



Lean Journey to Excellence - 65 Years at the Tucson Facility

Benchmarking to Optimize Performance

John Martinez
Denise Tepe

Raytheon

Customer Success Is Our Mission

This is an oral presentation that is
incomplete without the narration



Raytheon Company Overview

3 min



Source: Raytheon YouTube



1951





Hughes Aircraft Company

8 min



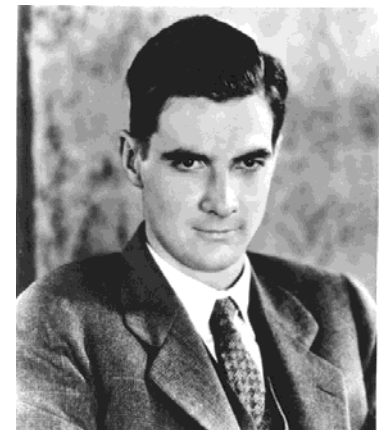
Source: 4416055_V3654



Hughes Aircraft Company - 1951

Beginning of Purpose-Driven Excellence
in Tucson

- Number of employees
- Burning platform / prevailing culture
- Improvement technique or method
- Challenges / lessons learned





GM purchase of Hughes Aircraft Company Missile Division - 1985

- Number of employees
- Burning platform / prevailing culture
- Improvement technique or method
- Challenges / lessons learned



HUGHES MISSILE
SYSTEMS COMPANY

HUGHES
AIRCRAFT

Subsidiary of
GM Hughes Electronics



GM (HMSC) acquisition of General Dynamics Missile Division - 1992

**GENERAL
DYNAMICS**

- Number of employees
- Burning platform / prevailing culture
- Improvement technique or method
- Challenges / lessons learned

HUGHES MISSILE
SYSTEMS COMPANY

HUGHES
AIRCRAFT

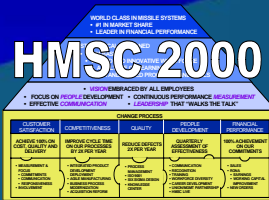
Subsidiary of
GM Hughes Electronics



**Advanced
Manufacturing
Development
Center**



Affordable Multi-Missile Manufacturing Program



**Arizona
Governor's
Award for
Quality**



Plant Consolidation



Process
Improvement
Partnership



~~Visioning Team~~

Factory Agilization Projects



Navy Best Practices

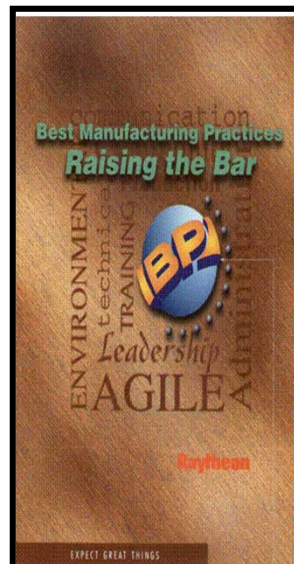
1994 1995 1996 / 1997 1998 1999 2000 2001 2002 2003 2004



1996 - 1999 Agile Metric Averages

- Cycle Time Improvements up 40 to 92%.
- Performance to Schedule Improvements up 60 to 100%.
- Square Footage Reduction Improvements up to 78%.





Best Manufacturing Practice Survey

September 1998

- ❑ Navy Center of Excellence BMP Office
- ❑ 129 Practices Submitted / Reviewed
(Largest submittal ever!)
- ❑ 84 Determined Industry Best Practices
(Highest rate of selection!)

Rick Purcel, leader of Subteam 6 suggests that RMS apply for Industry Week's "America's Best Plant" award.



