Improving Fighter Jet Maintenance with Critical Chain :

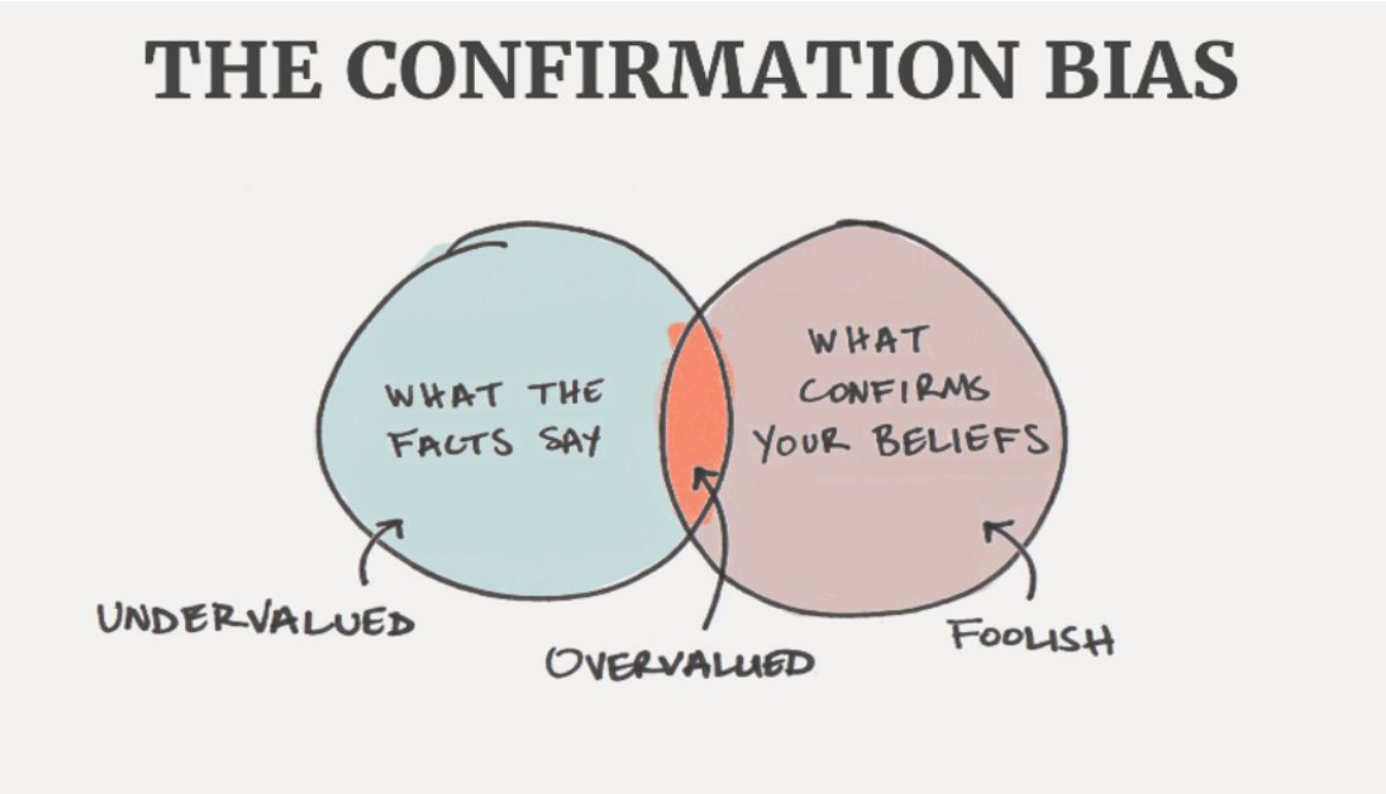
The LIF/BAE Journey

Presented by:

