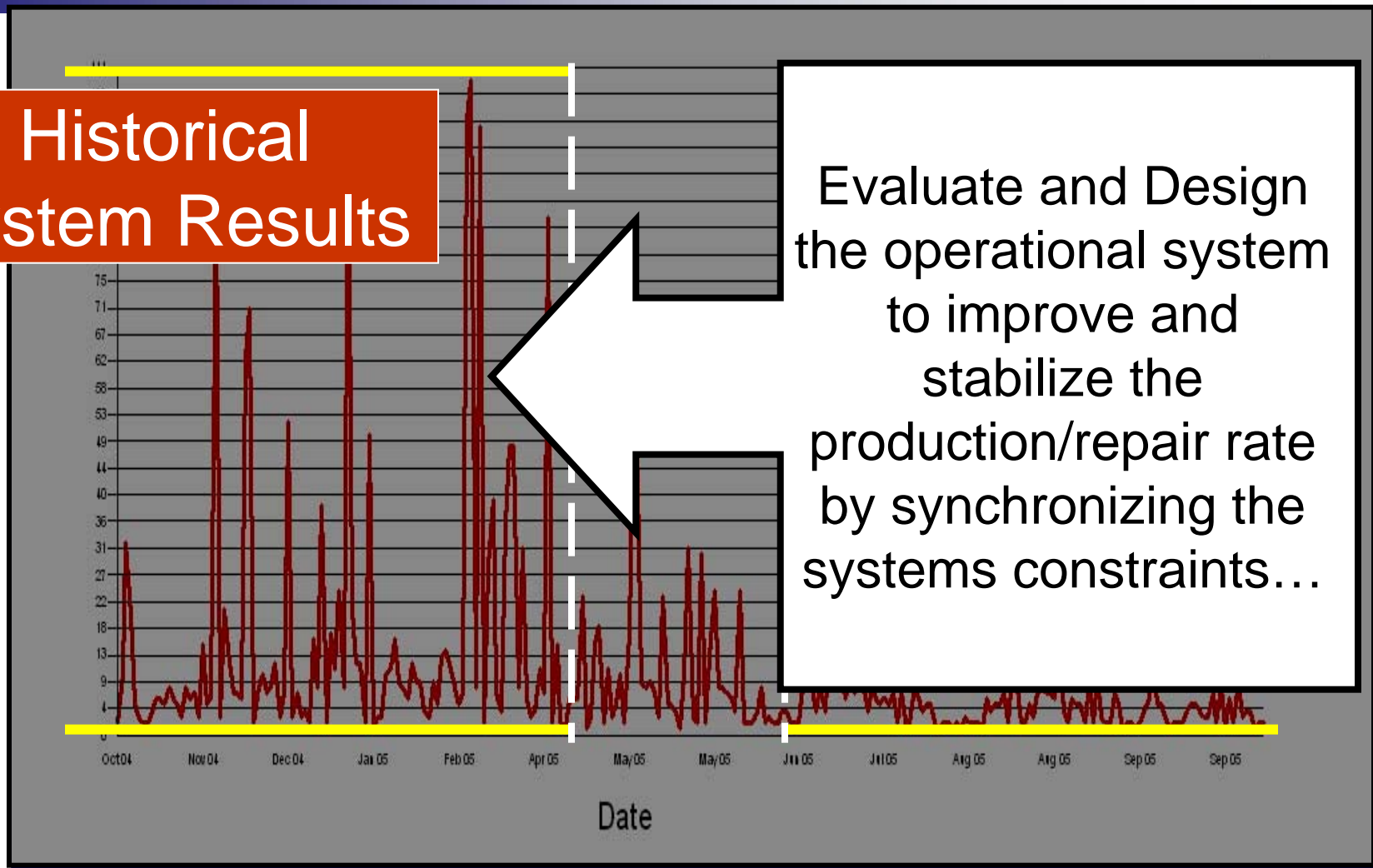
Improve

“Combining TOC, Lean, Six Sigma” Diagram