Industry Week
AMERICA'S BEST PLANTS
Tenth Annual Salute

Industry Weekly

(Oct 1999)

America's Best Plant Award



AT A GLANCE

- 84 practices cited as "industry best practices," the most ever by a U.S. Navy contractor, by 28-person Navy survey team in 1998
- In 1997 became one of only three plants ever to win the Arizona Pioneer Award, the state's highest award for quality
- Hosted 2,500 visitors last year—half of them international
- Agile-manufacturing initiative produced cycle-time improvements ranging from 40% to 92% in various missile lines; performance-to-schedule improvements from 60% to 100%; square-footage reductions from 12% to 78%
- Reduced defect rates 50% a year between 1994 and 1998
- On-time-delivery—99%
- Achieved energy savings of \$15.6 million since 1996
- Reduced chemical consumption and waste generation by 93% during last decade



GM sale of Hughes Missile Systems to Raytheon - 1997

- Number of employees
- Burning platform / prevailing culture
- Improvement technique or method
- Challenges / lessons learned

HUGHES MISSILE
SYSTEMS COMPANY

HUGHES
AIRCRAFT

Subsidiary of
GM Hughes Electronics

Raytheon



Journey to Excellence



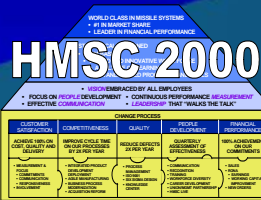
Customer Focused Marketing

Advanced Manufacturing Development Center

Lean Enterprise



Best Plant Award



Visioning Team



Arizona Governor's Award for Quality



Plant Consolidation



Affordable Multi-Missile Manufacturing Program

Engineering Relocation to Tucson



Process Improvement Partnership



Factory Agilization Projects



Navy Best Practices

1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004



**2004 Recipient
of
Manufacturing's
Most
Prestigious
Award**

**SHINGO™
PRIZE**

**for EXCELLENCE in
MANUFACTURING**



Elite Factories

By Abraham Lustgarten
September 6, 2004

(FORTUNE Magazine) – A common thread connects this year's standouts: They all responded to crisis by radically changing the way they make things. Autoliv reprocessed its factory to fend off stiff competition in airbags; biotech giant Amgen engineered a solution to soaring drug demand; and Raytheon answered a call to arms by quadrupling its missile production.

Autoliv

Learning lean production--and making it stick--took into

When Toyota Motor Corp.'s Takashi Harada arrived at the airbag module factory in April 1998, he made a quick

FORTUNE

Raytheon

Making a missile every eight minutes required a total manufacturing overhaul.

The second hijacked airplane had scarcely struck the World Trade Center on Sept. 11, 2001, when the phones began ringing at Raytheon's Tucson missile factory. By December, Raytheon had won a \$156 million contract from the U.S. Air Force to make 10,000 new kits for the Paveway laser-guided bomb—a two-foot-long module containing the laser and GPS guidance that tells the bomb where to go and flies it there. Before they were done, Paveway kit orders would leap fourfold.

Unfortunately ramping up production wasn't as simple as asking employees to work harder, adding another shift, or ordering more parts. In August 2001, Tucson was producing about 350 missiles a month—roughly half its maximum capacity. The factory was cramped. Inventory was stacked between the delivery area and the production line, with barely enough room left to squeeze a forklift through it. "We needed four times the amount of material on hand to run the factory," said production operations director Ricky Nelson. "The reality was we weren't going to be able to carve that out."

For a solution Raytheon went back to the lean-production playbook. It distilled its assembly process down to the barest value-added components and rooted out waste—time spent searching for misplaced items and moving materials around the plant. It solicited suggestions from workers and experimented with new solutions such as an assembly line built by employees. It eventually increased inventory turns 400% and reduced the cost per missile by 40%. For its success, it received the 2004 Shingo Prize.

Raytheon, which invented the guided bomb, is the world's largest weapons systems producer, with about 43% of the domestic market. More than half the missiles fired on the opening night of the Iraq war in 2003 were made by Raytheon. But it learned lean production from Hughes, which it had acquired in 1997, as well as from some others. Hughes had spent \$20 million reengineering its infrastructure. It had stripped factory floors of their fixtures, moved plumbing, electric, and communication lines to exposed overhead routing fixtures so they could be easily relocated, and put wheels on every piece of machinery to create an open, easily arrangeable plant floor adaptable to changing needs. The ideas were not new in the manufacturing world, but they were new at Raytheon. "It all seems pretty obvious now, but we had many years of assembly heritage built on how America did manufacturing," says president Louise Francesconi. "I'll call it the unmaking of that. It was really revolutionary."