Simon White – BAE Systems Australia

CRITICAL CHAIN 2020

NOVEMBER 23 - 24, 2020


THE CONFIRMATION BIAS
WHAT THE FACTS SAY
WHAT CONFIRMS YOUR BELIEFS
UNDERVALUED
OVERVALUED
FOOLISH

79 SQN

Pearce

76 SQN

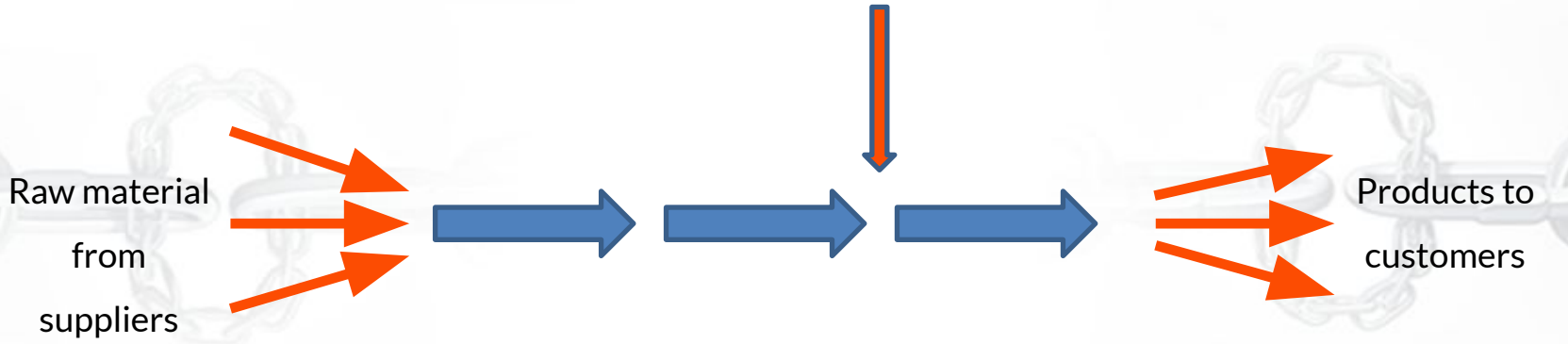
Williamtown

6 months

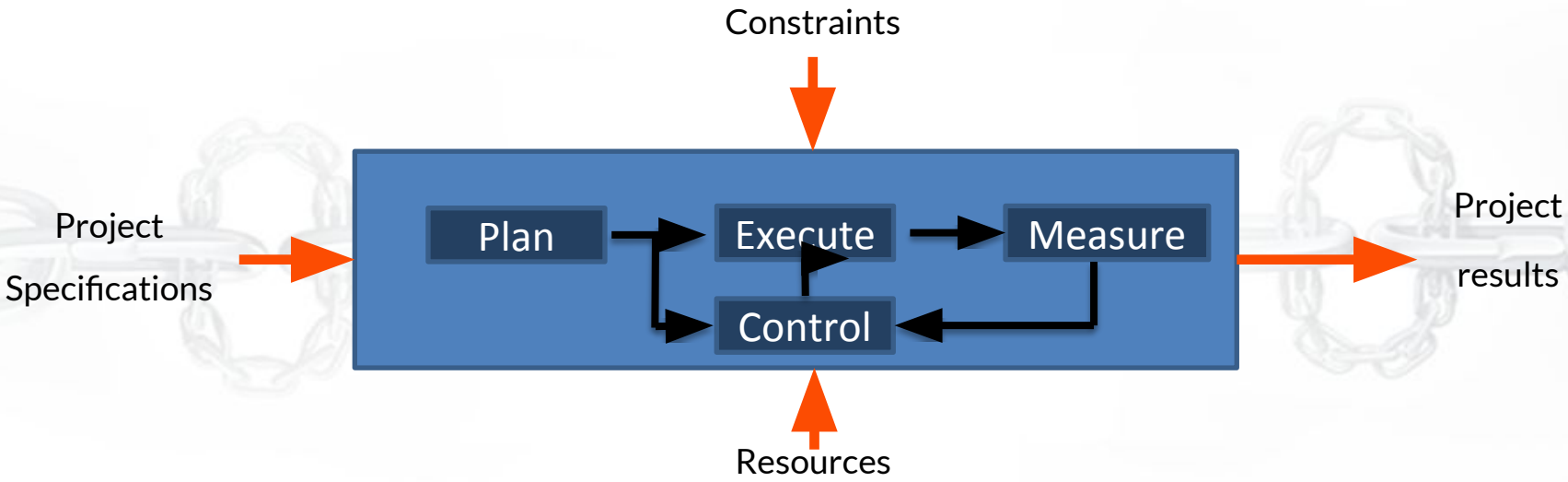
18 months

2 years +

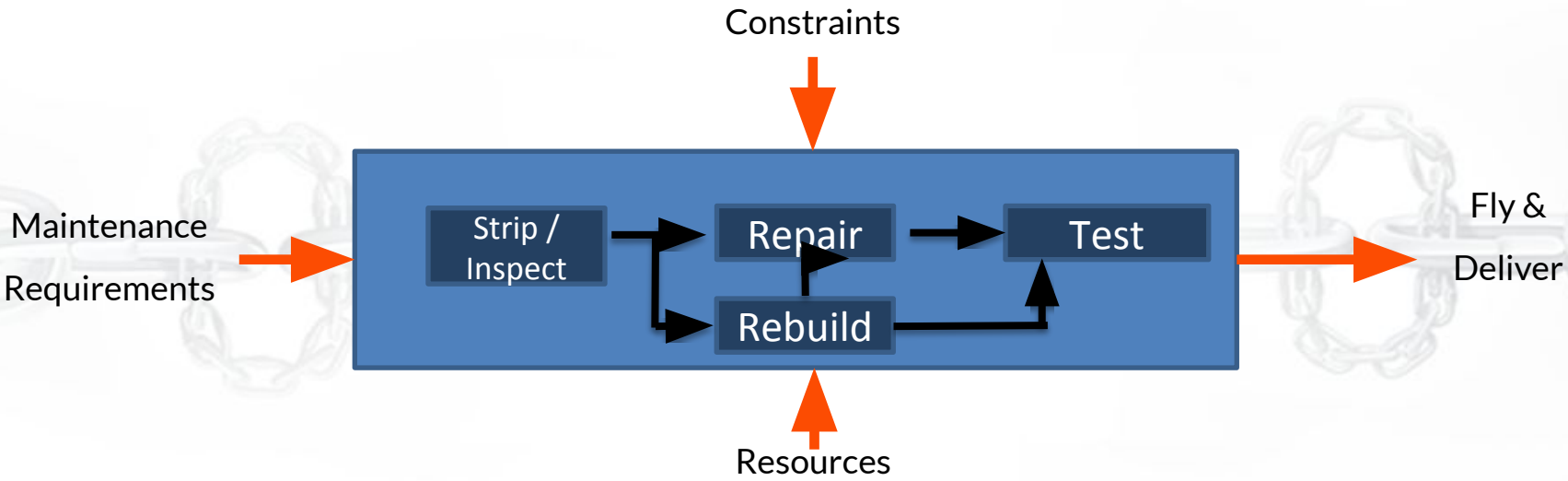
System **Throughput** limited by a constraint