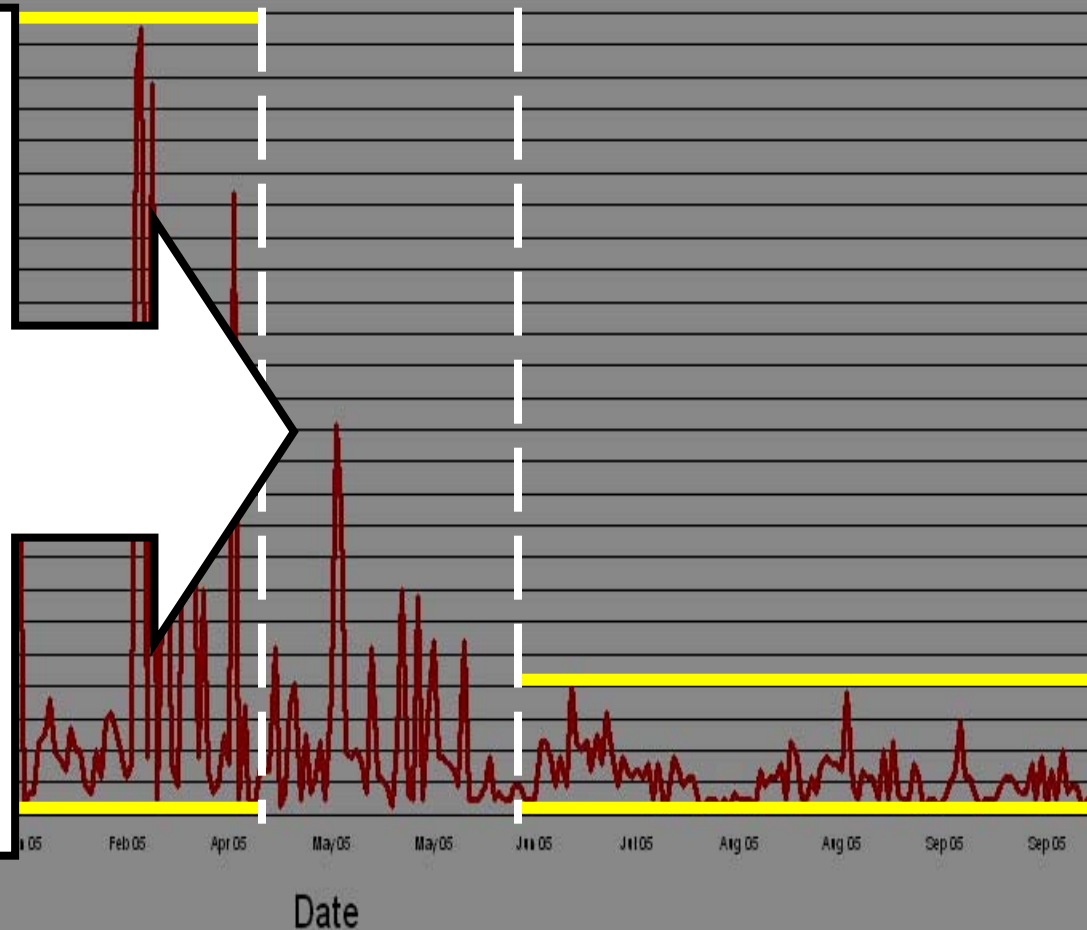
“Combining TOC, Lean, Six Sigma” Diagram