At the Tucson facility, workers install global-positioning and laser-guidance systems into bullet-shaped missile heads. About a dozen people work at four or five mini-stations in the main assembly area. Before 9/11, Paveway operations manager Pat McKinney had already been working to simplify and shrink his subassembly stations. The line had been made more efficient, but it was designed for only 350 missiles per month. Pushing for 1,500 a month forced more thorough analysis and drastic action.



RMS Legacy

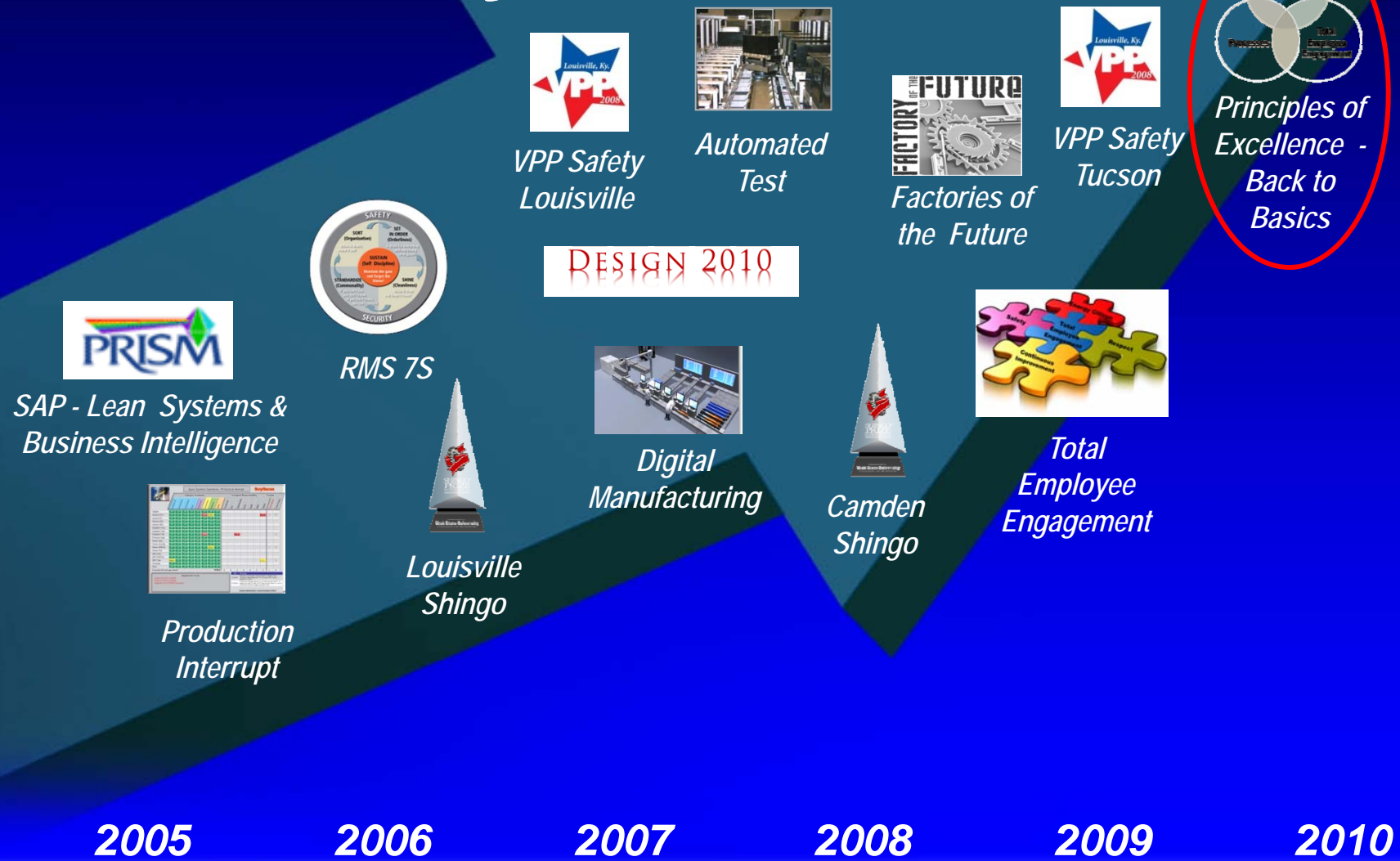
3 min



Source: V3657



Journey to Excellence





Raytheon Missile Systems 2009 - 2012

- Committed Leadership
- Benchmarking of industry “better” practices
- Integrating lean advancements into proven lean deployment process
- Identifying opportunities
- Challenges / lessons learned