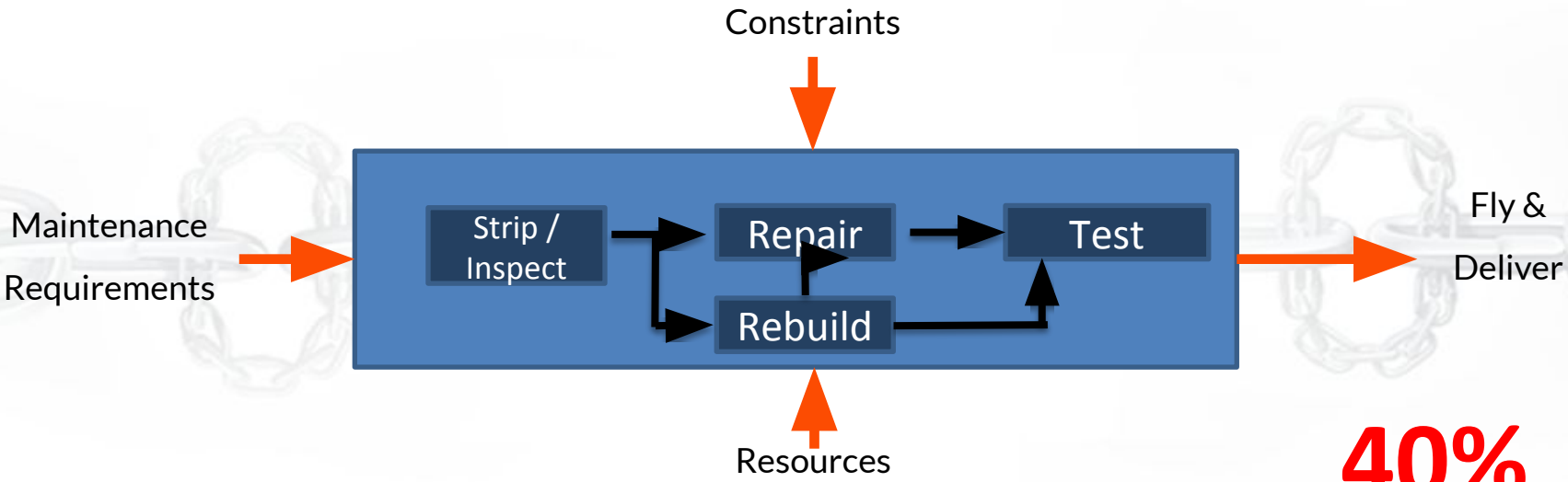
Typical Production relationships


Constraints
Project
Specifications
Plan
Execute
Measure
Control
Project
results
Resources

The Maintenance Environment



The Maintenance Environment



40%

on time

The Maintenance Environment

Maintenance is Complex

1. Known work – R-servs – must be performed, can still suffer from variation
2. Anticipated work – performed on *some*, but you can't predict *which*
3. Unanticipated – completely unpredictable

The Maintenance Environment

Resources are finite

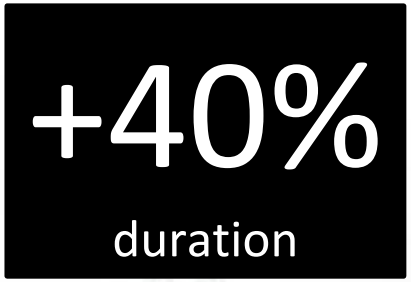
1. Manpower, Facilities, Parts, Tools

2. This creates competition and cascading impacts, seriously affecting execution of *all* schedules

The Maintenance Environment

Synchronisation and Integration

1. For all elements to be ready, departments have to work together
2. In an uncertain environment, with constantly changing priorities, it can be difficult to agree on priorities.
3. Every integration point means multiple activities or tasks must be complete before commencing the next, or you suffer from outstanding work, re-work, or even genuine safety issues.



40% on time ?

Extending this BREAKS the Fleet Capability …

Making it real – what you want

M	T	W	Th	F			M	T	W	Th	F
Bus to work	Bus to work	Bus to work	Bus to work	Bus to work			Bus to work	Bus to work	Bus to work	Bus to work	Bus to work
M	T	W	Th	F			M	T	W	Th	F
Bus home	Bus home	Bus home	Bus home	Bus home			Bus home	Bus home	Bus home	Bus home	Bus home

Making it real – what you get

M				F			M				F
Bus to work				Bus to work			Bus to work				Bus to work
M			Th				M			Th	
Bus home			Bus home				Bus home			Bus home	

Google

Interfaces
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THE FRANZ EDELMAN AWARD
Achievement in Operations Research

Warner Robins Air Logistics Center Streamlines Aircraft Repair and Overhaul

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At Warner Robins Air Logistics Center, long lead times for repairing and overhauling aircraft were a serious issue because some models were in short supply. In 2005, the center implemented Critical Chain, an operations research method for project management, to reduce lead time for repairing its C-5 transport aircraft. The implementation took eight months, without using any additional resources. The center returned five additional C-5 aircraft to the US Air Force's operational inventory and generated additional revenue to the Transportation Working Capital Fund estimated at $49.8 million annually. The replacement value for these aircraft is estimated at $2.37 billion. The center is implementing the method for the C-130 and the C-17 cargo aircraft to free up 11 dock spaces. With the additional dock space, the depot can accommodate additional work worth $65 million in 2006. The center expects the additional workload to total $248 million by 2009 (the current C-5 annual operating budget is $295 million). Nonquantifiable benefits include increased responsiveness and casualty avoidance during wartime.