Historical System Results

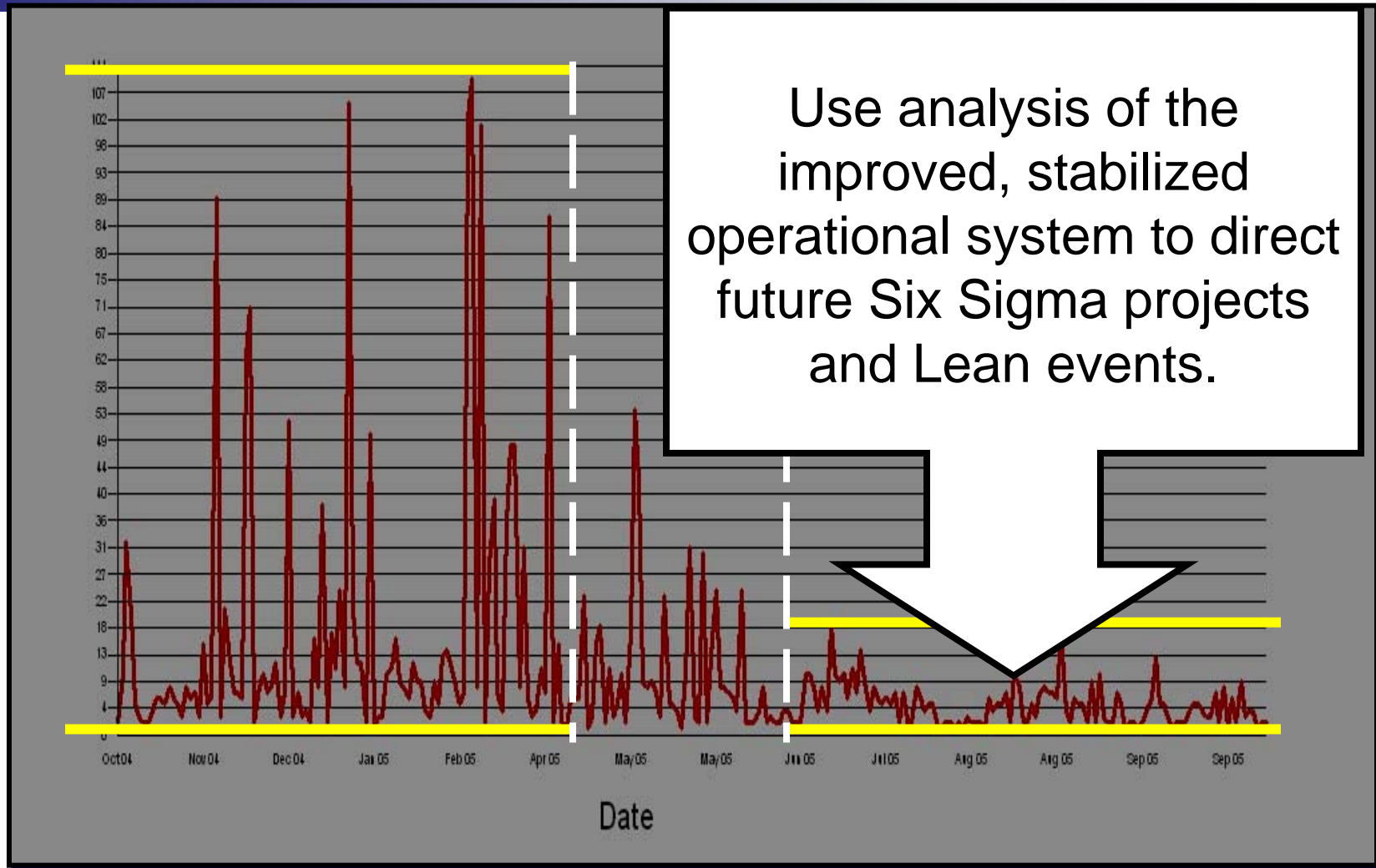


“Combining TOC, Lean, Six Sigma” Diagram

Begin operating the synchronized system as designed - removing unnecessary interdependencies and identifying additional sources of variation...



“Combining TOC, Lean, Six Sigma” Diagram



Creating a Continuous Process Improvement (CPI) Culture using TOC, Lean and Six-Sigma

Maximizing the Return on Your Improvement Dollars