Journey to Excellence



Additive Manufacturing



*Strategic Make Center
Value Stream Transition*



**Let's
LEAD** 



Benchmarking Strategy



■ Raytheon Precision Manufacturing (RPM)



Personal Warranty



*Continuous
Improvement Lean
Focus Resurgence*

2011

2012

2013

2014

2015

2016



Raytheon Missile Systems Today

- Continuous Improvement lean focus Resurgence in-work
- Application of lessons learned
- Ongoing benchmarking for industry “better” practices
- Integrated lean system & True North objectives
- Challenge





Raytheon's Historic Timeline

3 min



Source: Raytheon YouTube



Benchmarking

One of the Fastest Way to Improvement

- Improvement strategies
- Learning and sharing resources
- Supplier and customer partnerships
- Cooperative industry learning environments
- Purpose-Driven Excellence



Public Domain Resources

Its Worth Looking Into....

Definition -The state of belonging or being available to the public as a whole, and therefore not subject to copyright.

- United States Government
- State Government
- US Armed Forces
- National Science Foundation



Lean Manufacturing

Working More Efficiently

http://www.snocamp.org/CurriculumResources/CoreManufacturingConcepts/LeanManufacturingandProductionAnalysis



Cut waste, increase quality and add value.

How much waste does your organization produce?

For example, do you ever have to wait for someone else to finish a task before you can get on with your own work? Do you have a large inventory of unsold stock? Do you have more workstations that you need? Or do you order materials months in advance of when they are needed?

How about flexibility? If consumers want a modification to your product, can you quickly change your processes to meet their needs?

Waste costs you and your customers money. And if your customers have to pay more because of it, they might go elsewhere. Being competitive also requires a lot of flexibility. You must be able to meet the changing demands of your customers quickly and effectively, and adapt to a rapidly changing business environment.

So, how can you reduce waste and do things more efficiently? And how can you keep up with the changing demands of consumers?

First mentioned in James Womack's 1990 book, "The Machine That Changed the World," **lean manufacturing** is a theory that can help you to simplify and organize your working environment so that you can reduce waste, and keep your people, equipment, and workspace responsive to what's needed right now.

Tip:

The idea of lean manufacturing is just as applicable to offices and other work environments as it is to manufacturing plants. It's helpful to relate words like "inventory," "customers," and "production" to whatever you're processing – data,

Resources

How to Present Presentations

- Lean Manufacturing Definition
- Lean Essentials
- 7 Wastes
- 5 Whys
- Value Stream Mapping

Web Resources

- "Production Analysis" – *Slideshare* Website
- "Production Costs" – *Investopedia.com* website
- "Lean Manufacturing for the Wood Products Industry" – by Brian K. Bradshaw, University of Minnesota Duluth Natural Resources Research Institute, February 28, 2007

Teacher Resources

"Core +" Resources

Documents

- Root Cause Analysis (pdf.)
- Foreign Object Damage (FOD) defined
- Lean Manufacturing Paper Airplane Activity – Greg Rohr, Pierce County Skills Center

Presentations

- Root Cause Analysis
- Value Stream Mapping
- Why One Piece Flow?

Snohomish County Advanced Manufacturing Project

NSF Org:	NSF Division of Undergraduate Education
Initial Amendment Date:	July 31, 2011
Latest Amendment Date:	April 19, 2013
Award Number:	1104095
Award Instrument:	Continuing grant
Program Manager:	Gul Kremer DUE Division Of Undergraduate Education EHR Director of Academic and Human Resources
Start Date:	July 1, 2011
End Date:	June 30, 2015 (Estimated)
Awarded Amount to Date:	\$879,725.00
Investigator(s):	Robert Osnes rosnes@everettcc.edu (Principal Investigator) Steve Cottenill (Co-Principal Investigator)
Sponsor:	Everett Community College 2000 Tower Everett, WA 98201-1390 (425)388-9389
NSF Program(s):	ADVANCED TECH EDUCATION PROG
Program Reference Code(s):	1032, 9178, SMET
Program Element Code(s):	7412