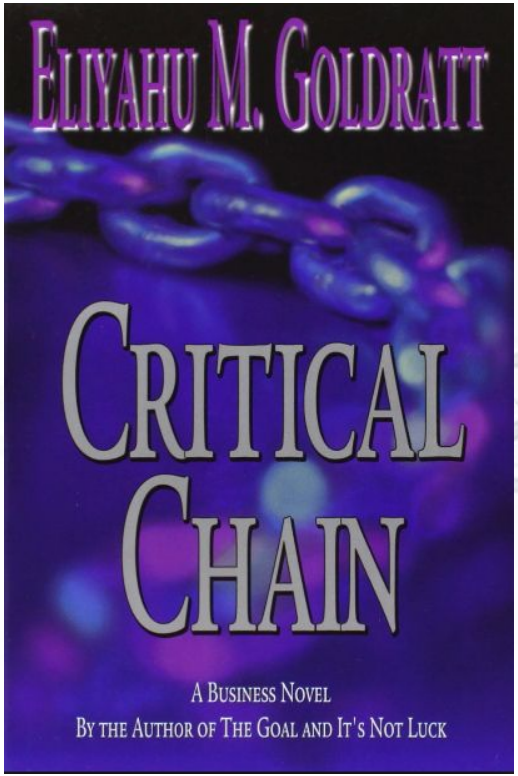
Key words: facilities–equipment planning; maintenance, replacement; project management.

Annual spending on maintenance, repair, and overhaul (MRO) for aircraft is now about $96 billion worldwide, exceeding the $75 billion estimated to be spent on producing new aircraft annually (Stewart 2005). Spending in the military aircraft MRO market alone is estimated to be about $50 billion, with the US accounting for about 40 percent of that amount. To manage the MRO activity effectively, Warner Robins Air Logistics Center (WR-ALC) applies operations research tools for project management and scheduling.

WR-ALC provides MRO services for various weapon systems for its customer, the US Air Force. These systems include transport aircraft, fighter jets, and ground systems that provide maintenance support to these aircraft. WR-ALC provides MRO services to four types of aircraft: the C-5 Galaxy, the C-17 Globemaster, the C-130 Hercules transport aircraft, and the F-15 Eagle fighter jet.

The MRO activity consists of (1) program depot maintenance (PDM), a heavy repair and overhaul of aircraft with long lead times, and (2) unscheduled depot level maintenance (UDLM), a short-cycle maintenance that takes from one to 30 days or more. The US Air Force sends approximately equal numbers of C-5 aircraft to WR-ALC for PDM and UDLM each year. We focus on the C-5 aircraft that require PDM.

The C-5 line has 24 frontline supervisors and about 460 mechanics, organized into skill groups, for



Implementation

- DIY (Self-help)
- Rent an SME
- Total and complete business solution
- All have a Cost of sorts …

Cost of Labour

Labour + Direct

Expensive but effective

Implementation

Our Goal - 95%

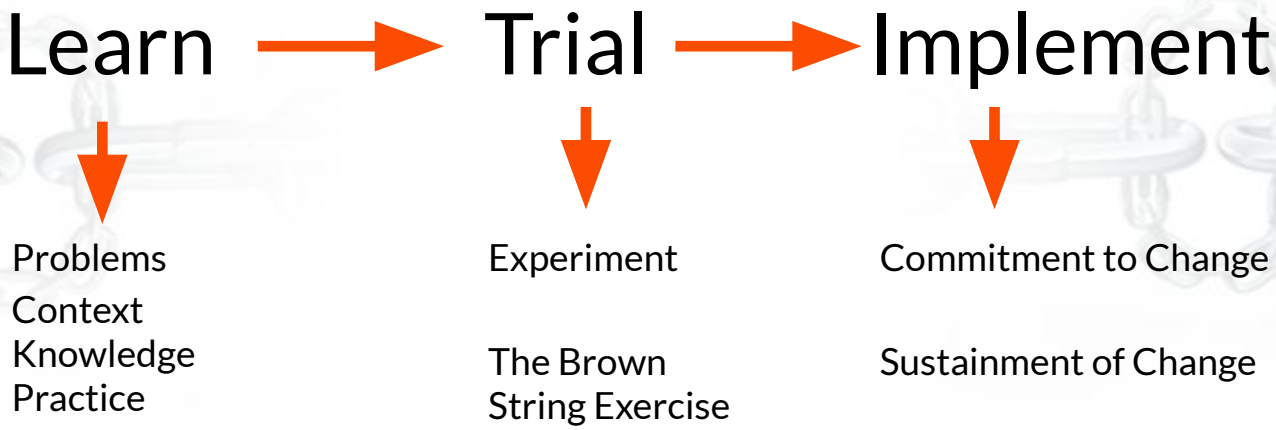


Image: Marris Consulting

DIY

Open Plan Professional (OPP)

MS Excel

Software	Lynx *TameFlow*	BeingManagement 3	Exepron	CC (M) Pulse	ProChain Scheduling Pipeline Enterprise	Concerto	CCPM +	Aurora-CCPM
Logo	LYNX A-dato	BeingManagement 3	EXEPRON	Pulse	ProChain SOLUTIONS INC.	Concerto REALIZATION	CCPM+	Aurora-CCPM Stottler Henke
Editor	A-dato	Being CO., Ltd.	Exepron	-	ProChain Solutions	Realization	Robbin Gioia	Stottler Henke
Release date	Continuous Deployment of Updates	2007	2010	-	Version 1 in 1997 Current V12	V1.0 in 1997	RB founded in 1980	Founded in 1988 CCPM since 2005
Criteria								
Software architecture	Web-based/ Smart Client / Inhouse / Cloud	Cloud / On-premises	Cloud & Private Cloud Exepron Mobile available	Single Machine	Single Machine / Customer Servor or Cloud	Web-based Option for MSP add-on, Supports SaaS & private/on-premise installations	Single Machine	Cloud, or Standalone, or In-house cloud/server
Langages	*		Available in 14 languages					
Customer service	✓	✓	✓	✗	✓	✓	N/A	✓

