Critical Chain Project Management
An Introduction Workshop

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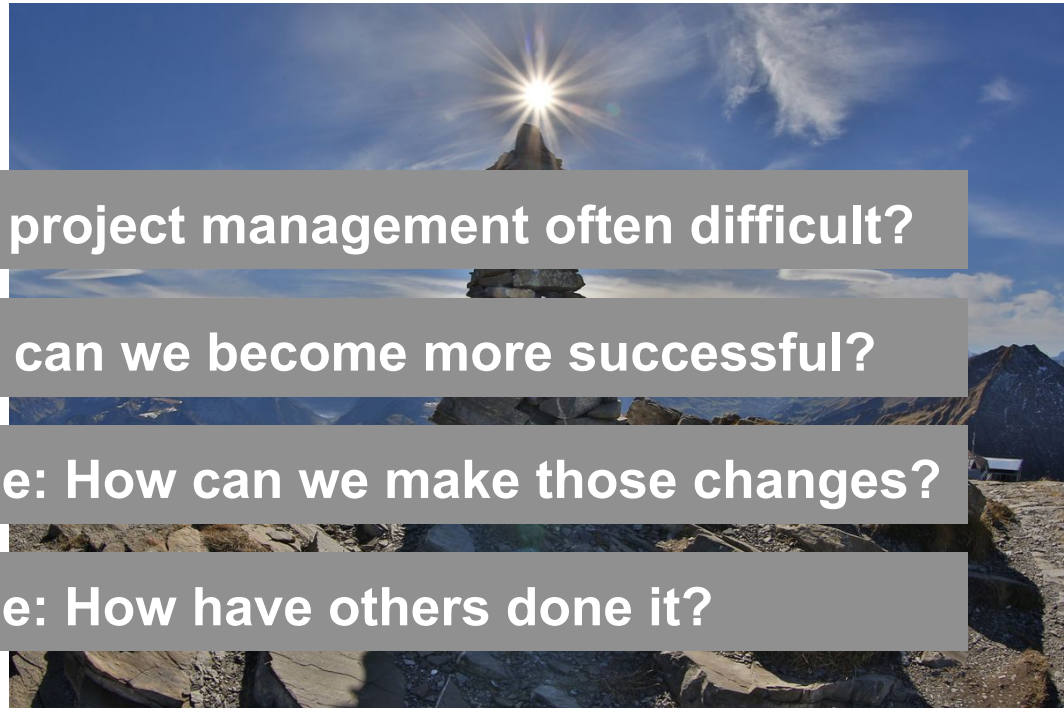
Workshop Objectives and Topics

Objectives

- Introduce you to the basic ideas of Critical Chain Project Management
- Prepare for advanced presentations, discussions, exam etc.



Topics

1. What to change: Why is project management often difficult?
2. What to change to: How can we become more successful?
3. How to cause the change: How can we make those changes?
4. How to cause the change: How have others done it?

What Is a Project?

- A project is a series of **interdependent tasks** that is supposed to create a **desired outcome** in terms of throughput for the organization.
- Throughput is the **contribution to bottom line**/units of organizational goals.

- In 2020, 25% of the world's GDP will be created through projects (source: Deutsche Bank Research).

How Are Your Projects Doing?

Get together in small groups and discuss:

1. What are the typical challenges and problems in your projects?
2. How do these impact your organization?
3. What are you typically doing to cope with these?

Most Projects…

are delayed,

exceed the budget,

don't meet all promised results.

A Massive Need for Change

Just looking at IT projects (Standish Group‘s CHAOS Reports)

	2011	2012	2013	2014	2015
Successful	29%	27%	31%	28%	29%
Challenged	49%	56%	50%	55%	52%
Failed	22%	17%	19%	17%	19%

Standish Group CHAOS Report 2012

- Schedule overruns **74%**, up from 71% in 2010
- Budget overruns **59%,** up from 46% in 2010
- Missing features **31%**, down from 26% in 2010

- IT IS GETTING WORSE!

Compromises Are the Norm

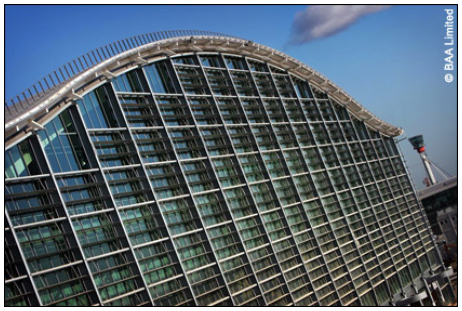
What Are the Effects of Such Delays?

For the customer:

- Customer's project is delayed
- Production, go live, market entrance is delayed
- Customers suffer economically from such delays

For the delivering company:

- Penalties
- Dissatisfied customers give fewer orders
- Payments are delayed (straining cash flow)
- Throughput per unit of time decreases
- Net return and cash flow worsen



Projects Get in Trouble Because of…

- Task **delays**
- Too many **changes**
- **Resources are not available** when needed
- Necessary **things/inputs are missing** (information, specifications, material, designs, approvals)
- **Unclear priorities** and resource allocation between projects,
- **Budgets** for individual tasks are **exceeded**
- **Rework**: completed tasks have to be taken up again
- and many other reasons…

Although projects are different, the problems are the same almost everywhere!

However, it Is not our First Project…

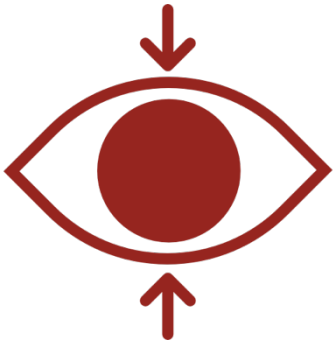
What Are the Reasons?

We still don‘t know how to do projects.

Or, we have created the problem
by the way we manage projects.

What Rules Project Management?

How do existing rules impact project perofrmance?



What should be the rules to achieve better performance?

When Do we Start Things?

Everyone Starts Early…

Let's Play a Game!

- We'll play two rounds.
- You just need a piece of paper and a pen and your phone to keep the time

First round:

- Write WASHINGTON,DC (13 letters incl. the comma)
- Then write 12345TOC67890
- Note the time and check quality

Second round:

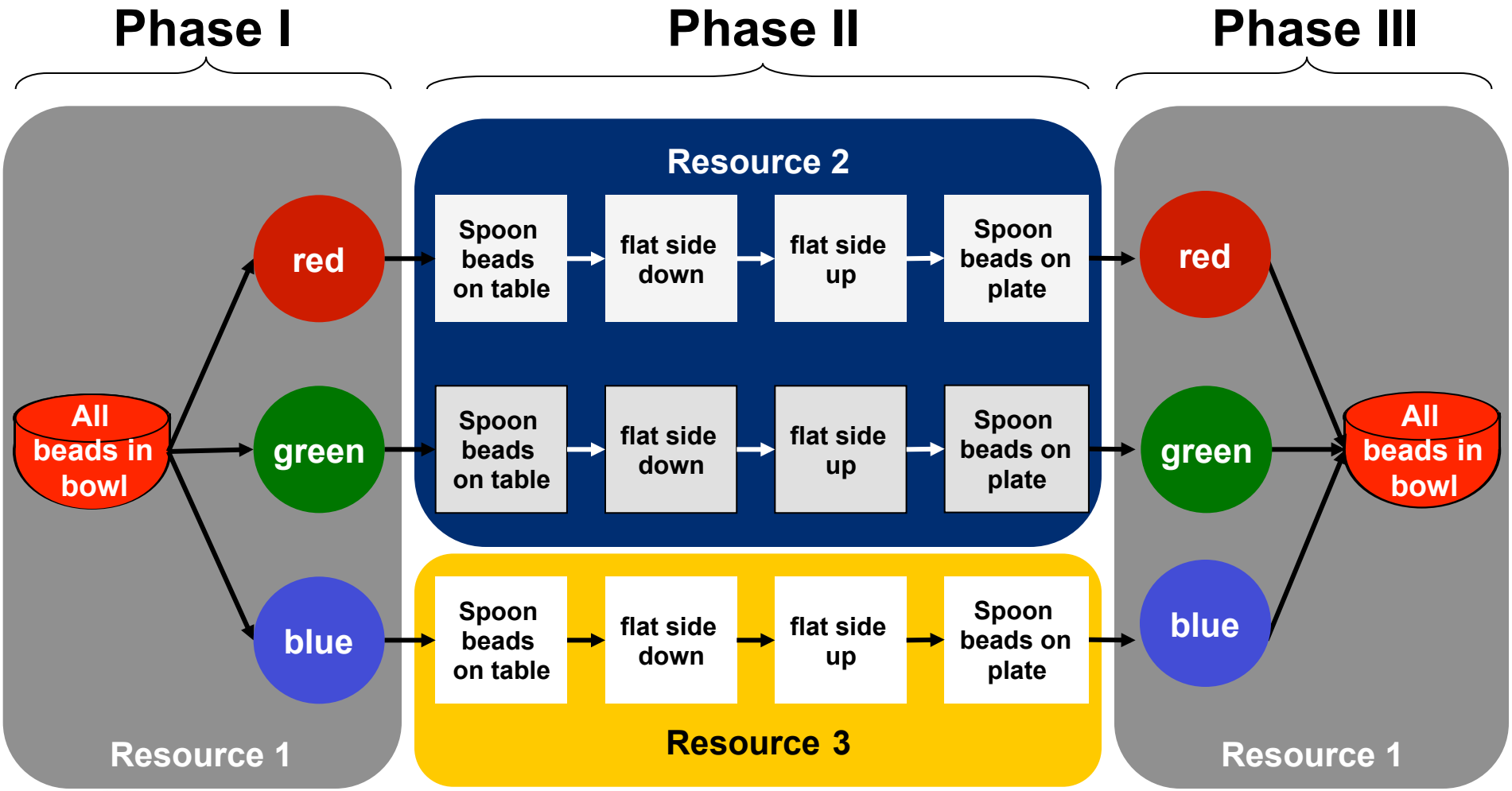
- Switch:
  - W1A2S3H4I5NTGOTCO6N7,8D9C0
- Note the time and check quality

Let's Play a Game!

- Our task: to quality check diamonds
- A set of diamonds in 3 colors is a project

- 3 phases per project:
  1. Sort
  2. Check
  3. Mix
- 3 highly specialized resources per team:
  1. Sort and mix
  2. Check red and green
  3. Check blue

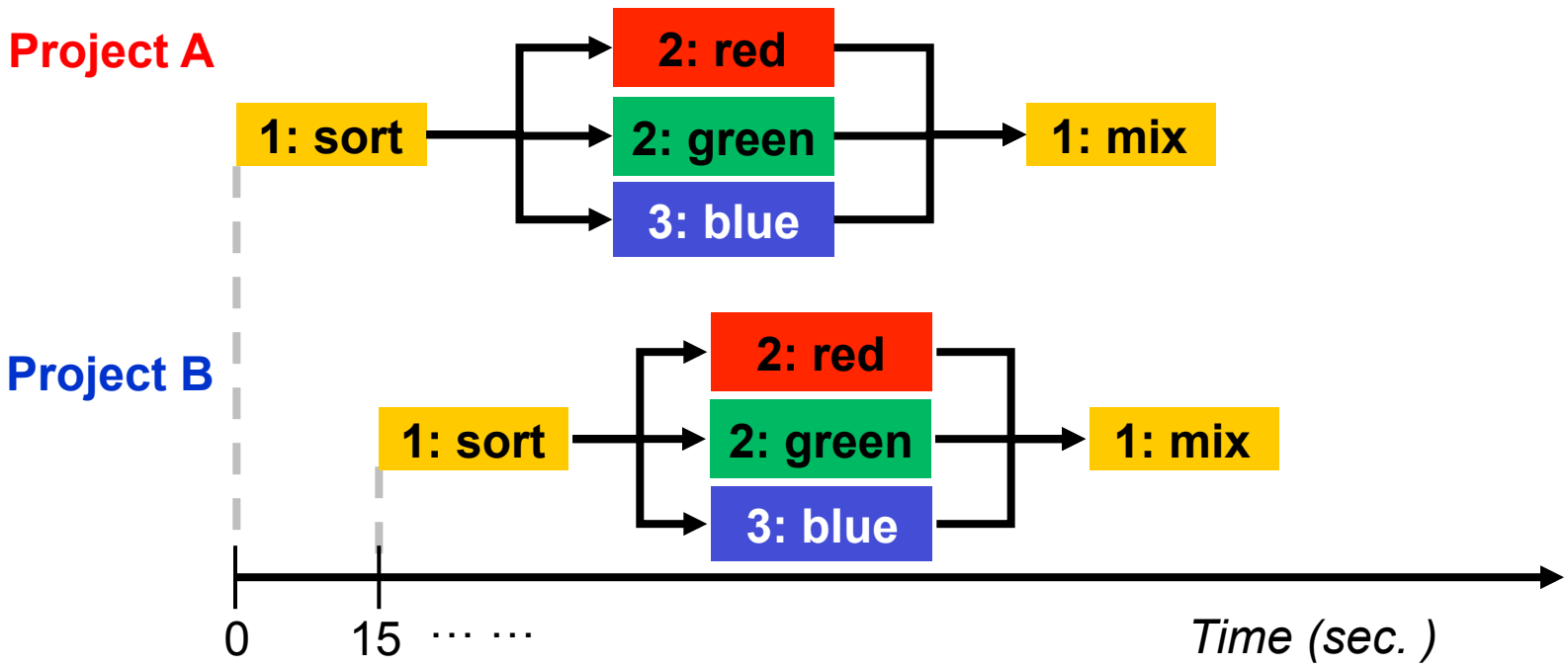
Simulation 1 (Beads)



Simulation 1 (Beads)

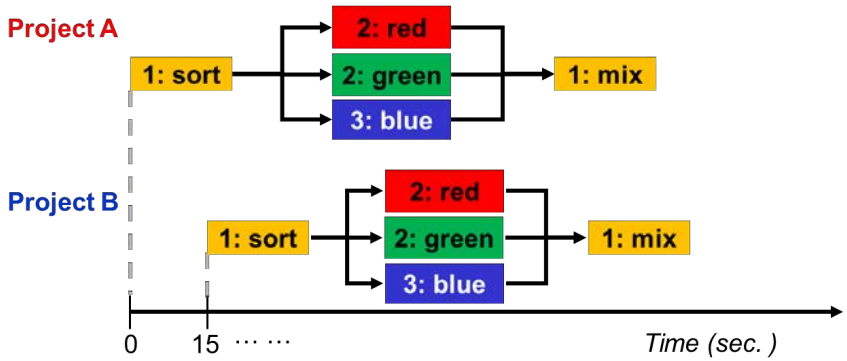
Run	Team	Project	Start	End	Duration
1	1		0:00		
	2		0:00		
2	1	A	0:00		
		B	0:15		
	2	A	0:00		
		B	0:15		
3	1	A	0:00		
		B	1:15		
	2	A	0:00		
		B	1:15		

A More Realistic Situation

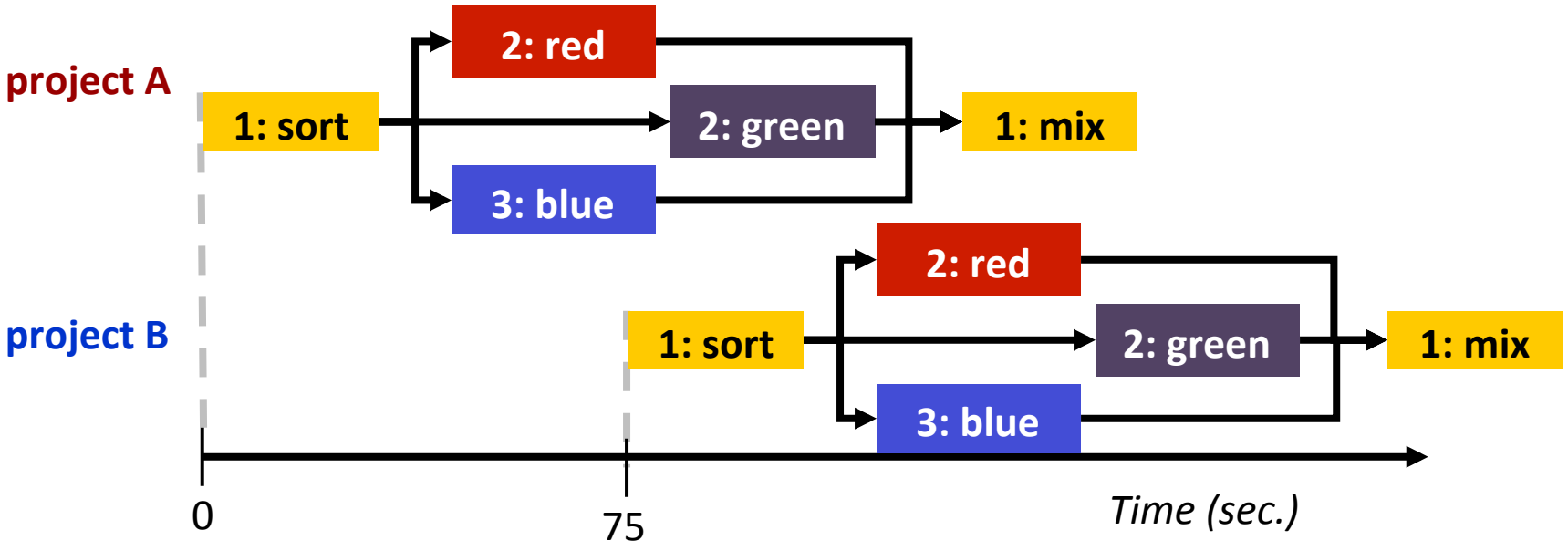


Instructions for Second Round

- We start a second project (B) –15 seconds after A.
- Project B is identical to project A.
- Each team works in parallel on project A and project B
- Both project managers:
  - want to complete their project as fast as possible,
  - make sure that resources focus on their project.
- Whenever team members have work from two projects at the same time, they multitask.
  - They are allowed to work 3 times per project, then they have to switch to the other project.



A Different Approach



- No change to the rules compared to round 2

A Different Approach

- In the third run, we set off setting the projects to avoid resource contention between the projects
- The official rules do not change but there usually is sufficient time for each resource to finish the tasks for one project before the other projects arrives
- As a result:
  - Resources finish their tasks faster
  - Project lead times decrease
  - Throughput of the organization (number of completed projects per time frame) goes up
  - More throughput with same resources means significant profit increase

Key Learning

Starting many activities/projects early (ASAP) and trying to keep resources busy at all times does not result in effective resource usage.

A Vicious Cycle

Resources are scarce

There is always the possibility to do more projects

WiP (Work in Process) is high

Projects compete for resources.

Projects fight for resources.

- Resources are spread across projects
- Bad multitasking

Tasks und projects take much longer than necessary!

"Any man who can drive safely while kissing a pretty girl is simply not giving the kiss the attention it deserves"

–Albert Einstein

A Vicious Cycle

Resources are scarce

There is always the possibility to do more projects

WiP (Work in Process) is high

Resources are spread over projects

Bad multitasking

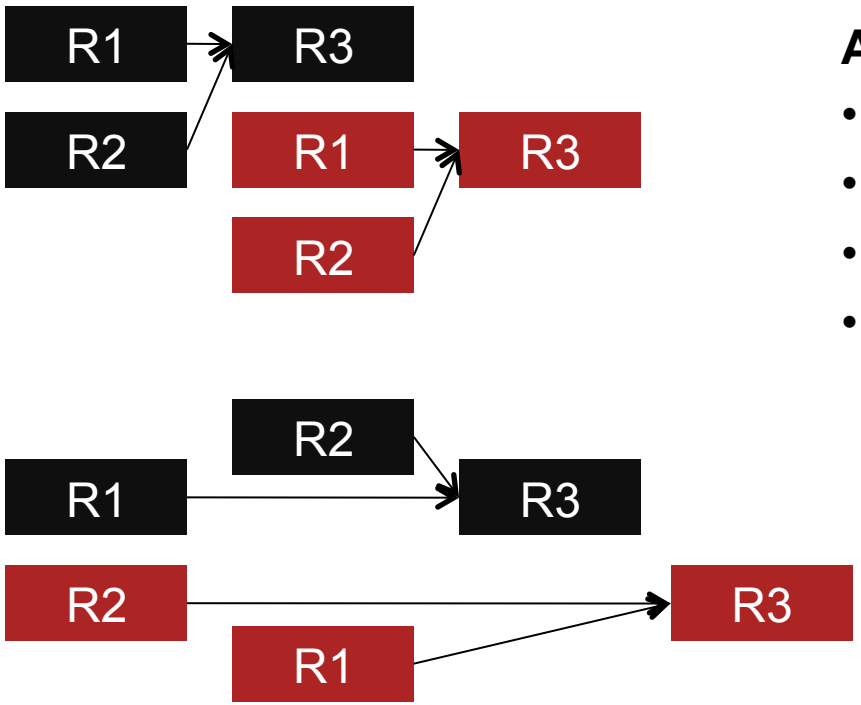
Other effects:

De-synchronization

Bad multitasking with management and support functions.

Projects take much longer than necessary!

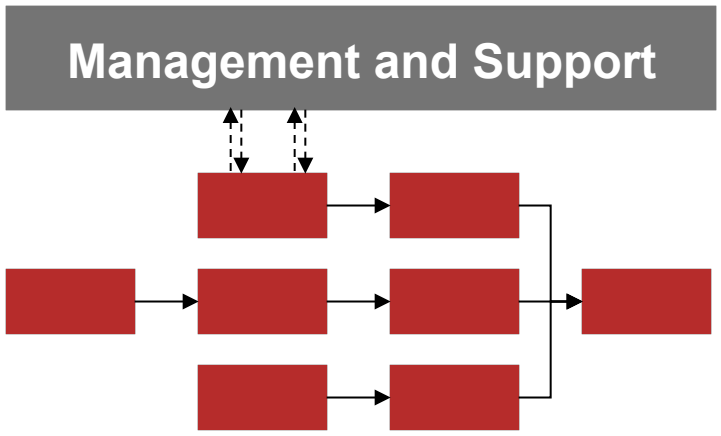
Loss of Synchronization



A loss of synchronization results in:

- Delays
- Wasted capacity
- Quality problems
- Overload on some employees, "underload" on others

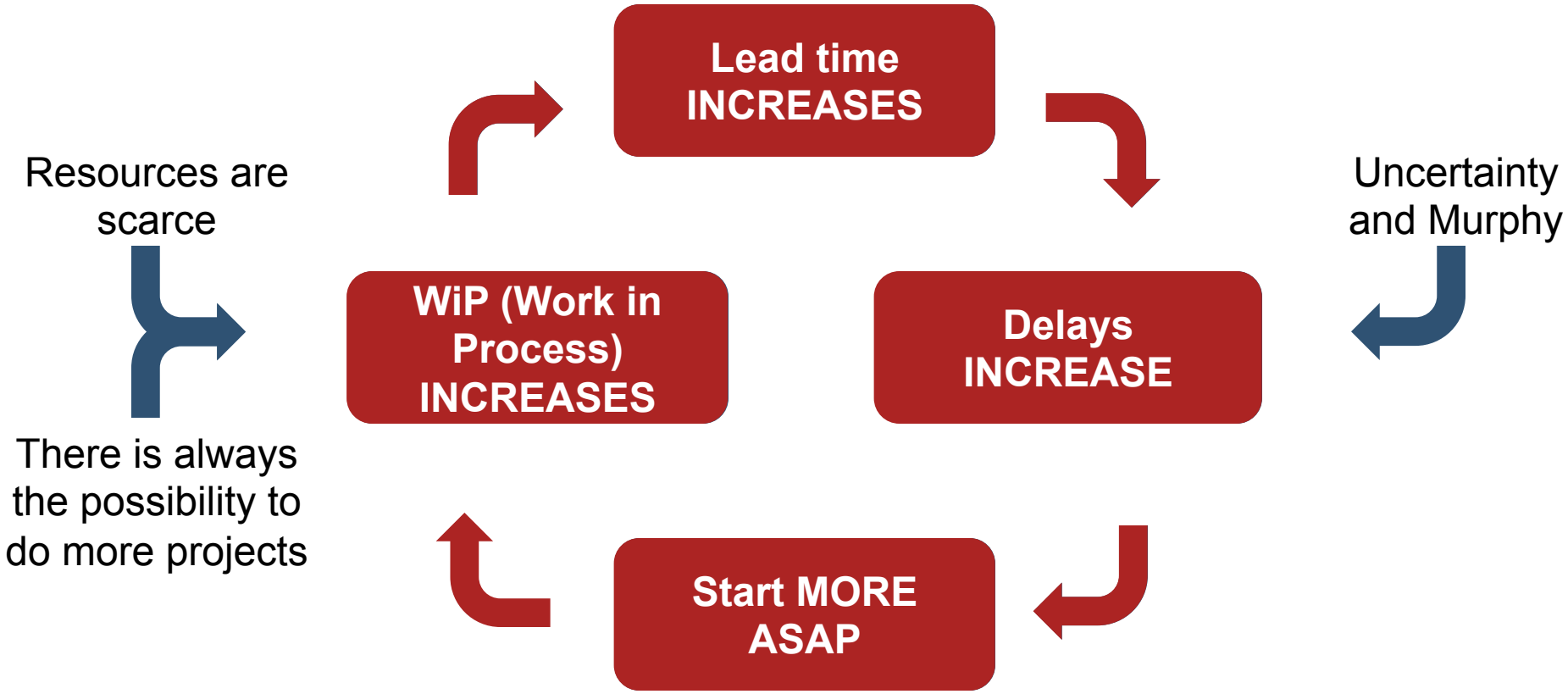
Management & Support



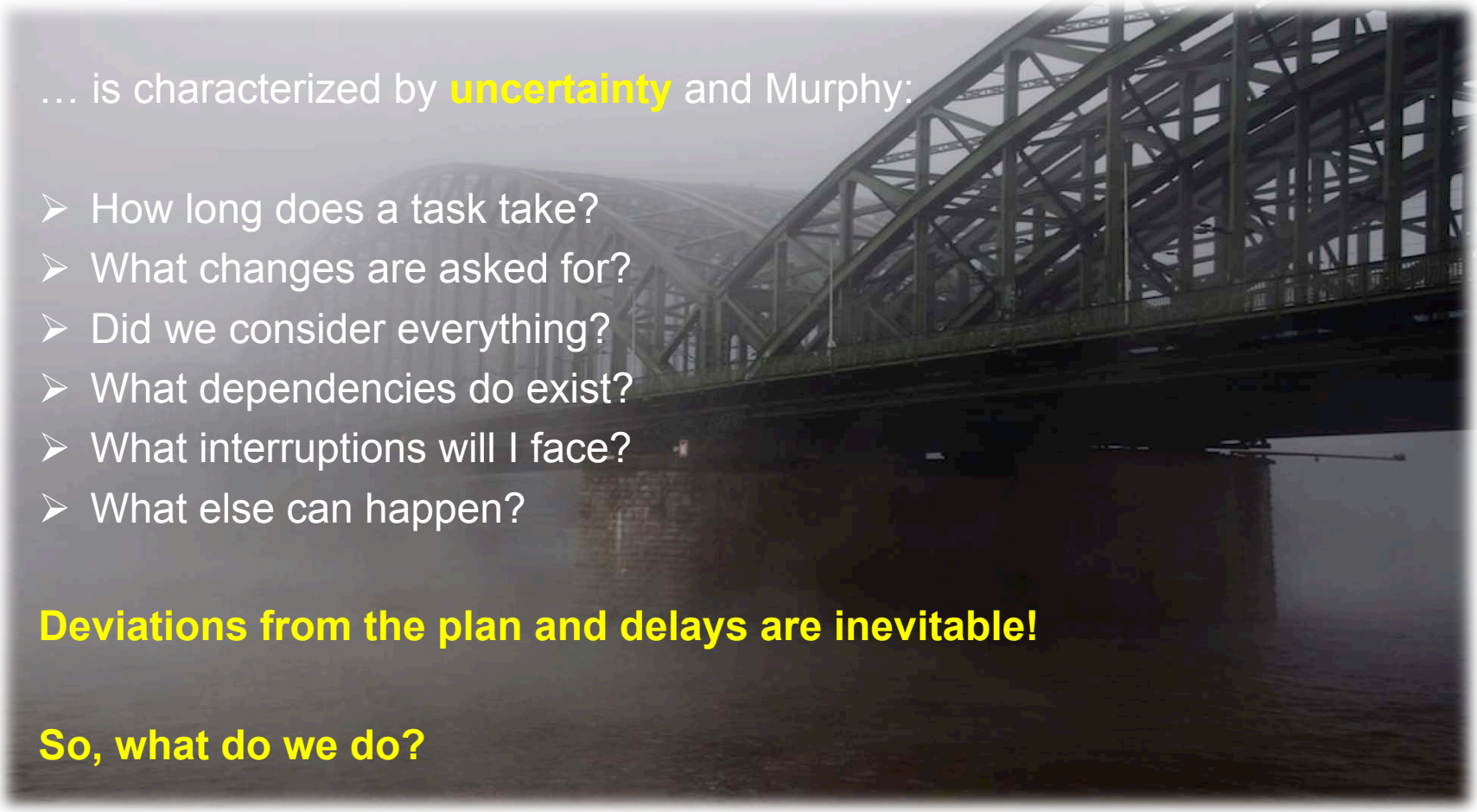
Project

- (Multi-) project management is characterized by uncertainty and “Murphy”.
- Management and support capacities are often required.
- Too many open projects result in multitasking with management and support functions.
- Delayed interventions by management and support functions delay the projects.

A Vicious Cycle



Project Management …



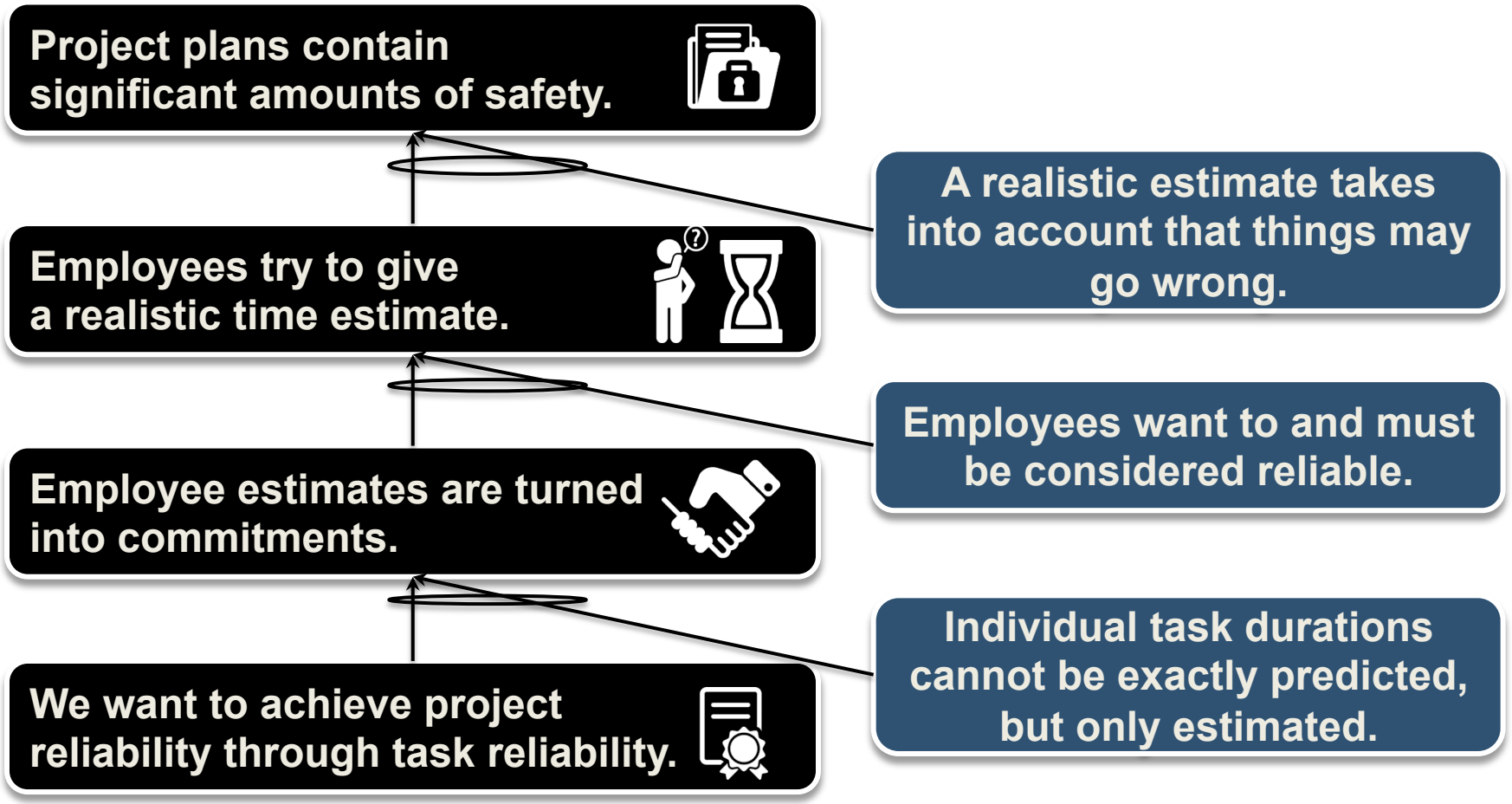
… is characterized by **uncertainty** and Murphy:

- How long does a task take?
- What changes are asked for?
- Did we consider everything?
- What dependencies do exist?
- What interruptions will I face?
- What else can happen?

Deviations from the plan and delays are inevitable!