Murphy's Law

Parkinson's Law

Late Student Syndrome

Behaviour

Ford

Ohno

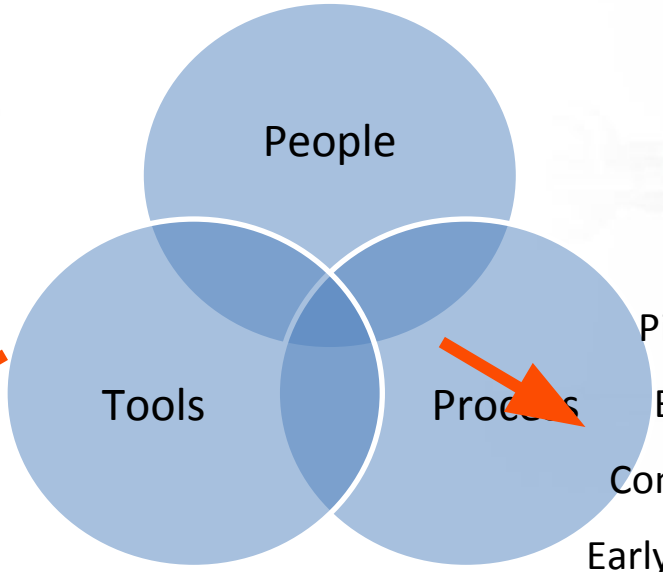
Goldratt

TOCICO

Knowledge

Experience

Software



Pipeline

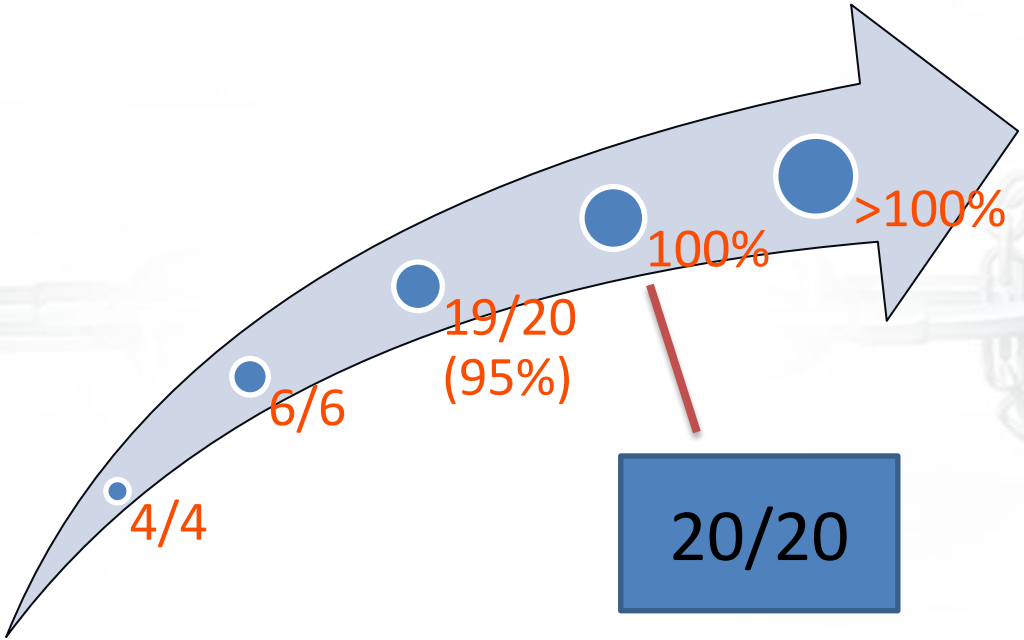
Buffer

Constraints

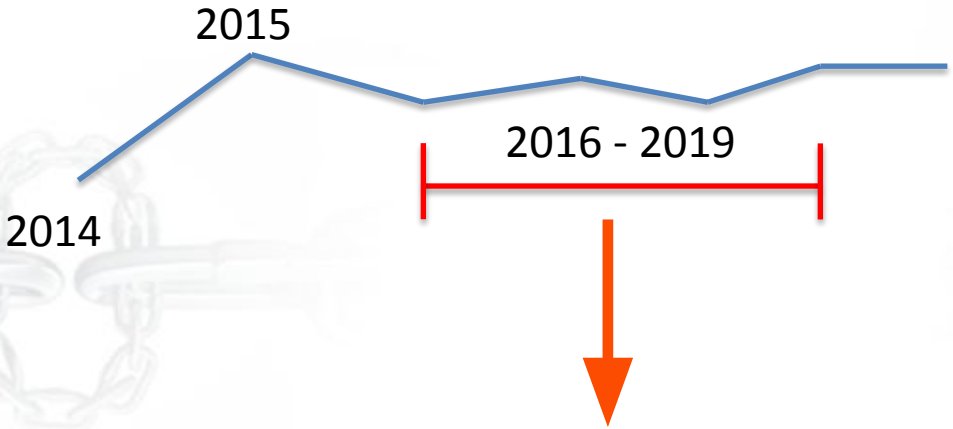
Early Warning

CCPM

2015 Deep Maintenance TAT – On or ahead of schedule



And then … ?



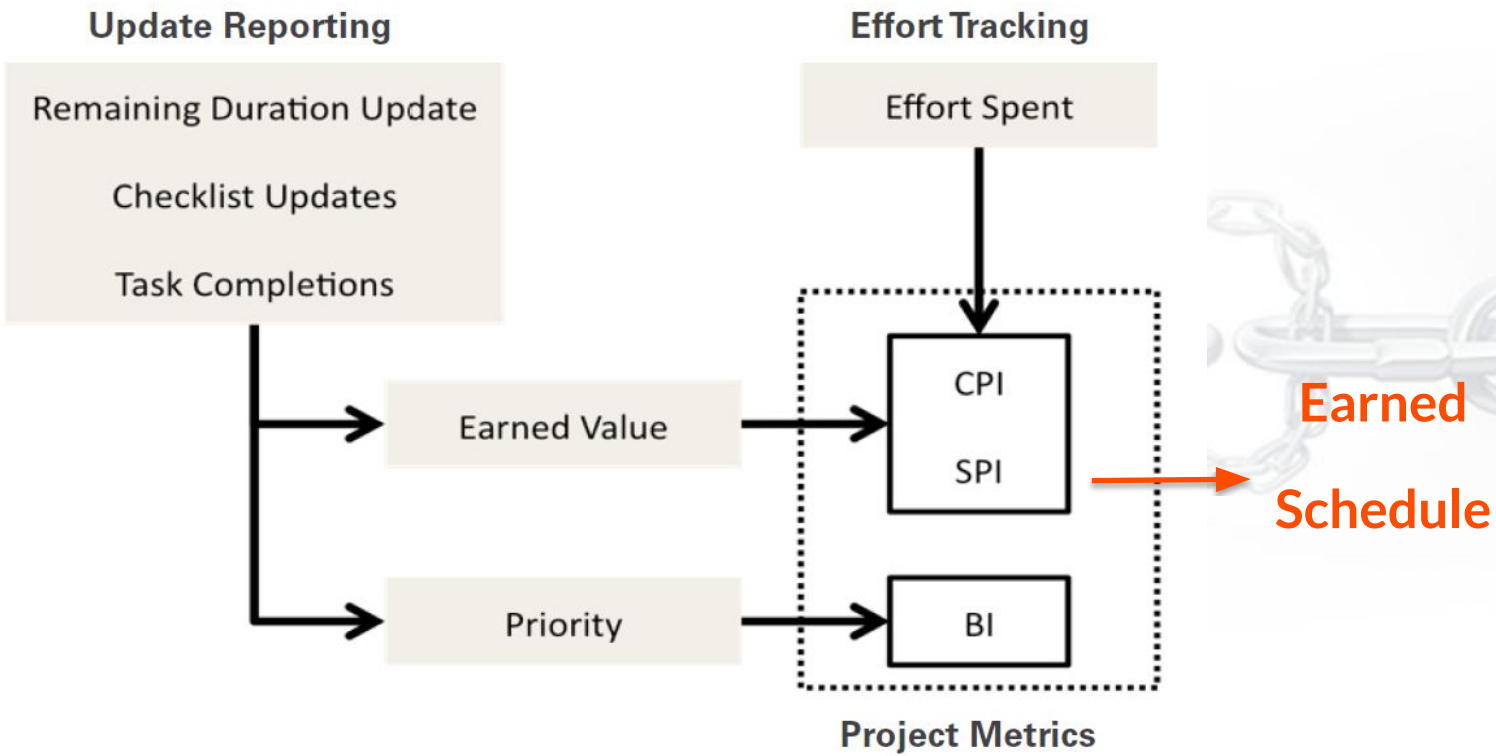
Entire fleet modification/upgrade program, ***on top of normal maintenance***
(33 jets Ahead of Schedule, On Budget)

Entire fleet modification/upgrade program

33 jets, many, many thousands of man hours

AHEAD of SCHEDULE, ON BUDGET

EVMS		CCPM
Yesterday	Today	Tomorrow
% Complete		Remaining duration
Responsible Spending		**Daily**
monthly		


Update Reporting
Remaining Duration Update
Checklist Updates
Task Completions
Effort Tracking
Effort Spent
Earned Value
Priority
CPI
SPI
BI
Project Metrics
Earned
Schedule

	BI GOOD	CPI GOOD	SPI GOOD
BI POOR	X	Buffer recovery is required. Check if adding resources will help.	This will happen when the longest chain is behind schedule and feeding chains are executing well. Plan buffer recovery.
CPI POOR	Resources are wasted. Make resource concentration effective for project by: • Cutting resources • Cutting the time lines	X	Resources are wasted. Make resource concentration effective for project by: • Cutting resources • Cutting the time lines
SPI POOR	This can only happen if resource dependencies are missing in CC plan as discussed in the beginning. Fix the CC plan.	In this case BI will be bad too. So, buffer recovery is required. Check if adding resources will help.	X