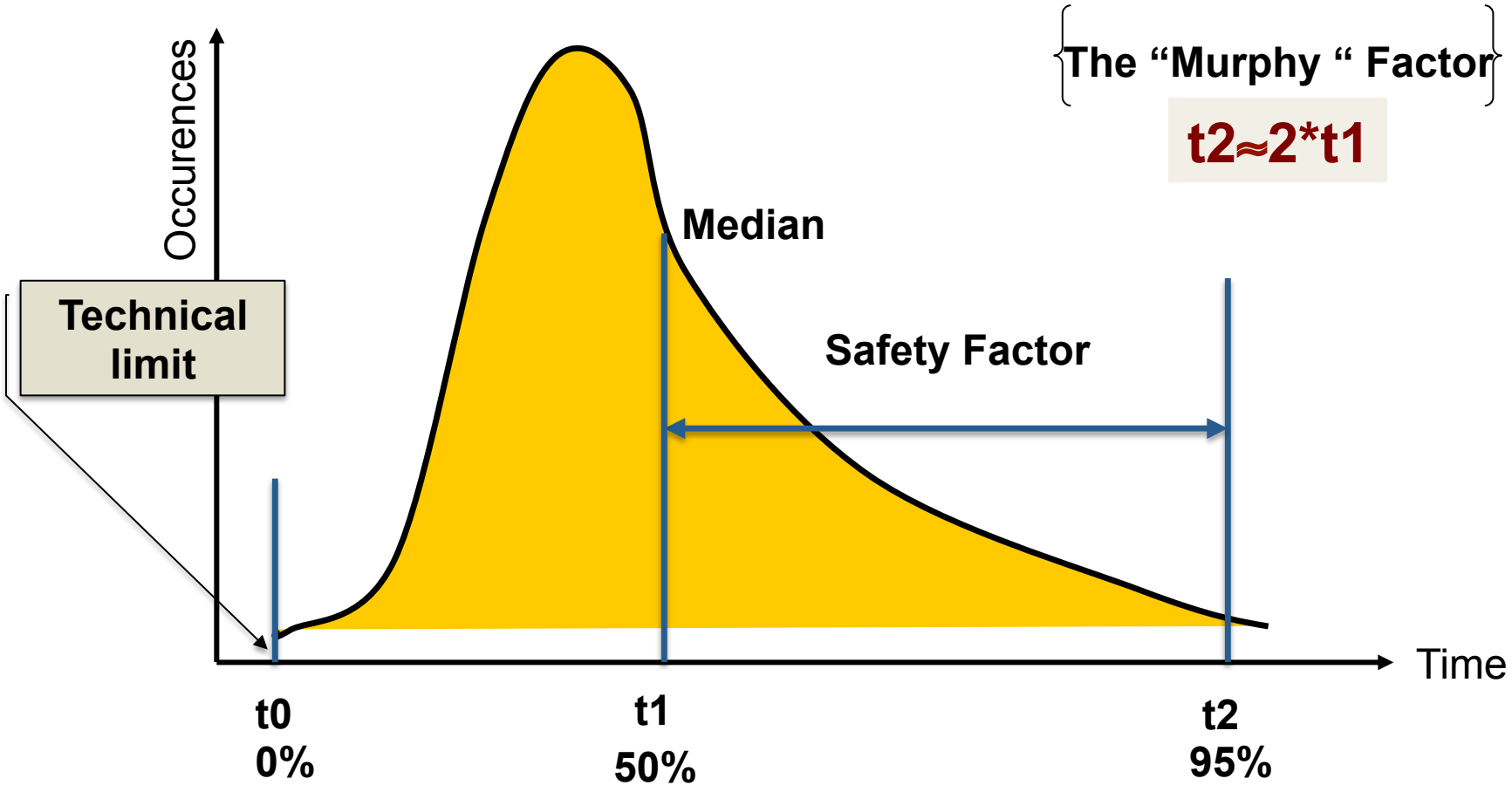
So, what do we do?

We Add Safety to the Plan



What Task Estimates Do you Give?

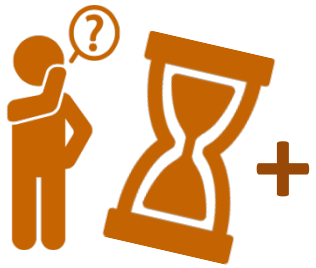
Estimation Is a Probability Forecast



How Much Safety Do we Have?

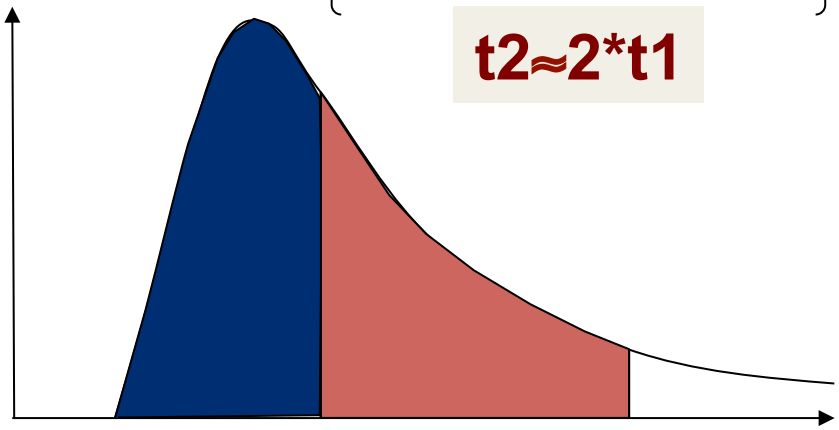
- Time estimates have an asymmetric probability.
- A time estimate with an 80-95% probability therefore includes a large buffer, about 50% of the estimated duration.
- The larger the uncertainty, the larger the „hidden“ built-in buffer.

“Prediction is very difficult, especially if it’s about the future.” –Nils Bohr



The “Murphy “ Factor

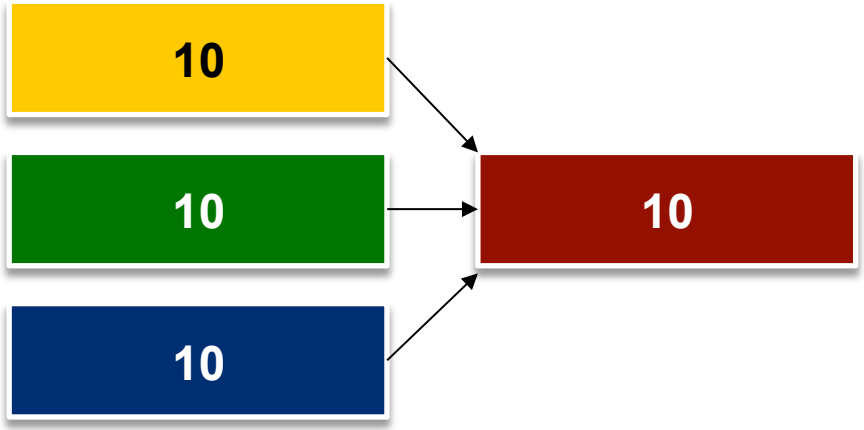
t2≈2*t1

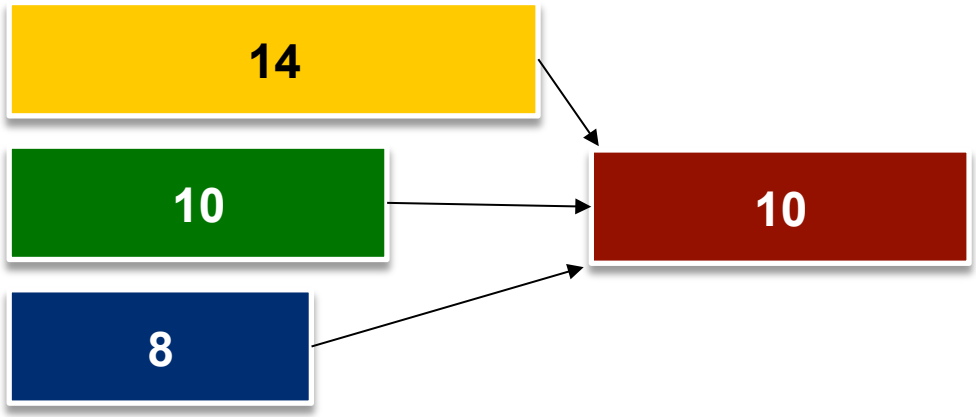


What Happened to Safety?

- Parkinson's Law
- Missing preparation (no "full kit")
- Unclear definition of "done"
- CYA
- Student syndrome

Integration Effects





- Early completions have no effect.
- Just one delay will have massive negative effects.

Current Rules and Their Effects

Projects take longer, are unreliable / resources are scarce

- Bad multi-tasking & thin resource spread
- Loss of synchronization and focus
- Safety buffers in individual project tasks
- Parkinson's Law (early completions are unlikely, delays are passed on)
- Delays due to lack of resources
- Resources are not released from projects

High WIP

- Start each project ASAP
- Resources must always be busy

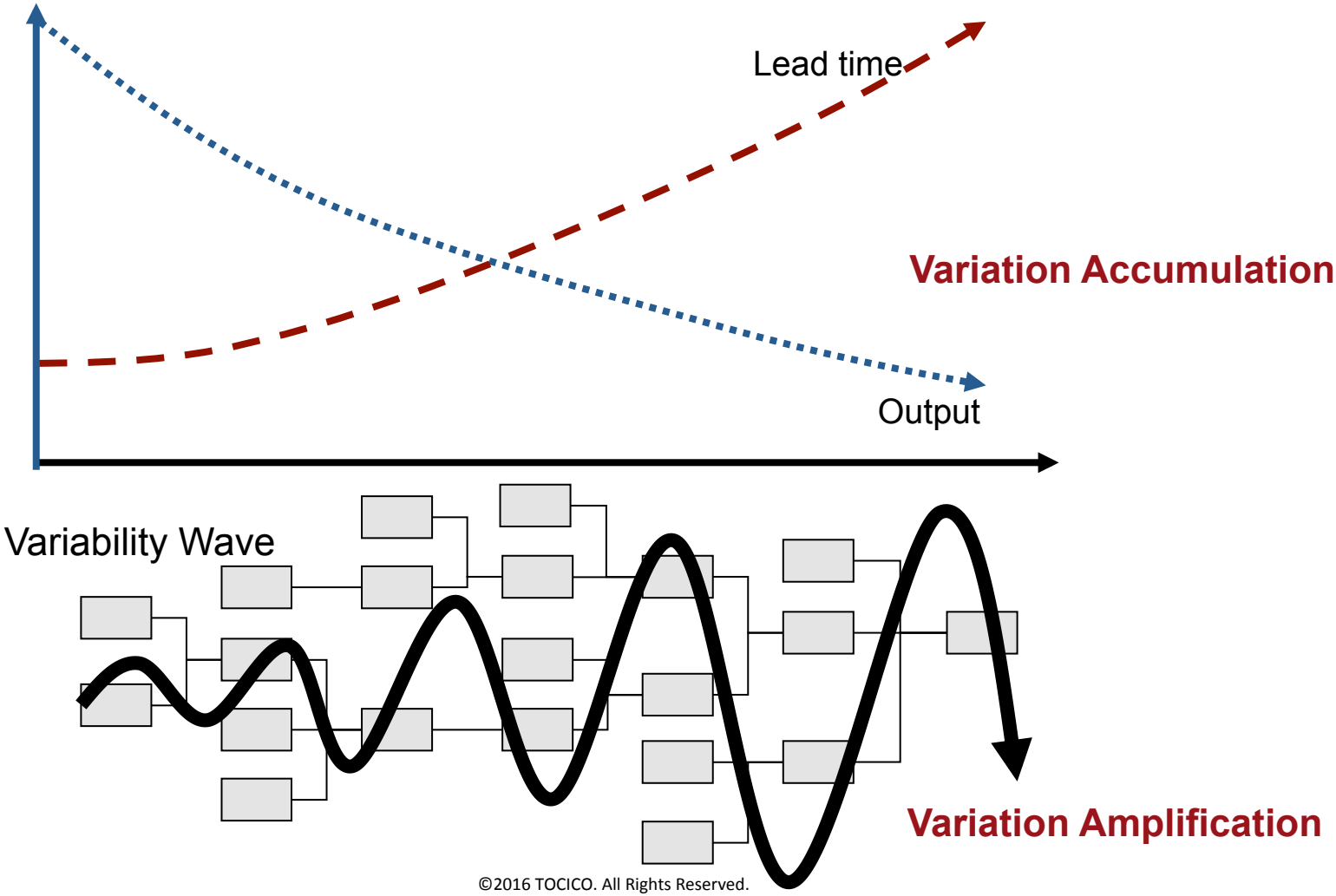
- Deadlines and budgets for individual project steps
- Resources are allocated according to plan (not according to actual need)

The Law of System Variability

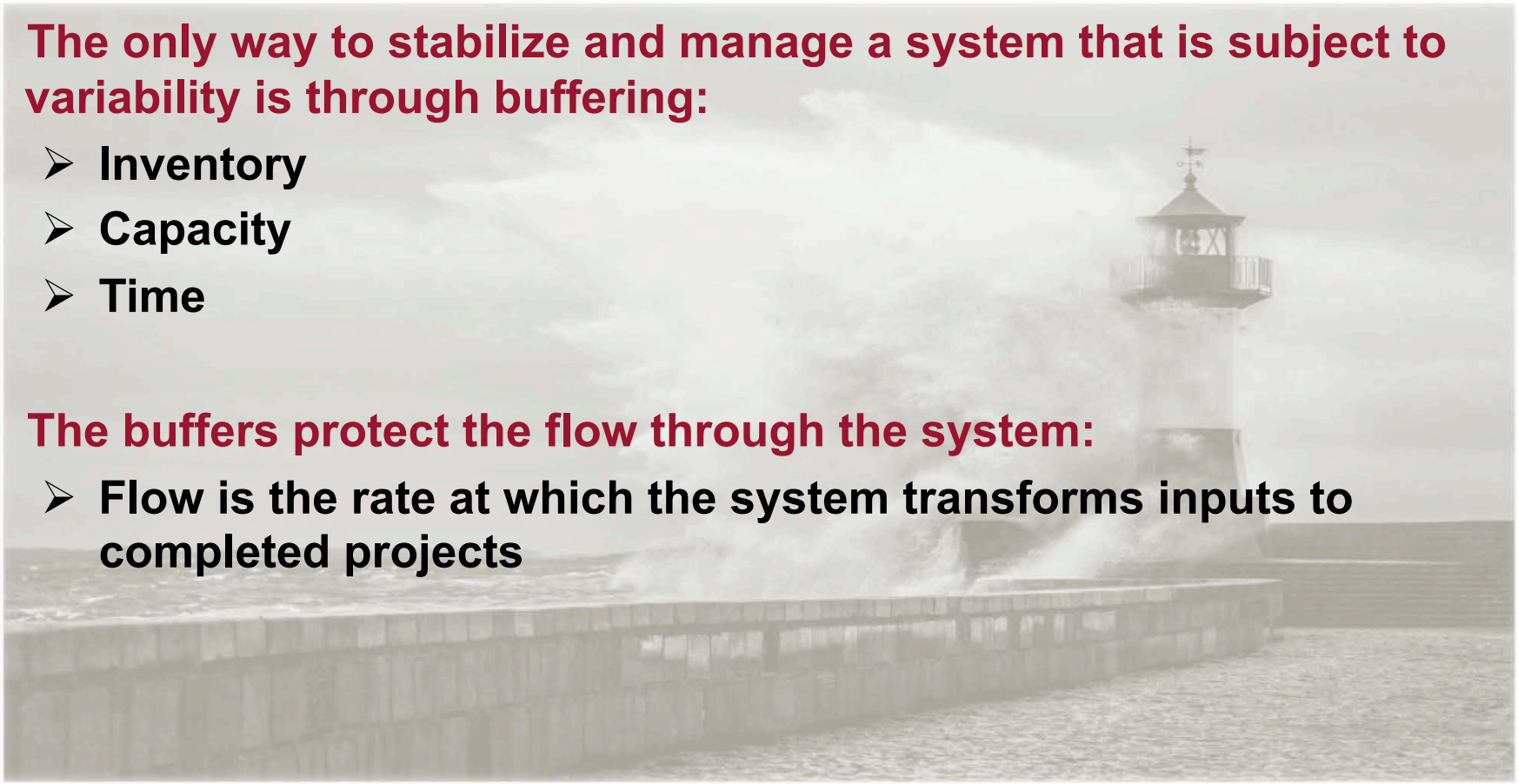
Uncontrolled variability is enemy number one of flow!

- The more that variability is passed between discrete areas, steps, or processes in a system, the less productive that system will be.
- The more areas, steps, or processes and connections in the system, the more erosive the effect to system productivity will be.

Variability Accumulation & Amplification



Law of Buffering



The only way to stabilize and manage a system that is subject to variability is through buffering:

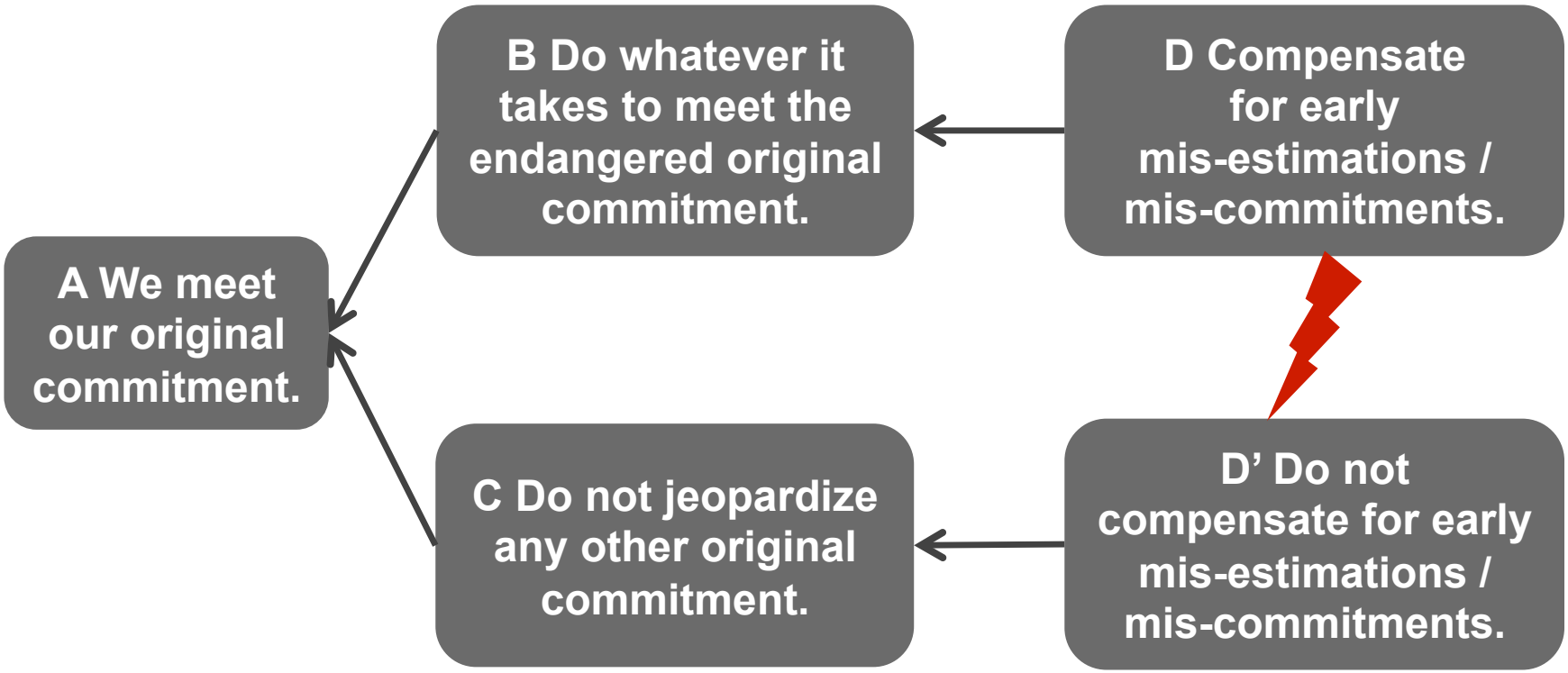
- Inventory
- Capacity
- Time

The buffers protect the flow through the system:

- Flow is the rate at which the system transforms inputs to completed projects

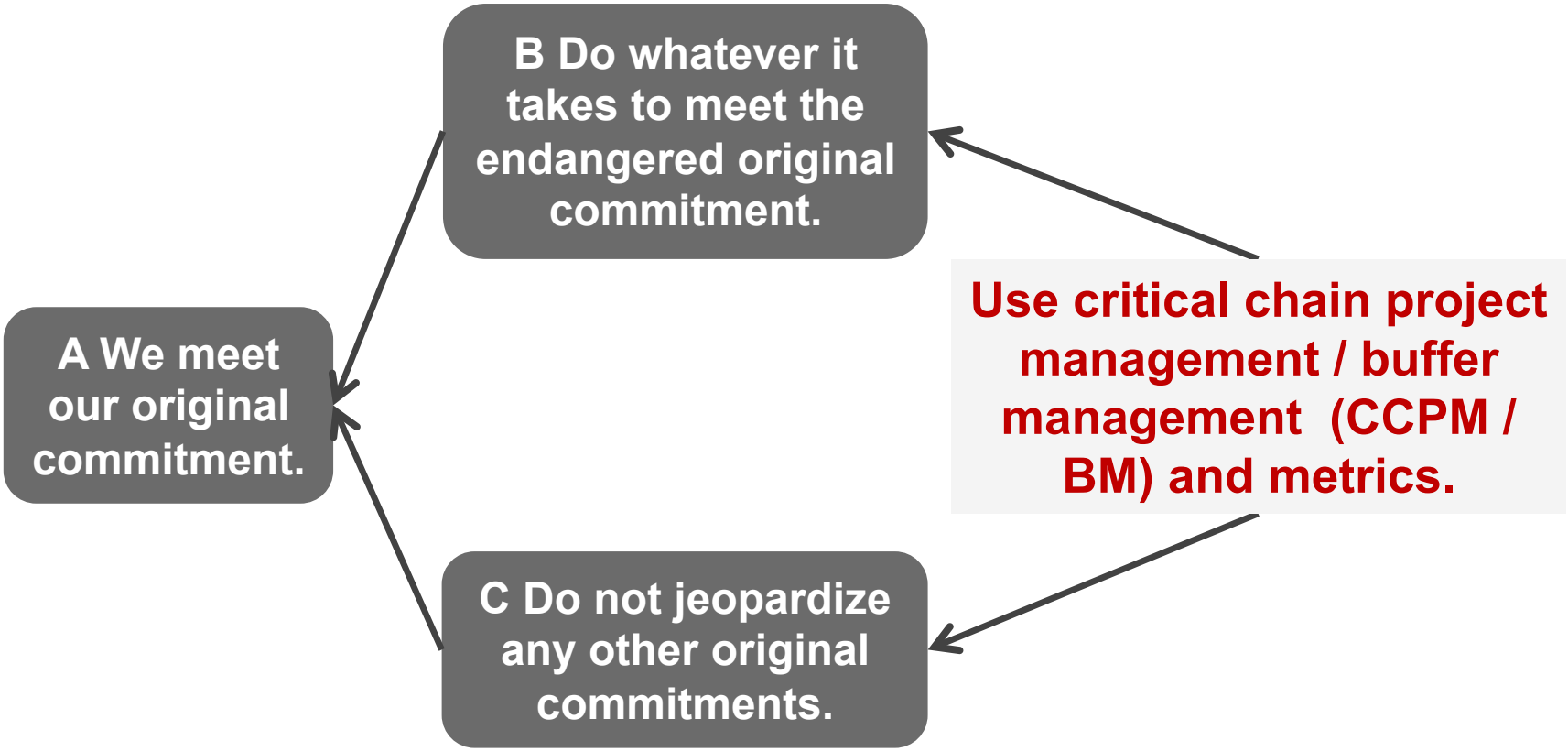
And now?

Project Management Core Conflict



Goldratt, 1999. Session 3 Project Management Engineering

Breakthrough Injection: Critical Chain Project Management



Goldratt, 1999. Session 3 Project Management Engineering

What Is the Key to Success?

Systems that flow provide more benefits!

- Faster = smaller target for changes
- Faster = same projects with less effort
- Faster = more projects with same resources

- Faster = more market share
- Faster = shorter pay-back period
- Faster = more rapid learning and change

Focus and Flow

- **Doing what should be done**
  – create flow
- **Not doing what should not be done**
  – don't create waste

- **Complete tasks and projects faster**
- **Increase throughput and productivity**

Solution: Create Project Flow

For each decision / action we must evaluate whether it supports achieving the goals for the entire organization

(instead of local KPIs and local objectives)

Solution Elements

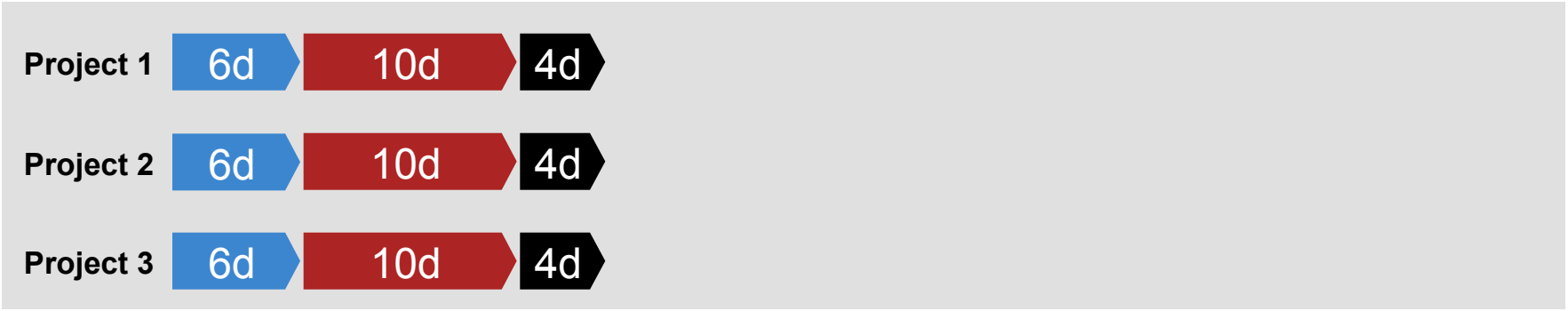
Actively manage Work in Process

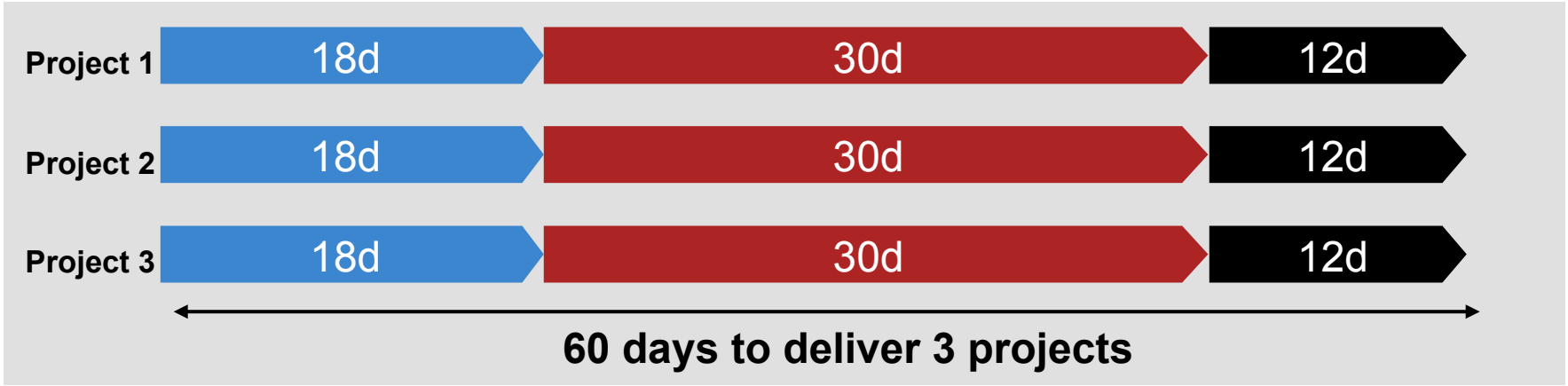
Explicitly plan and aggregate buffers

Execution management with robust tactical priorities

Critical Chain: Portfolio Challenge

Three projects in execution at a time

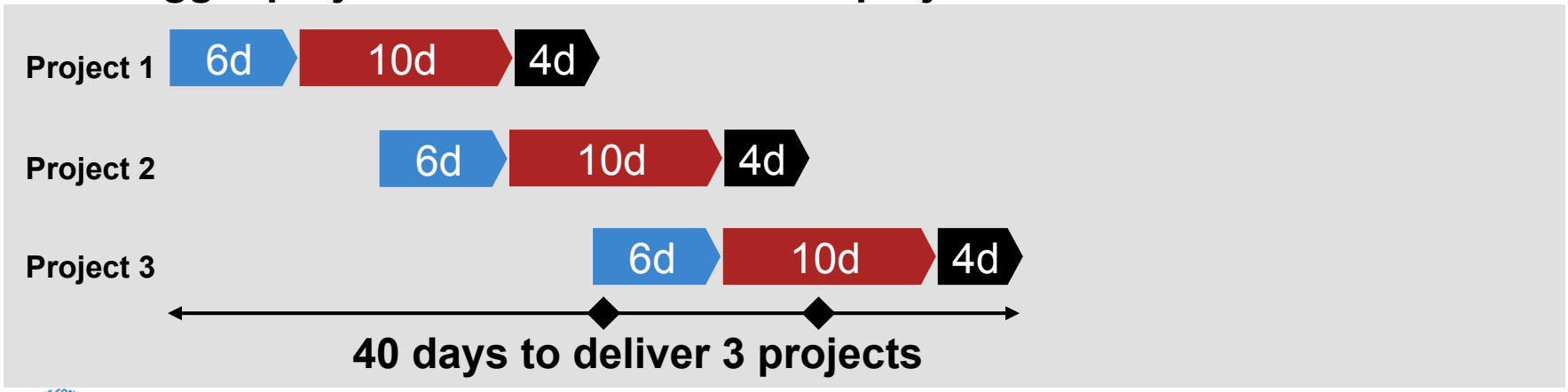




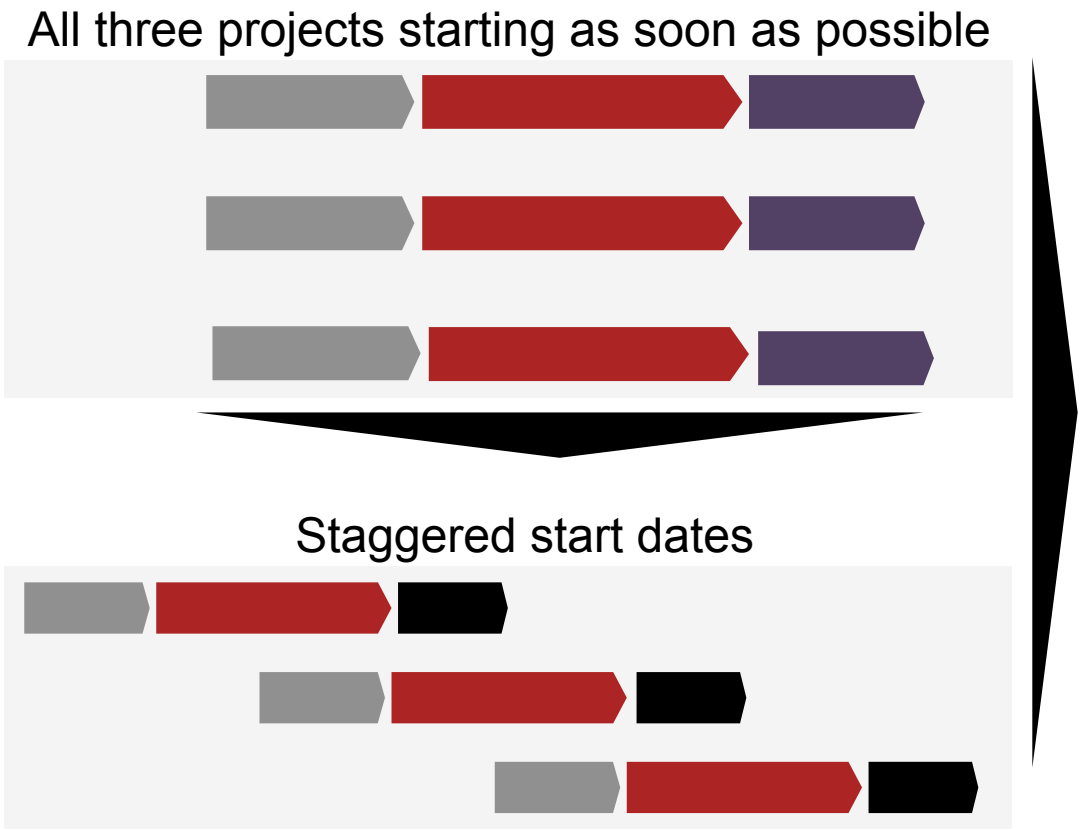
Critical Chain: Portfolio Staggering

Three projects in execution at a time

Stagger project starts: Maximum two projects in execution at a time



CCPM: Staggering Reduces WIP



Effects:

- Less bad multitasking
- Better resourcing of tasks

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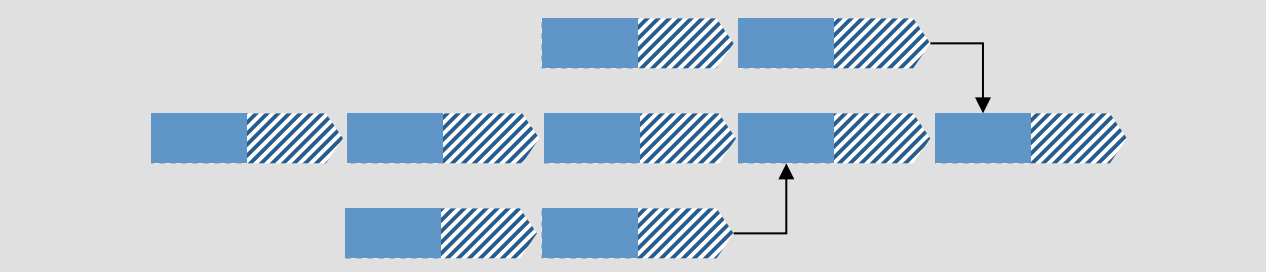
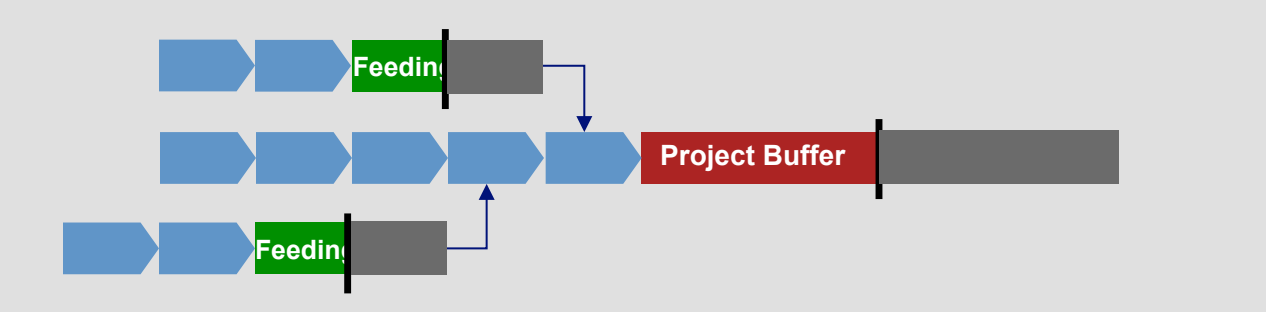
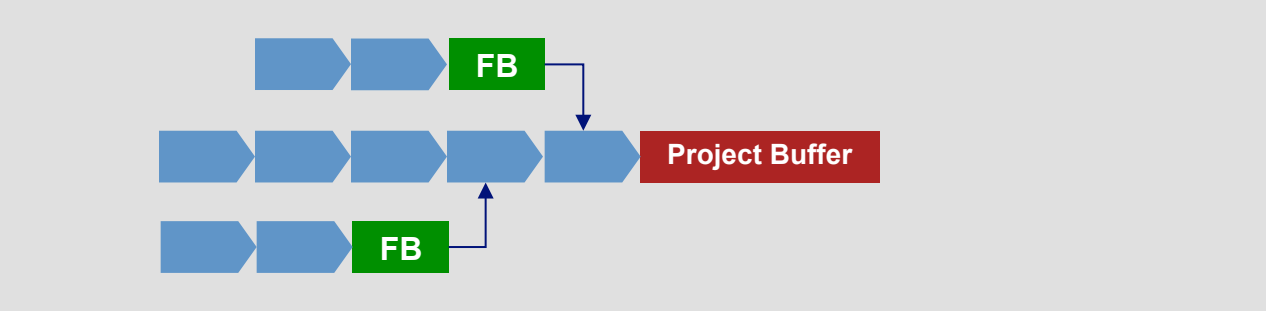
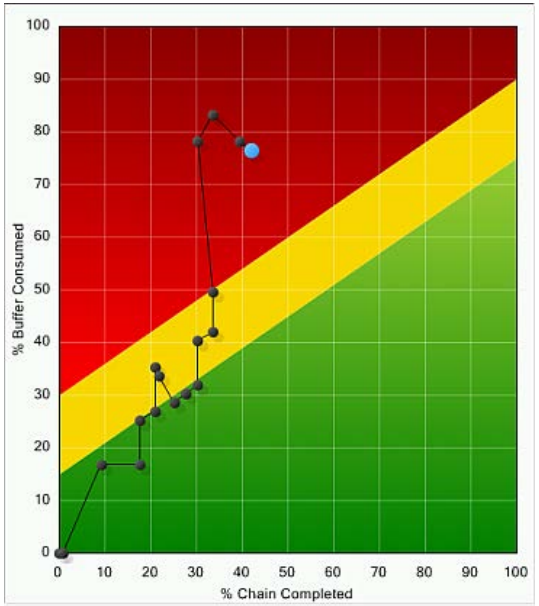
- Shorter task durations
- Shorter project lead-times
- More projects in the same time