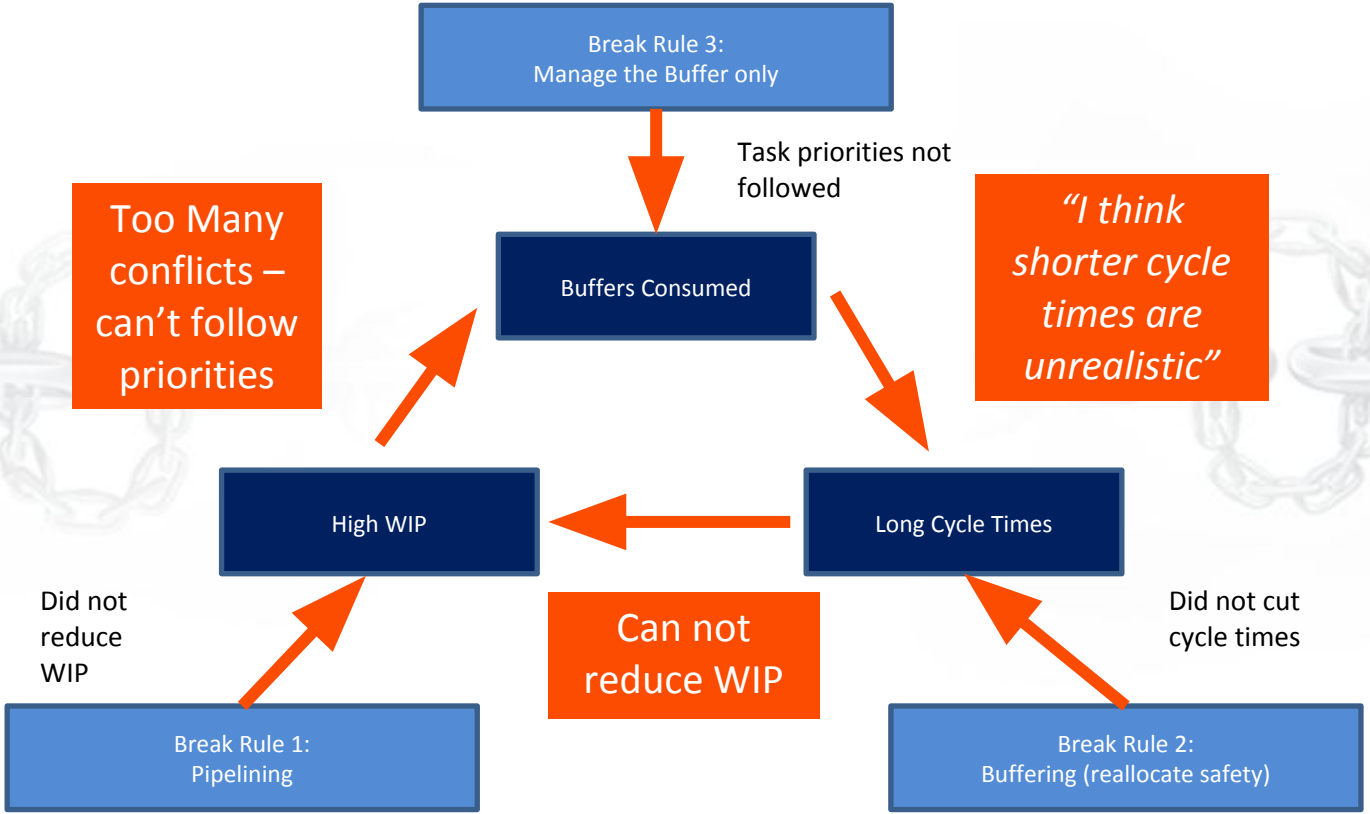
The Challenge of Change = Sustainment

Challenge 1: Managerial Commitment to the rules

Challenge 2: Theory/concept into practice

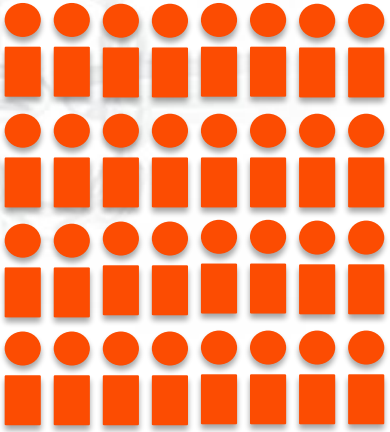
Challenge 3: Sustaining the Rule and the Results

Image: Lawrence Leech, CCPM



The Challenge of Change - Sustainment

Entropy & Dilution



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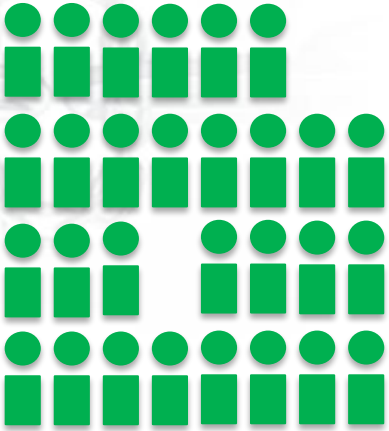
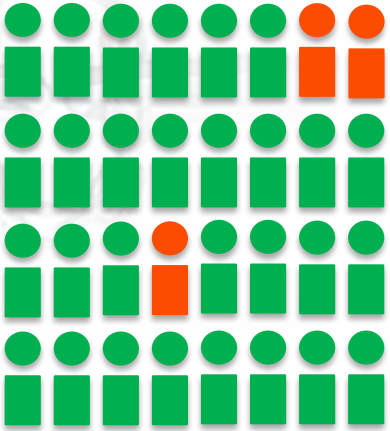
Entropy & Dilution



The Challenge of Change - Sustainment

Entropy & Dilution



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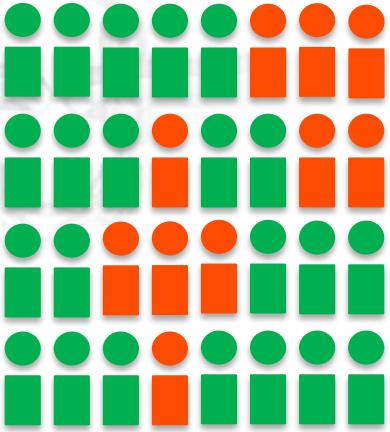
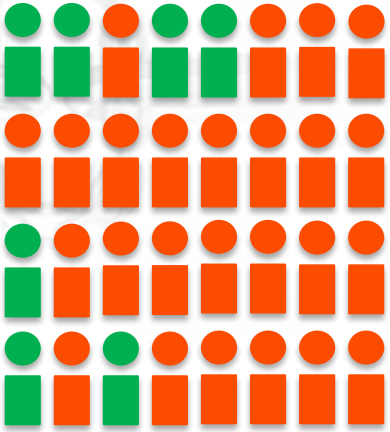
Entropy & Dilution



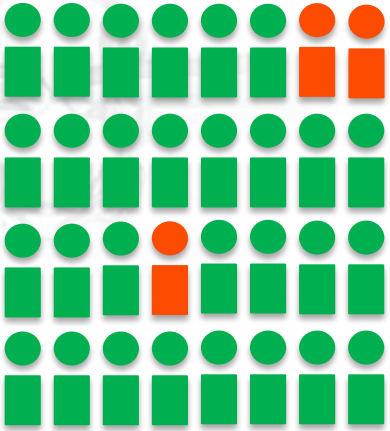
The Challenge of Change - Sustainment

Entropy & Dilution



The Challenge of Change - Sustainment

Entropy & Dilution



The Challenge of Change - Sustainment

Tell your story, so others may benefit.