Critical Chain Buffering

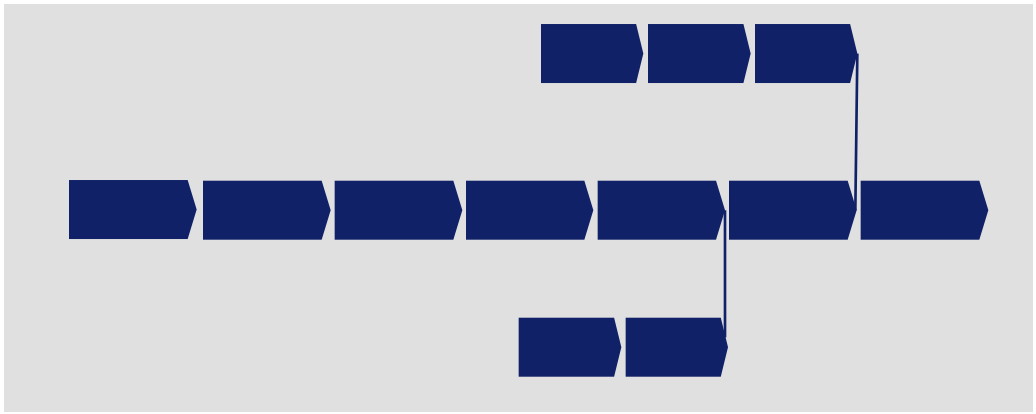






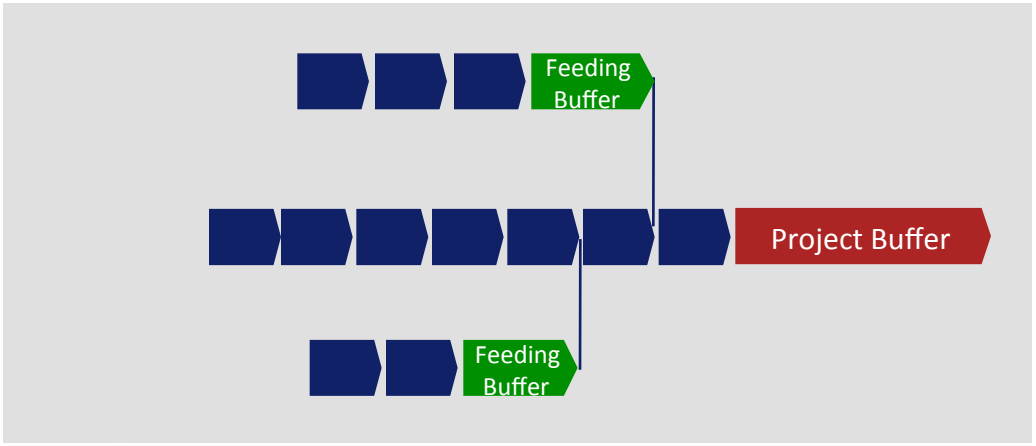


Explicit Safety



Without explicit safety:

- Delays on the feeding chains cause delays on the main chain
- Safety is wasted
- Delays accumulate



With explicit safety :

- Time buffers on feeding chains protect main chain from delays
- Project buffer protects due date
- Early completions can be used
- Roadrunner behavior
- Central Limit Theorem allows to reduce planned amount of safety

Critical Path vs. Critical Chain

Critical Path

- **Longest necessary sequence/path of task dependencies in terms of time.**

  This is the traditional understanding of term and path that is NOT used in TOC.

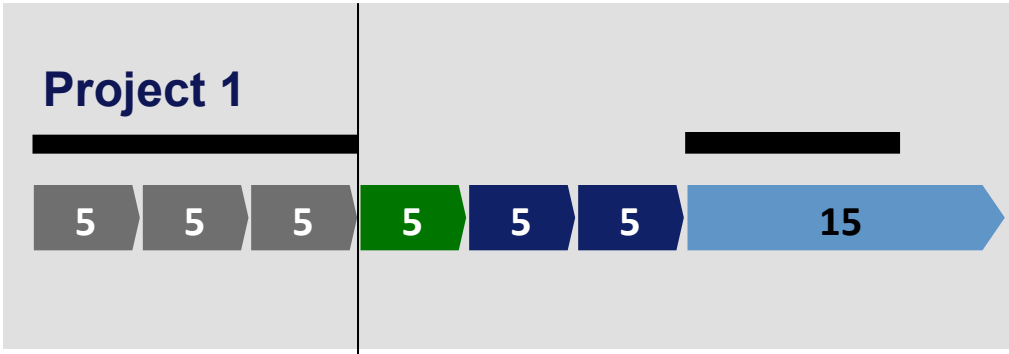
Critical Chain

- **Longest necessary sequence/path of tasks and resource dependencies in terms of time.**

  In other words, it is the longest sequence of dependencies, with explicit consideration of resource availability.

Buffer Status Determines Priority

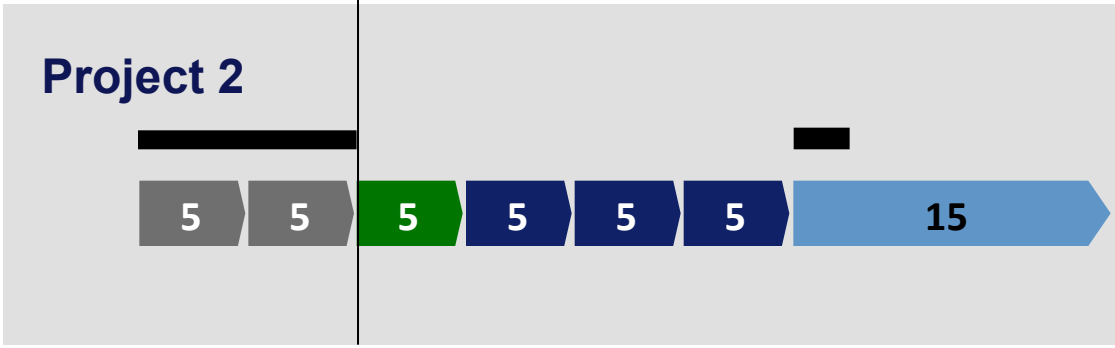
Green task in Project 1 has the higher priority because it has a higher Buffer Index



Buffer Consumption = 60%

Project Completion = 50%

Buffer Index = 0.6/0.5 = 1.2



Buffer Consumption = 20%

Project Completion = 33%

Buffer Index = 0.2/0.33 = 0.6

CC-Rule #1: Stagger Project Release

Old Rules:

- Start each project/task as soon as possible
- Keep resources busy at all times

Effects:

- High WIP
- Lack of focus for management and support functions
- Loss of synchronization
- Too little resources per task/project (peanut butter spreading effect)
- Bad multitasking

New Rules:

- Stagger projects (Pipelining)
- Assign optimum number of resources per task

Effects:

- Much less WIP (Less open tasks)
- Focus for management and support functions
- Focus on completion of tasks and projects
- Much less multitasking
- Shorter real project lead times

CC-Rule #2: Bundle Safety

Old Rules:

- Deadlines are set per task and must be adhered to

Effects:

- Project plans contain significant safety in each task
- No early completions, so safety is wasted
- Tasks don't finish on time
- Projects don't finish on time

New Rules:

- Bundle safety at project end and integration points (buffers)
- Nobody is measured against task due dates and milestones

Effects:

- Early completions are possible and can be used to make up for delays (thus adding safety)
- Projects are completed on time (in budget and within scope and quality)

CC-Rule #3: Set Priorities

Old Rules:

- Resources (names, effort) are assigned before project start
- Priorities are based on pressure and change frequently

Effects:

- Insufficient resourcing of tasks
- Resources who are not required are not returned to the pool
- Hectic and lack of trust

New Rules:

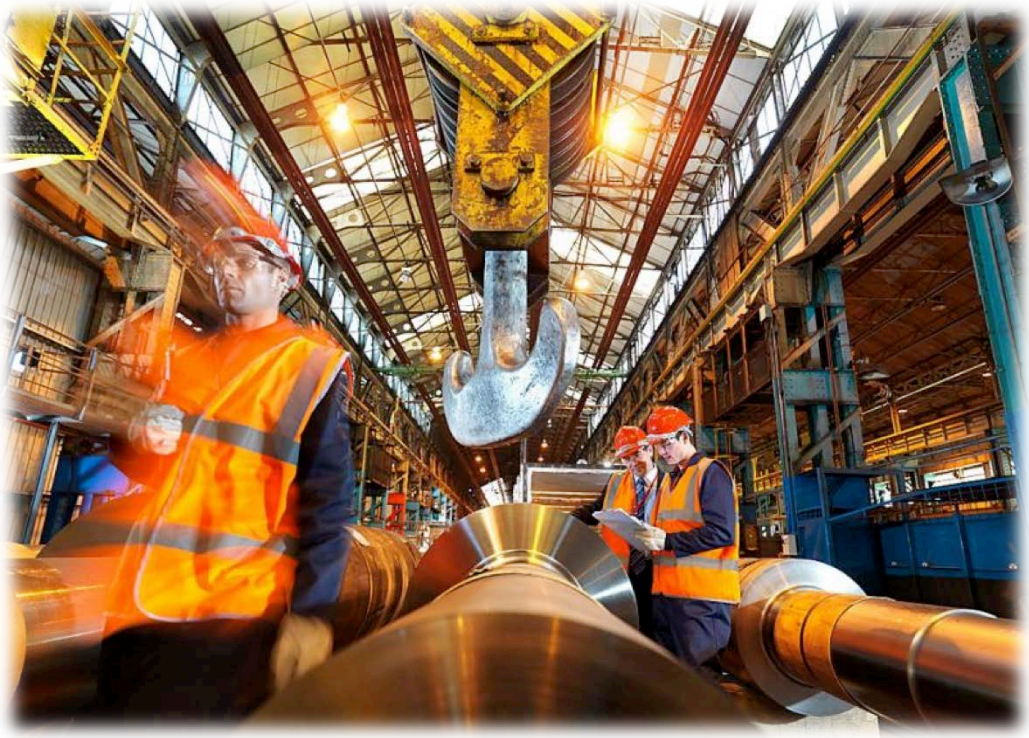
- Assign resources based on actual need
- Priorities are ONLY set by buffer index (project status)

Effects:

- Optimum resource assignment
- Little multitasking
- Faster task completion
- Resources are more productive
- Order and trust in daily business

Completing Projects Is Behavior

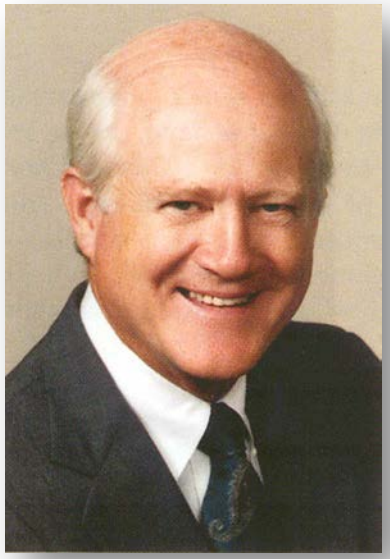
How to create the appropriate behavior
to drive the business in the right direction?

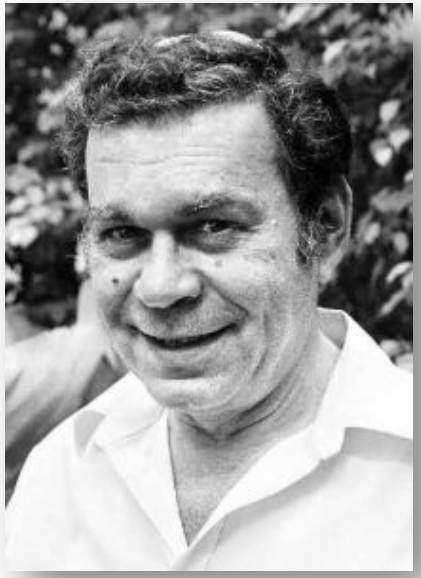


Behavior Is a Function of Consequences

People do what they do
because of what happens to them
when they do it

Aubrey Daniels





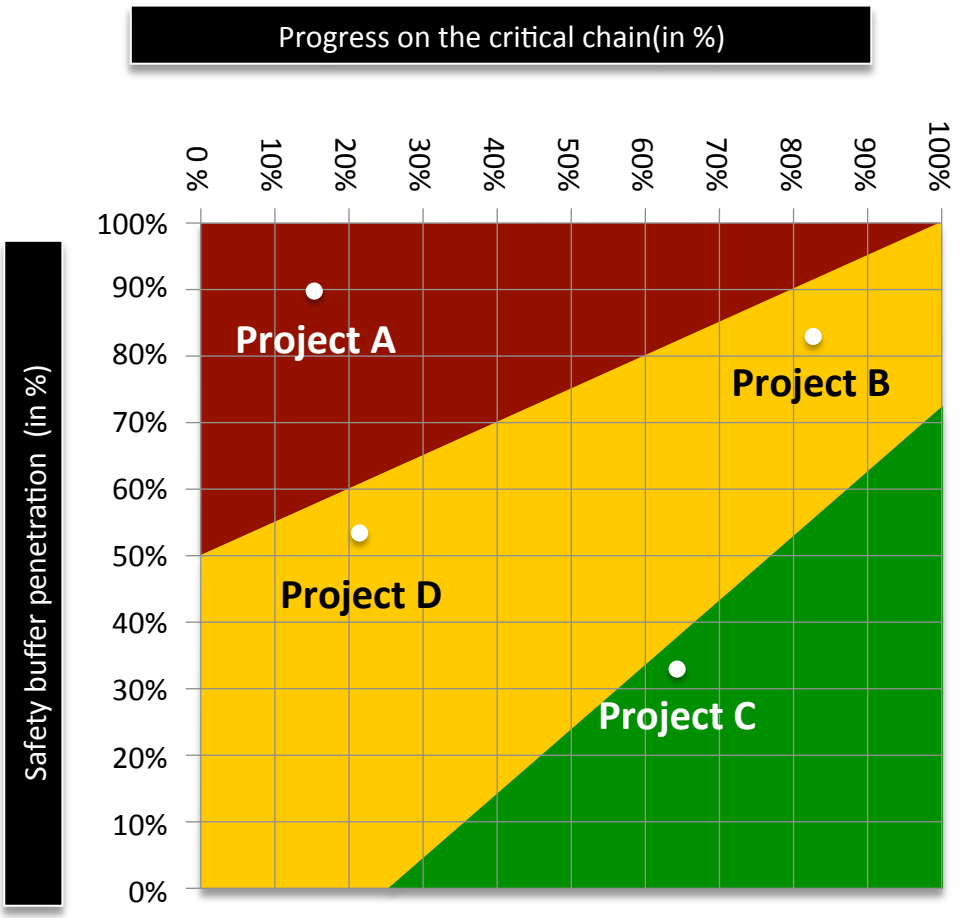
Show me how you measure me,
I'll show you how I'll behave
(If you measure me in an irrational way,
don't complain about irrational behavior.)

Eli Goldratt

What Do We Want our People to Do?

Move the project to completion (as fast as possible)

Tactical Priorities Provide Focus for…



- resources (and their managers),
- project managers and
- upper level management.

- **A red task is red for EVERYONE – and thus clearly has priority over all yellow and green tasks.**

Resource / Task Managers

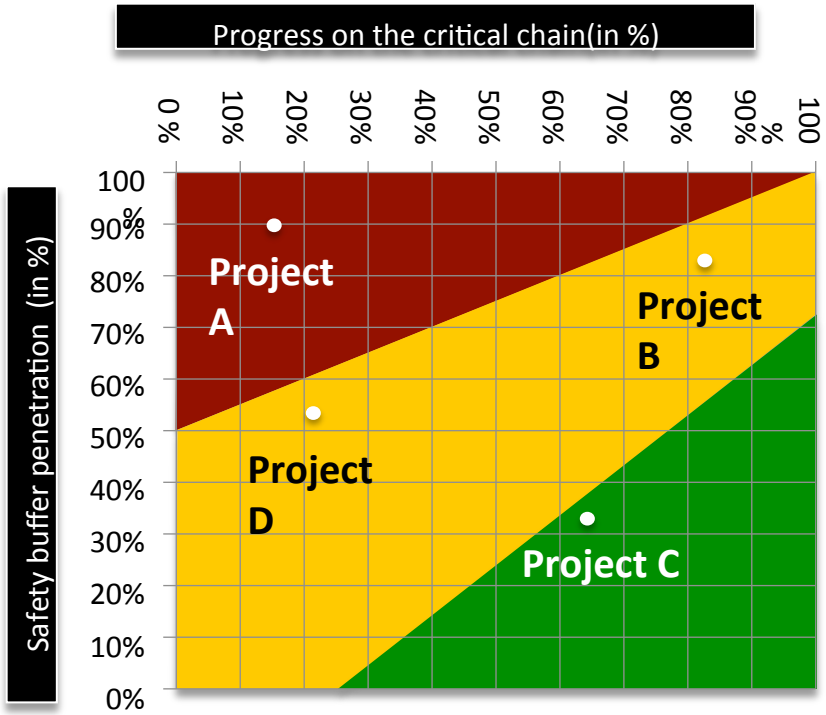
Status	Prio	Project	Task	Days remaining	expected
IP		XS-17	Construct enclosure	12	
		AD1-12	Construct framework	5	
		XP-18	Construct enclosure	3	
		XS-17	Construct PD12 connector	4	
NS		XS-19	Construct enclosure		
		AD7-15	Construct framework		
NTBS		XP-19	Construct enclosure		18/03
		XS-17	Construct P2 connector		19/03
		AD2-13	Construct enclosure		23/03
		XP-18	Construct X18 connector		27/03

- **Manage active tasks**
  - How are things going? Are we waiting for anything? How much longer is it going to take?
  - Report remaining duration!
  - Shield employees from interruptions
- **Prepare new tasks**
  - What do resources need to ensure they can actually work on the task and won't have to interrupt it soon?
- **Start new tasks**
  - In order of priority
  - With optimum resource allocation

Everybody works according to the „relay runner principle"

Project Manager

Status	Prio	Project	Task	Days remaining	expected
IP		CO	Construct enclosure	12	
		CO	Construct framework	5	
		SWE	Design management SW	3	
		SWE	Define interface	4	
NS		…	…		
NT BS					18/03
					19/03
					23/03
					27/03



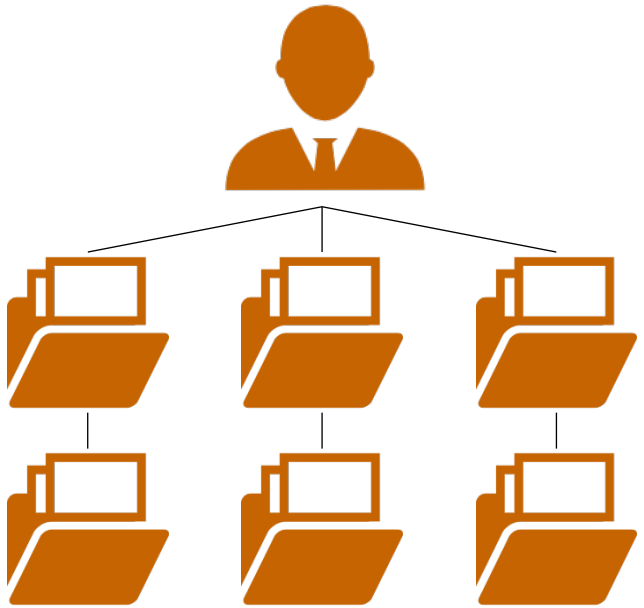
- Ensure communication between organization and client
- Adapt project plan if fundamental changes become necessary.

- Support resources who are stuck and can't solve the problem on their own.
- Do not interfere with their tactical priorities!

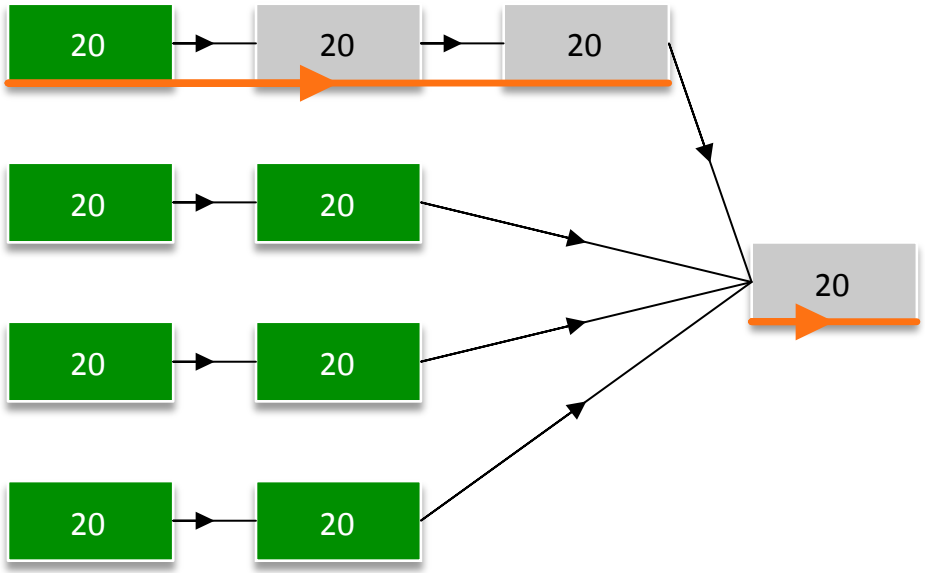
Top Management

- Knowing when not to intervene is as important as knowing when to intervene.
- Problem: In most multi-project organizations, top managers do not have sufficient visibility into current operations.
  - On the one hand, they are swamped with requests (because resources, materials etc. are missing).
  - On the other hand, projects which were progressing nicely are (suddenly) signaled as delayed and shortly after as dramatically late.

- Therefore the objective is: **top managers are fully informed and have complete management control of projects**.

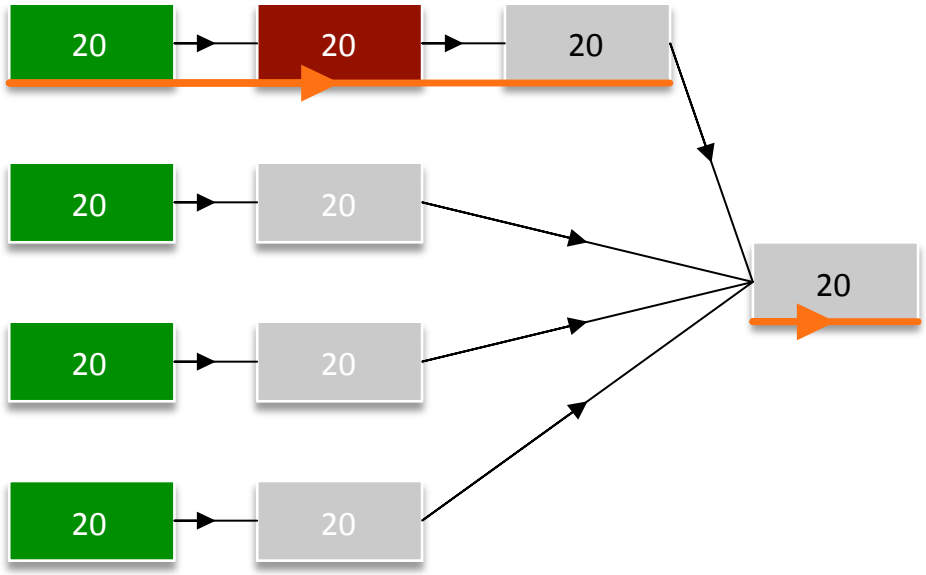


Project Progress



- Using the traditional method, we would report a project progress of 70%.
- Based on Critical Chain we have only completed 25%.
- Which statement is more realistic?

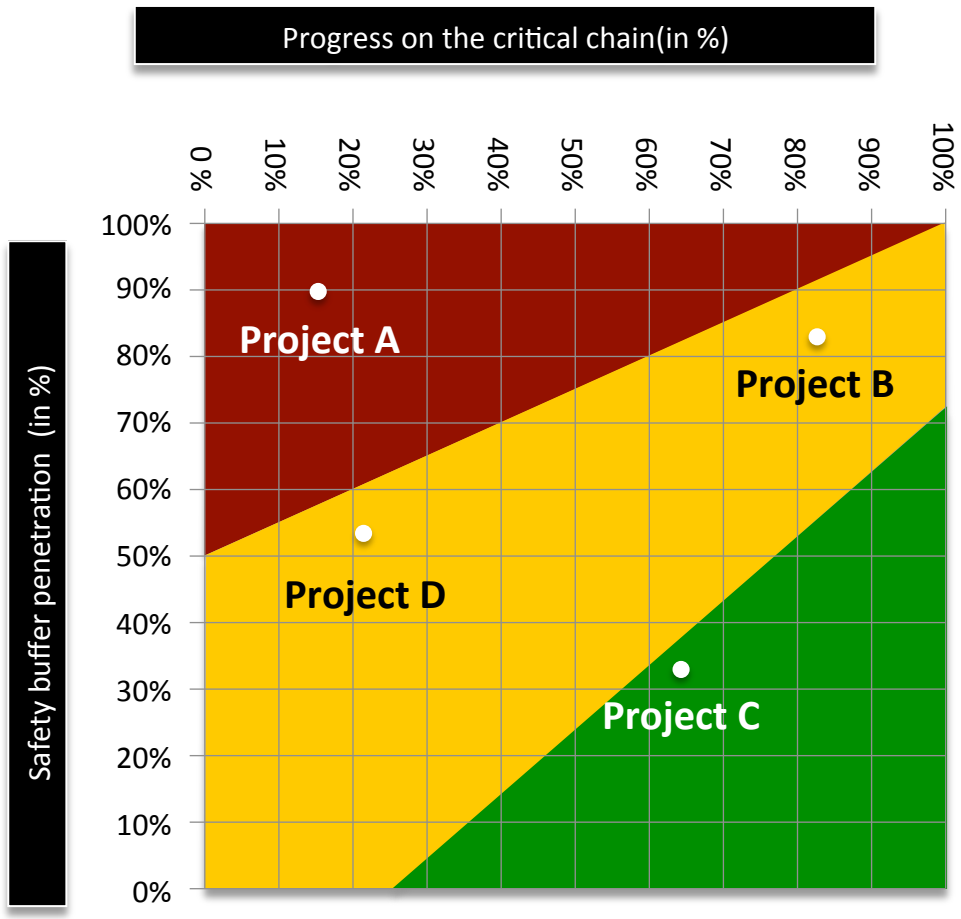
Project Progress



- Green tasks are complete.
- There is a problem with the red task.

- Where will you focus if you
  - measure and report project progress with traditional methods?
  - measure and report project progress based on the Critical Chain?

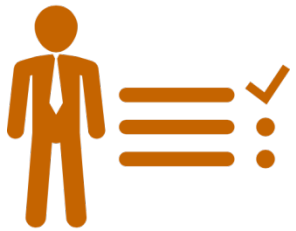
Top Management: Portfolio Status



- The project status (ratio between project progress and buffer penetration) shows how well a project is progressing.
- Which projects should a top manager check in on? Which ones should they rather not?

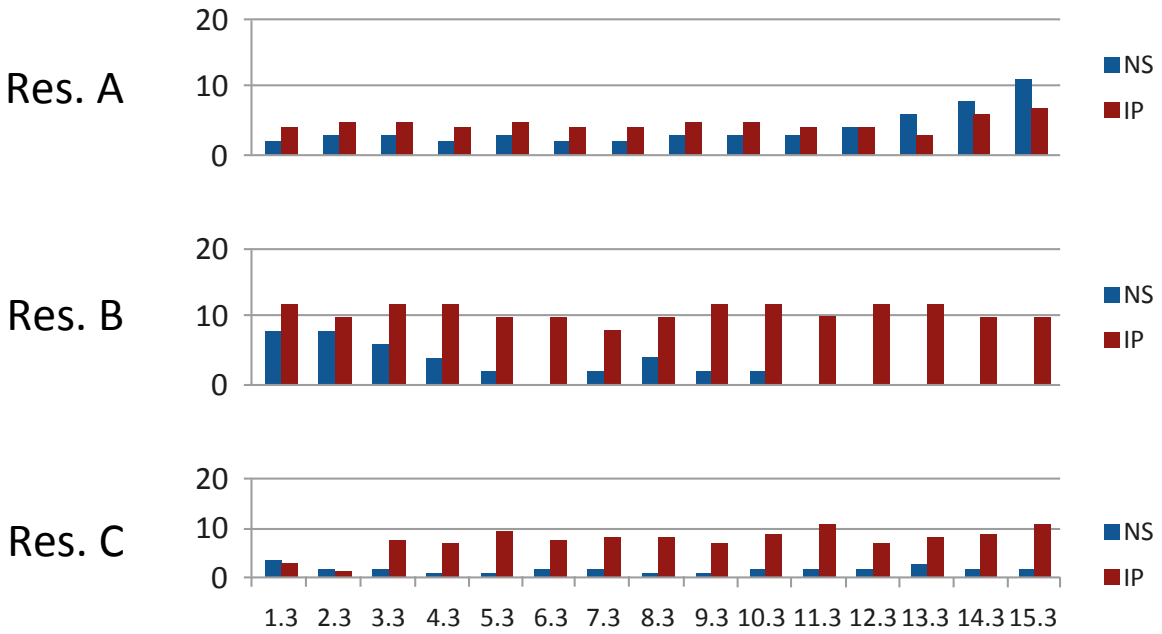
Top Management: Escalated Tasks

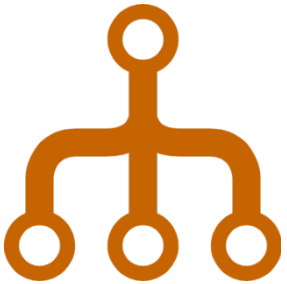
Prio	Proj	Res.	Task
	XS-17	KO	…
	AD1-12	SWE	
	XP-18	EK	
	XS-17	KO	
	…	…	



- Projects which have made less than 3 days progress in the last 7 days are stuck – despite interventions from task and project managers.
- These tasks may benefit from top management intervention.