Globally and nationally over 1,800 people

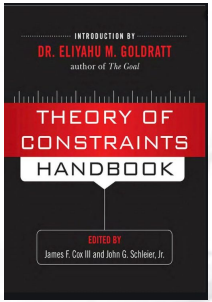
Evolve – expand upon the body of knowledge

And share it …

FOCUS

TOC Handbook, Cox & Schleier

Chapter 1, page 3
Eli Goldratt's Intro to TOC



"Can we condense all of TOC into one sentence?

I think that it is possible to condense it to a single word – focus."

ACT

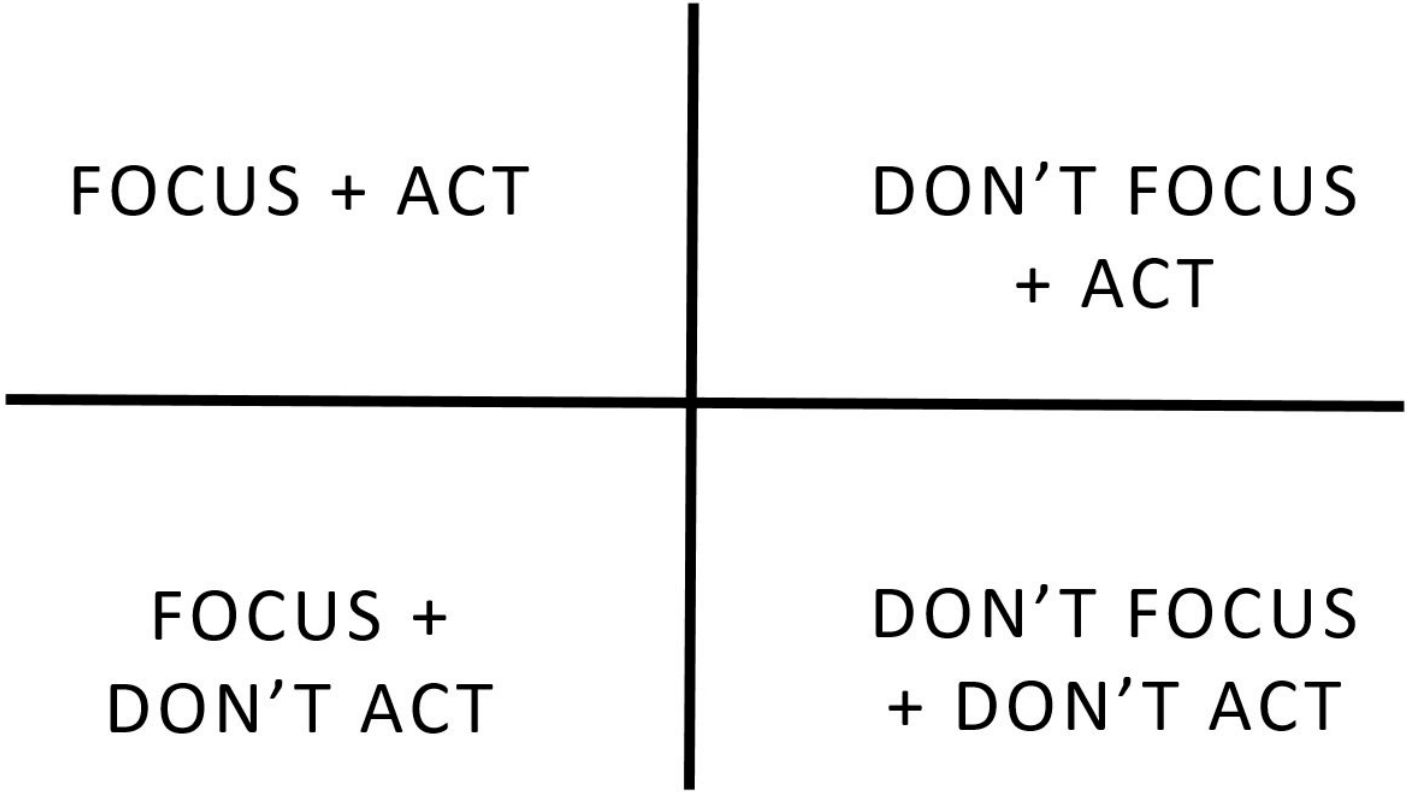
Theory of Constraints

FOCUS

+

ACT

Critical Chain



LIF / BAE Systems Australia – Our story

Chapter 1 **Chapter 2** **Chapter 3** **Chapter 4**

Intro
Problem
Solution
Results
Sustainment
Summary

A much greater, as yet unwritten, story …

Simon White
Delivering Reliable, Repeatable Project Control
BAE Systems Australia

Originally a trained aircraft maintainer, Simon was one of the key team members on the LIF / BAE Systems CCPM implementation. He has gone on to manage a fleet of fighter jets, manage Project Control for the Aerospace Business Unit, and now manages Project Control for BAE Systems Australia. He dislikes job titles, and prefers to describe people according to what they do, not what they're called.

He is more than happy to tell you about the problems (and successes) faced during the last 5 years, in the interests of expanding the global pool of knowledge and experience.

He likes to turn problems on their side, and sometimes do the opposite of the expected …

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BAE SYSTEMS

Or just stalk me on LinkedIn …