Top Management: Flow Trend

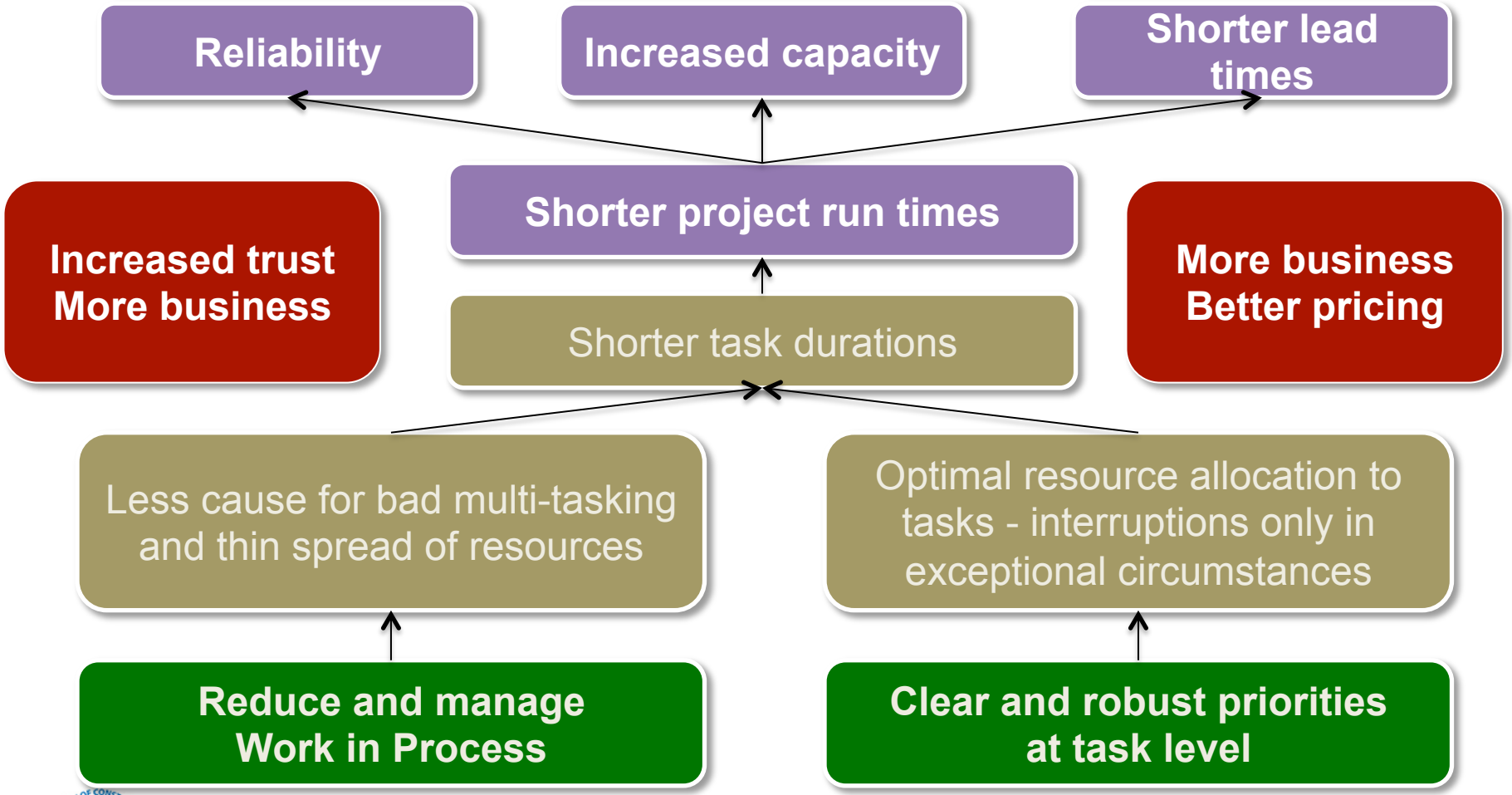




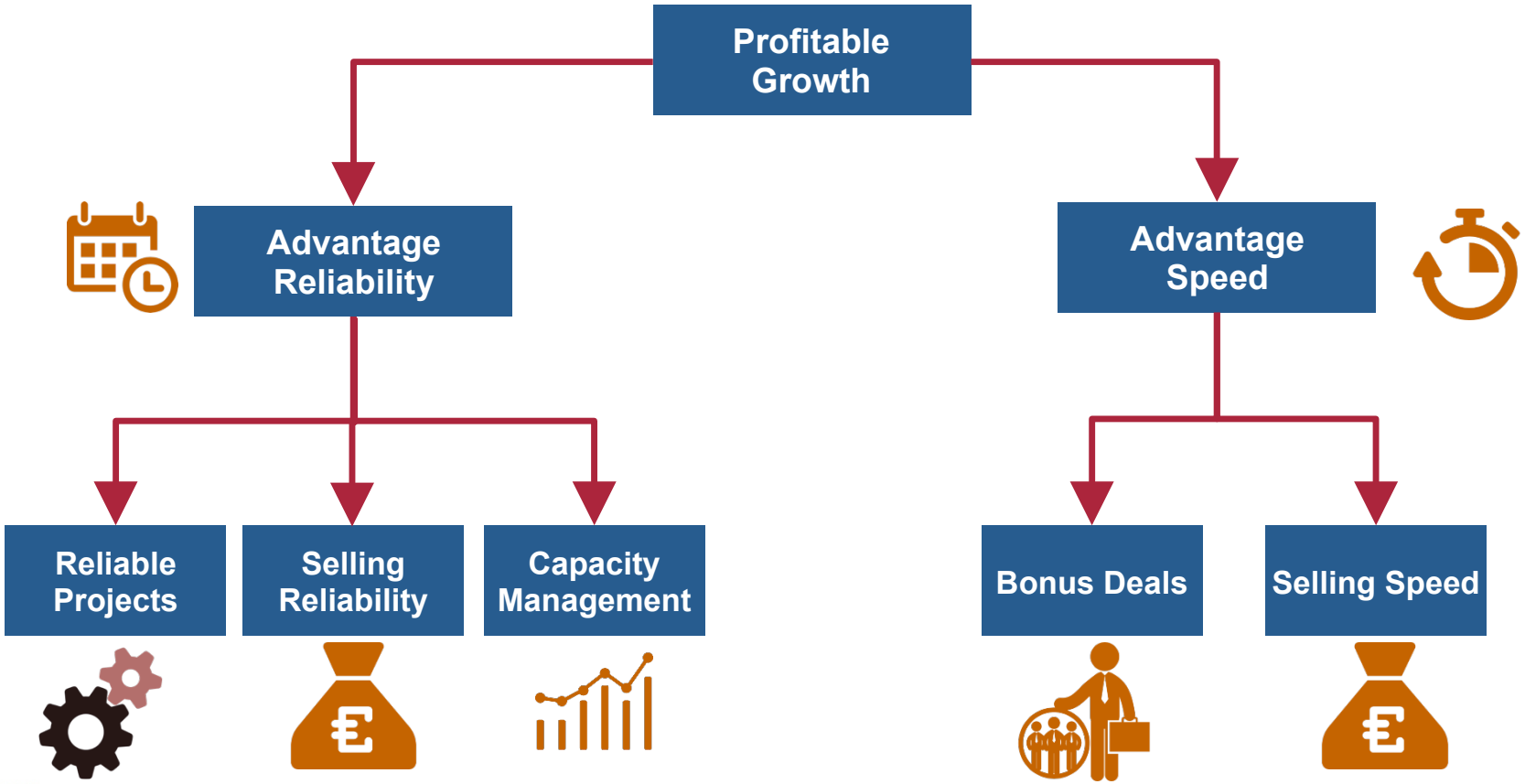
- A significant increased in the number of active tasks (IP) in an area may indicate bad multitasking or thin spread of resources.
- An increase in the number of not started (but ready to be started) tasks leads to congestion in front of this area.

How Can we Implement These Ideas?

Complete More Projects in Less Time



Standard S&T Roadmap – Overview



Reliability – Overview

Reliable Operations

Build

- Reduce bad multitasking and workload (freeze, prioritize, accelerate, defrost)
- Prepare Properly (full kit)
- Introduce Critical Chain planning (plans, buffering, staggering)
- Use software as required (install, interface, train)
- Execute projects (task, project, portfolio management)
- Manage customers and suppliers (mitigate disruptions, visibility)

Selling Reliability

Capitalize

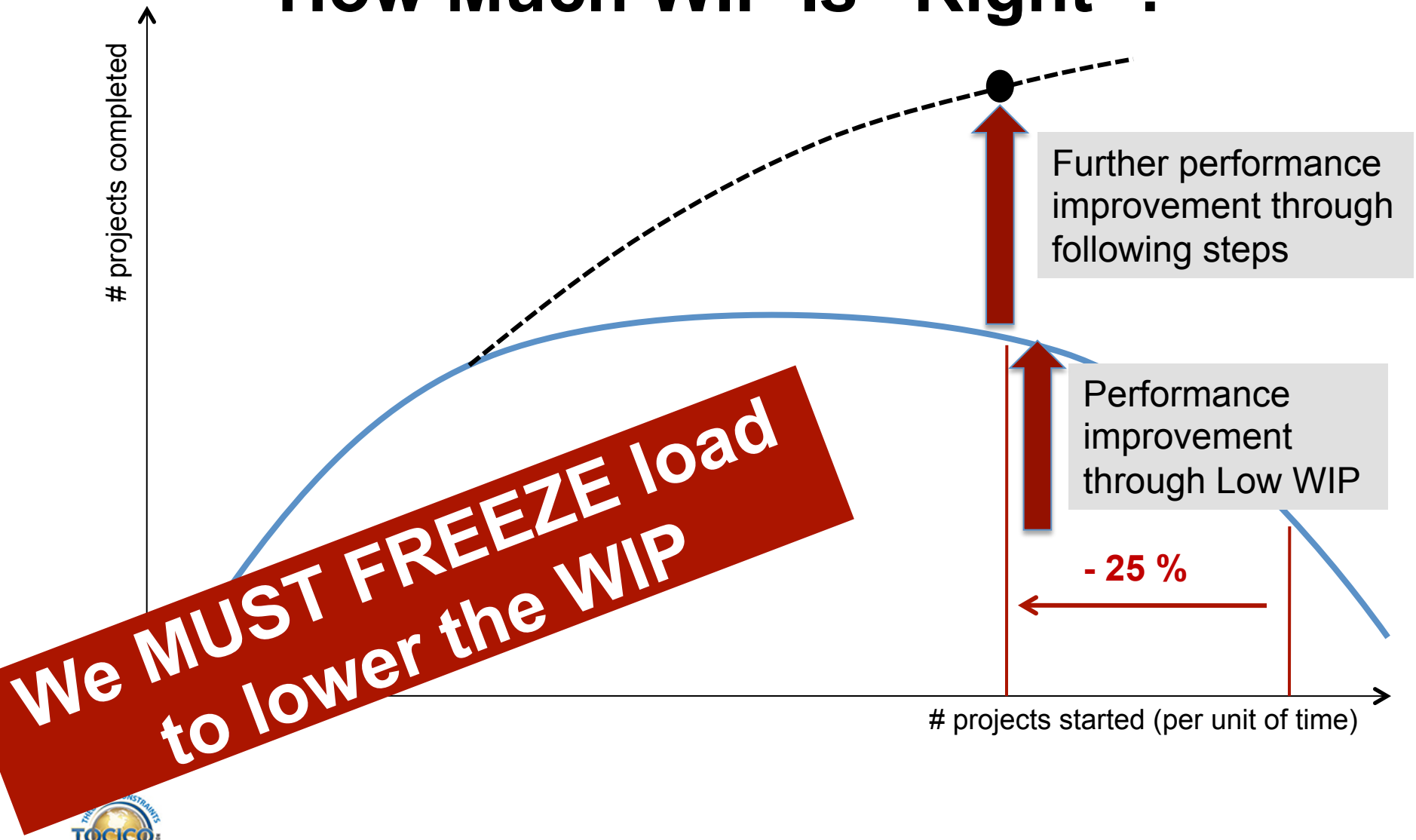
- Decide on target market and design offer
- Sell to current and new markets
- Capitalize on reliable internal projects (new product development and introduction)

Capacity Management

Sustain

- Control load
- Improve continuously (delay reason based)
- Expand capacity ion a controlled way

How Much WIP Is "Right"?



First Step: Reduce WIP by Freezing

All Projects

1. KLM
2. GHJ
3. DEF
4. XYZ

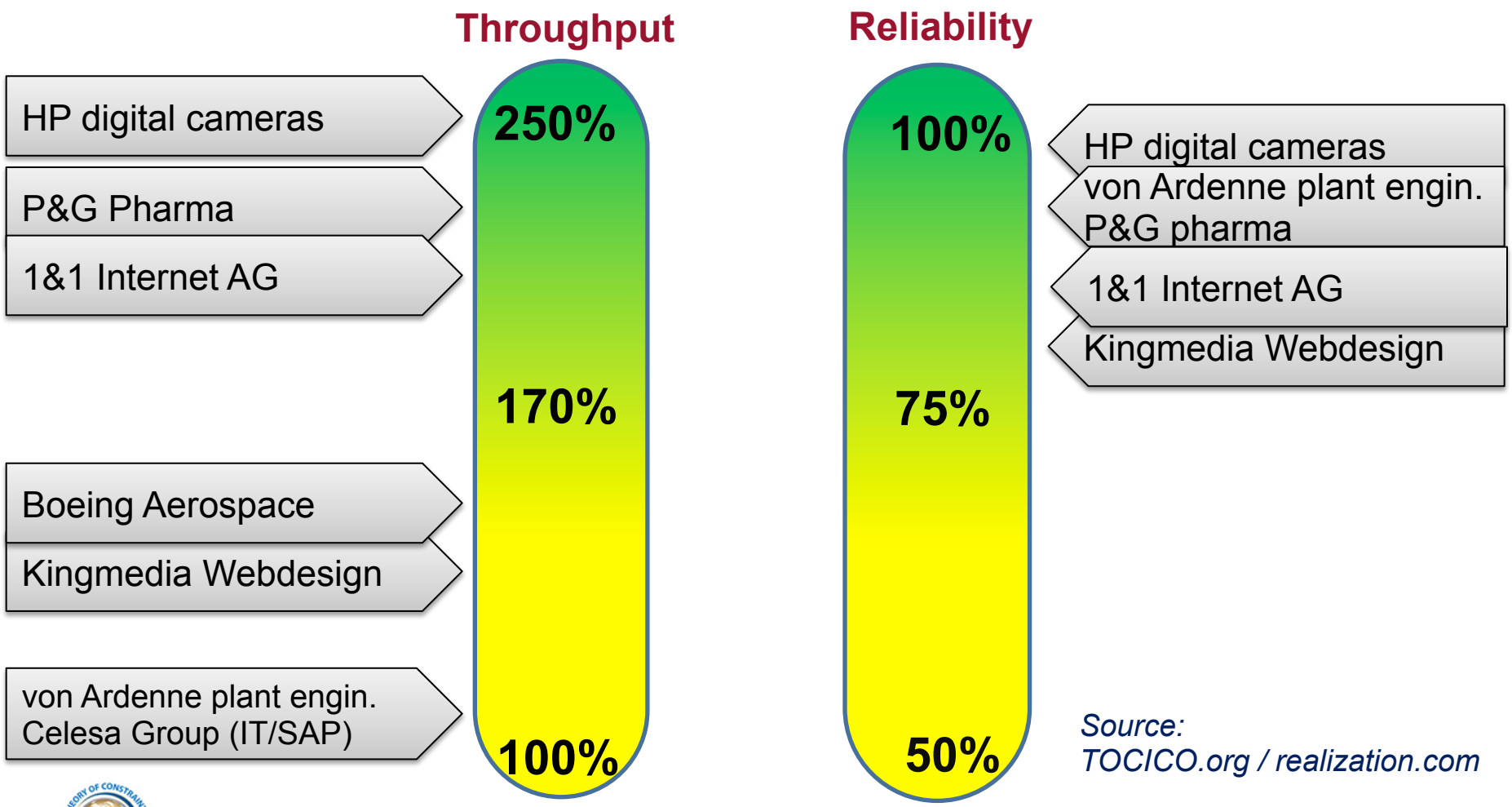
---

5. NOP
6. …
7. …

25% of load with lowest priority

Reallocate resources → Faster completion → Unfreeze → New projects

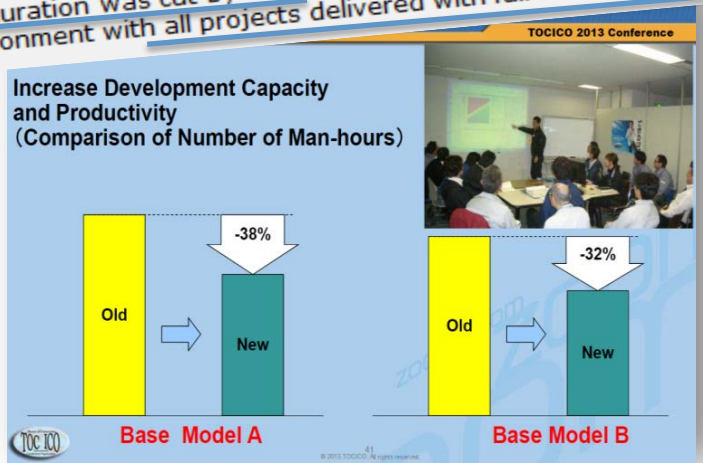
Critical Chain – Typical Results



Source:
TOCICO.org / realization.com

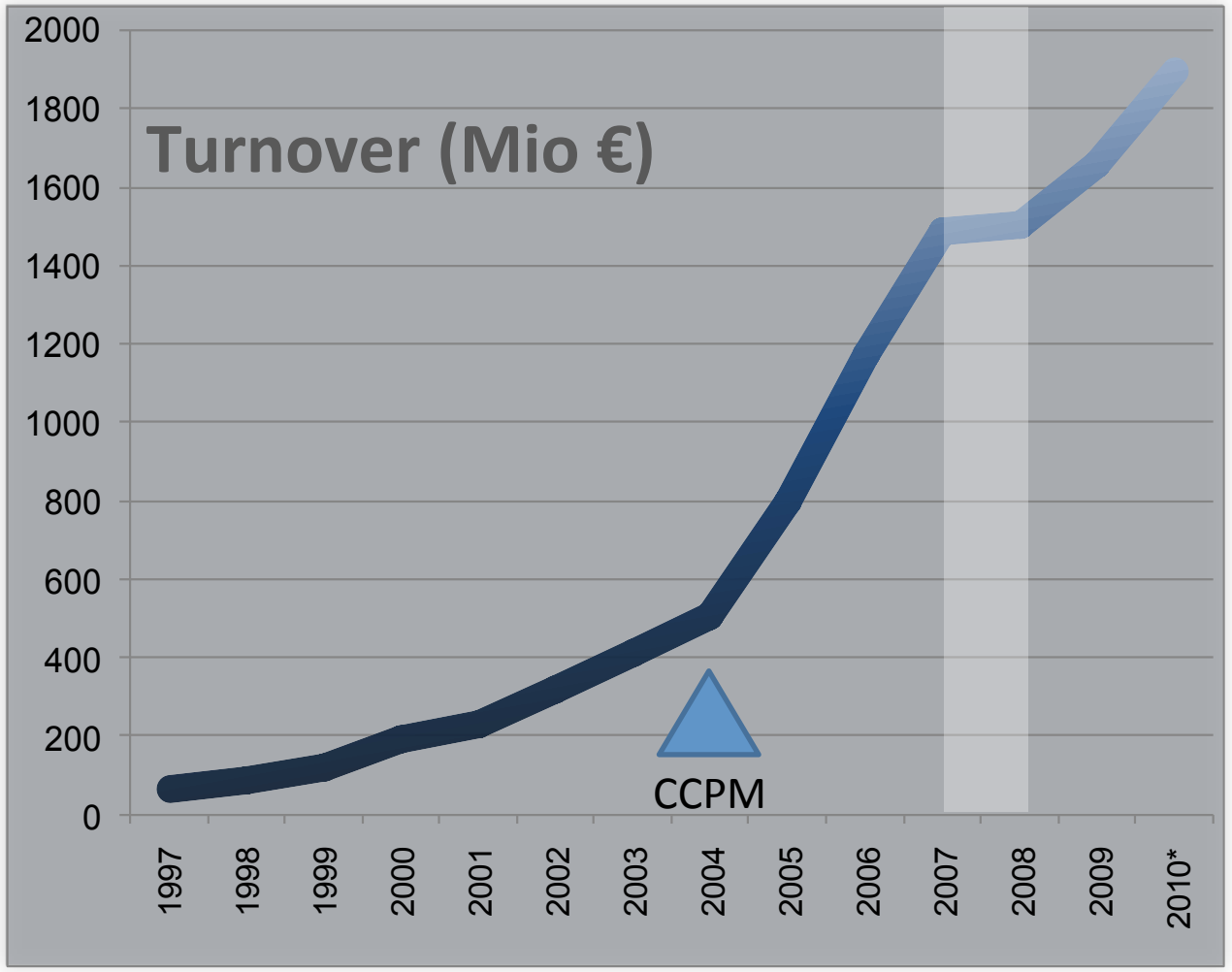
R&D Example: Mazda CCPM Results

Bad Nauheim, Germany, June 03, 2013 --(PR.com)-- At the 11th annual conference for theory of constraints professionals, Mr. Mitsuo Hitomi described the crisis faced by Mazda to offer creative and innovative exhilarating driving to those people who still hold dear the love of motion experienced as a child while surviving four straight years of significant financial losses. Mr. Hitomi described the last chance for Mazda to survive by developing technology that would achieve low fuel consumption from an internal combustion engine that would rival a hybrid engine, no compromise in the driving pleasure, and affordable for all customers. The product development cycle had to be cut in half for Mazda to survive. Starting with Critical Chain Project management education in 2007, the momentum grew within the company for holistic project management development project duration was cut by half. Mr. Hitomi then described how this new technology was applied in a multi-project environment with all projects delivered with full scope on time.



- Between 32% and 38% less effort per project
- 50% shorter development duration
- Turn-around in Mazda's bottom line results achieved in 2013

Case 1&1



*erwartet

Projects:
Development and introduction of internet service products

Interventions:

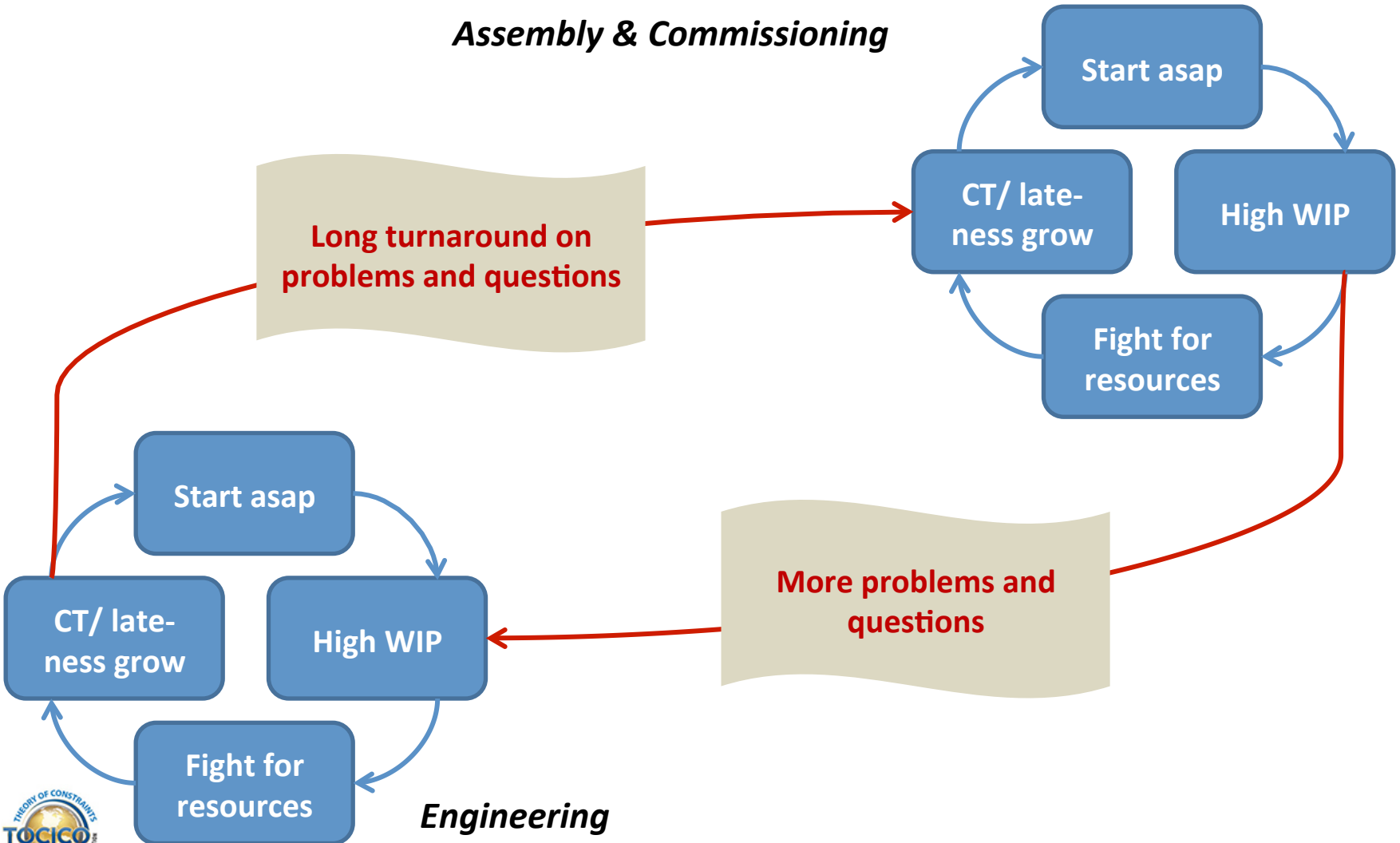
- Freeze
- Full Kit
- Staggering
- Priority
- Software

Case : Von Ardenne Anlagentechnik

- A leading manufacturer of equipment for industrial vacuum processes of plasma and electron beam technologies
- Key competences:
  - thin-film technologies for photovoltaics and architectural glass
  - electron beam technology
  - research and development

- Challenges:
  - Delays
  - Unhappy customers
  - Significant market growth
  - Shortage of engineers

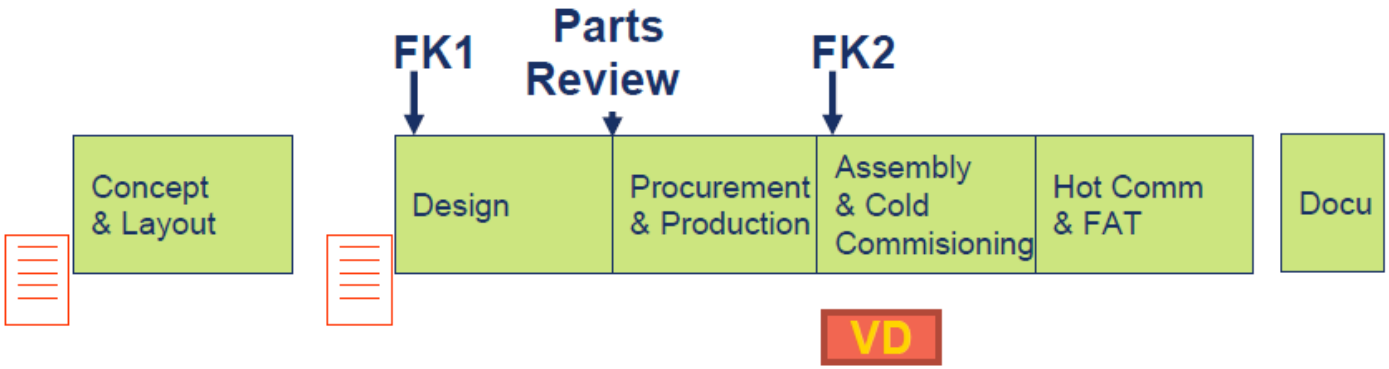
And a Double Vicious Cycle



Results

	Before 2007 (Nov)	After 2008 (Apr)	Change (within 6 months)
Business			
Revenue	130 Mio€	170 Mio€	+ 30 %
TVC 65%	84 Mio€	110 Mio€	
Costs	33 Mio€	38 Mio€	+15 %
Operational			
CT (months)	15 + 2 = 17	13 + 1 = 14	- 18 %
OT performance	80%	90%	
Average lateness	8 – 9 weeks	2 – 4 weeks	- 33 %

What Did They Change?



Pipelning	1. Allow only 3 „Field Assemblies“ at a time, freeze all other projects 2. Restart a frozen project only if another project has finished assembly 3. Implement 2 Full-Kit-Points
Buffering	1. Build templates – tasks are „real work“ 2. Create project plan for every project 3. Shift safety from every task to project and feeding buffers 4. Don’t use dates and deadlines to manage tasks
Exc.	1. Task management (remaining duration and controlled start) 2. Execution review

Case: Telecom Operator

- Infrastructure projects: new antennas and upgrades
- Challenges: Heavy delays, missed service, low coverage, low cash, no synchronization with product offerings

- Solution:
  - Prioritize projects (minimum service, products, customer density, complexity)
  - Freeze 30% of load
  - Full kit: License, land, grid connections
  - Replenishment solution on hardware
  - CCPM planning and execution

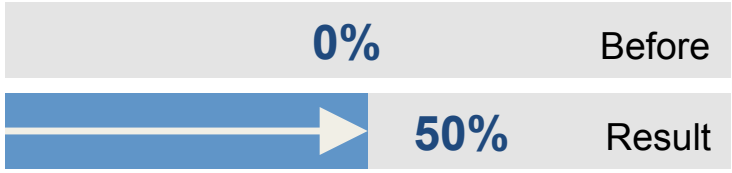
- Results:
  - New antennas: -60% duration, upgrades: -95% duration

Case Study ACC

Introducing CCPM has increased the rate of completion by 164% (expected: 82%) and on-time-delivery from 0% to 50% (within 6 months of go live)

Result: +164%

Throughput
(completed projects p.a.)



Significant Improvement

Share of projects in time
(Actual vs. planned due date)

Scientifically Proven Approach

- In the survey of over 100 cases, no failures or disappointing results were reported.
- Some substantial improvements in operational variables as well as financial variables were reported. On average, inventories were reduced by 50%, production times (measured by lead-times, cycle times or due date performance) improved by over 60%, and financial measures improved by over 80%. In addition, inventory reductions were accompanied by lead-time reductions - a feat not matched by JIT[3].
- The vast majority of cases reported only partial applications of TOC. We are left to wonder whether improvements would have been even greater had more of the methodology been applied.
- The entire survey revealed over 300 articles and books on TOC, of which only a handful contained negative comments, and none of these related to actual applications of the methodology.
- While there were several papers reporting computer s… comparing TOC with

A Review of Goldratt's Theory of Constraints (TOC) – lessons from the international literature

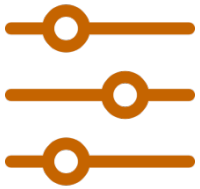
Steven J. Balderstone and Victoria J. Mabin
School of Business and Public Management
Victoria University of Wellington
New Zealand
Steven.Balderstone@vuw.ac.nz, Vicky.Mabin@vuw.ac.nz

Three Rules for Project Execution Management

1

Actively manage WIP

(Stagger projects) instead of starting every project as quickly as possible



2

Explicitly plan buffers

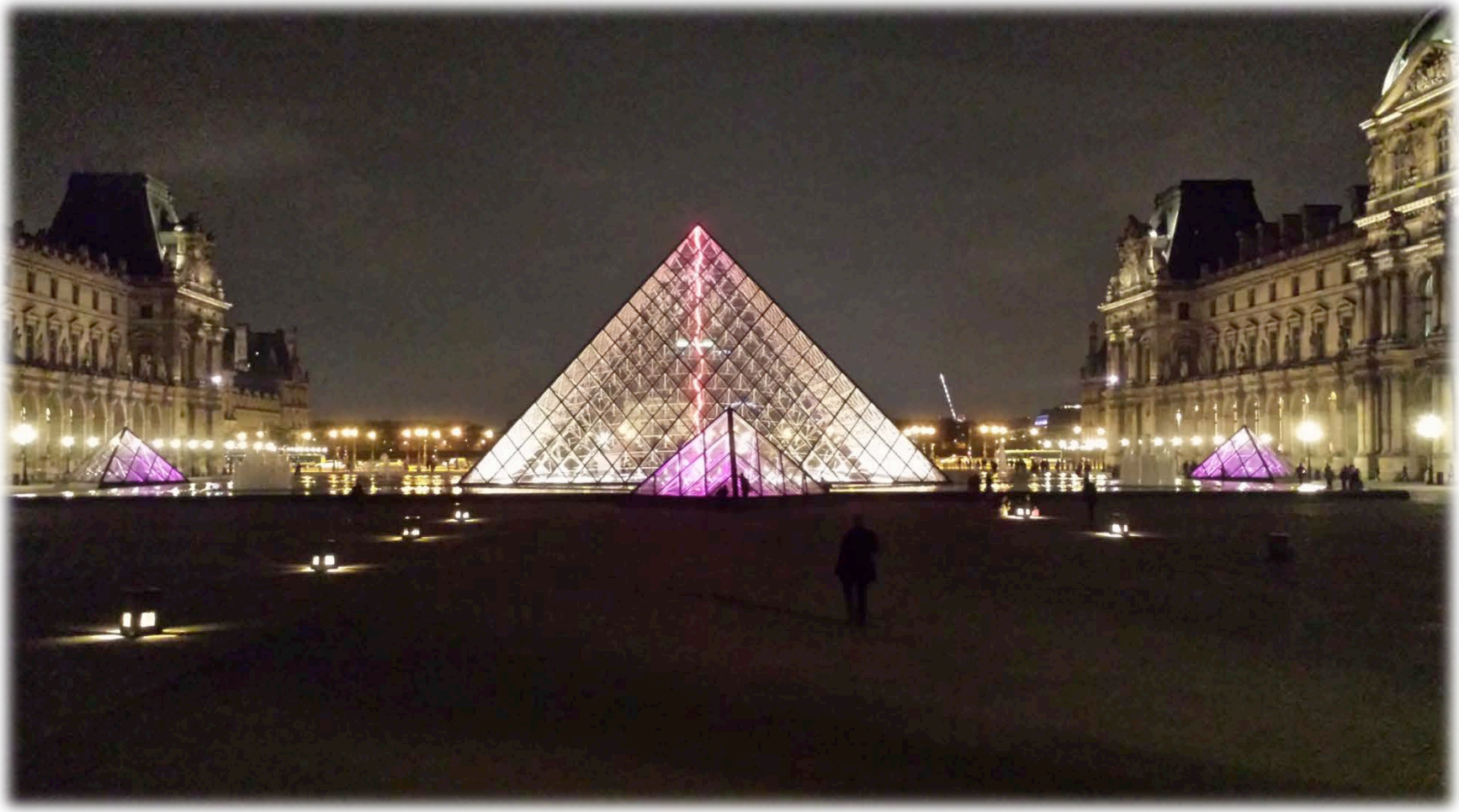
instead of concealing them in the individual processes and wasting them

3

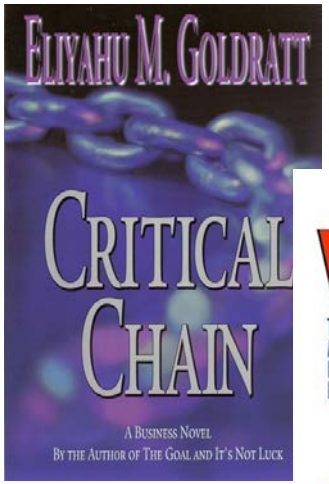
Operational management using robust tactical priorities

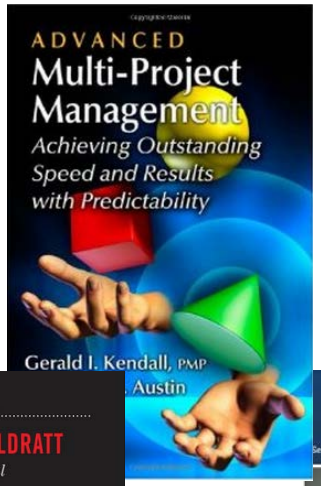
(Project progress/buffer penetration) instead of according to highest pressure

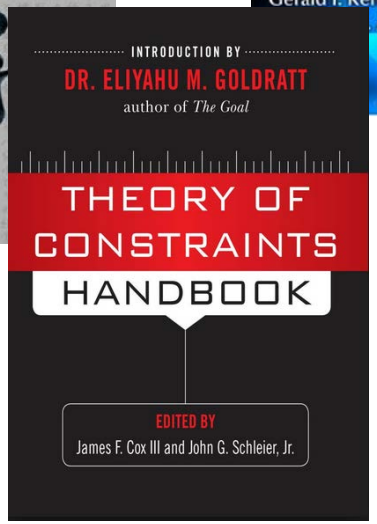
Questions & Answers



Some Additional References







Thank You

About Christoph Lenhartz

Christoph Lenhartz (MBA, Jonah, TOCICO-certified, Certified Consultant (bdvb), CDDP, CDDL, Master Instructor DDI) is Founding Partner of Catena Strategies, a leading expert in project, operations, and supply chain consulting.

In over 20 years he has acquired a wide-ranging, international experience in industry, as a successful entrepreneur and also a leader of management consulting teams in high complexity implementations. He has lead strategic, business transformation, supply chain management and IT projects and his expertise also includes post-merger integration of supply chain operations for major international groups.

As one of the leading TOC and management experts in Europe he serves on the Board of the Theory of Constraints International Certification Organization (TOCICO), where he was Chairman of the Board from 2012-2013.

He has published articles on management topics and is an appreciated speaker, educator, coach and a recognized expert in developing and implementing highly effective operations management and execution methodologies based on TOC principles and related approaches.

Christoph holds an MBA from Clemson University (USA), he graduated from the University Essen (Germany) as a Diplom-Kaufmann and has pursued post-graduate studies in Engineering Management at Washington State University (USA).

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