ABSTRACT

This project is a partnership between Snohomish School District and Everett Community College. Everett Community College will use facilities provided by Snohomish School District to teach Advanced Manufacturing skills. The partnership will better utilize equipment and facilities, allow middle and high school students access to advanced



★★★ 1,477 page views

Definition [\[Suggest Change\]](#)

Continuous Process Improvement (CPI) is an integrated system of improvement that focuses on doing life right, things, right. It is also an enterprise-wide way of thinking for achieving lower cost, shorter lead times, and higher quality. As a way of thinking, CPI is relevant to any process, regardless of complexity or relative importance. CPI provides an ongoing focus on enhancing the satisfaction of the way, which is a key to "CPI Breakthrough" incremental improvement and "Breakthrough" improvement all at once. CPI is a customer valued processes are constantly evaluated and improved in the context of their efficiency, responsiveness and flexibility.

Source: DAU CLE 015 Continuous Process Improvement Familiarization, Lesson

[Contents](#)

- Definition
- General Information/Narrative
- Defense Acquisition Guidebook, Policies, Directives, Regulations, Laws
- Best Practices, Lessons Learned, Stories, Guides, Handbooks, Templates, Examples, Tools
- Training Resources
- Communities
- Related Articles

General Information/Narrative [Suggest Change]

Continuous Process Improvement (CPI) concepts and tools include the following:

- **Lean**, a methodology for continuous process improvement which focuses on work flow, customer value, and eliminating process waste; unique from traditional process improvement strategies in that its primary focus is on eliminating non-value added activities.
- **Six Sigma**, a disciplined data-driven methodology for process improvement which focuses on satisfying customer requirements while minimizing waste by reducing and controlling variation.

Source: the Glossary of DoDI 5010.43 Implementation and Management of the DoD-Wide Continuous Process Improvement/Lean Six Sigma (CPI/LSS) Program, dated 17 July, 2009

Note that Lean and Six Sigma are often referred to, and performed in combination, as Lean/Six Sigma (LSS).

- DoD 5010.42 DoD-Wide Continuous Process Improvement/Lean Six Sigma Program, DoD 5010.42, dated 15 May 2008
- DoD 5010.43 Implementation and Management of the DoD-Wide Continuous Process Improvement/Lean Six Sigma (CPI/LSS) Program 17 July 2009
- Better Buying Power 1.0
- Better Buying Power 2.0
- Better Buying Power 3.0
- PSM Policy, Guidance, Tools & Training Site on LOG CoP
- DoD PSM Guidebook
- Defense Acquisition Guidebook (DAG)
- DoD Instruction 5000.02
- Performance Based Logistics (PBL) Guidebook
- Business Case Analysis (BCA) Guidebook
- Logistics Assessment (LA) Guidebook
- Public-Private Partnering (PPP) Guidebook
- Integrated Product Support (IPS) Element Guidebook
- DMSMS Guidebook (SD-22)
- Condition Based Maintenance (CBM+) Guidebook
- Open Systems Architecture Guidebook
- Services Acquisition Guidebook

Best Practices, Lessons Learned, Stories, Guides, handbooks, Templates, Examples, Tools [\[Suggest Change\]](#)

- Continuous Process Improvement, Lean Six Sigma Guidelines, 1 July 2008
- Supply Chain Management (SCM)
- Supply Chain Management (SCM)
- Condition Based Maintenance (CBM+)
- Prognostics and Health Management (PHM) and Advanced Diagnostics
- Reliability Centered Maintenance (RCM)

Training Resources [\[Suggest Change\]](#)

- CLUE 004 Introduction to Lean Enterprise Concepts
- CLUE 007 Lean-Six Sigma
- CLUE 015 Continuous Process Improvement Familiarization
- CLU 020 Independent Logistics Assessments
- CLU 001 Life Cycle Management & Sustainability Metrics
- CLU 005 Developing a Life Cycle Sustainability Plan
- CLU 008 Designing for Supportability in DoD Systems
- CLU 011 Performance Based Logistics (PBL)
- CLU 012 Supportability Analysis
- CLU 036 Product Support Manager (PSM)
- LOG 102 System Sustainment Management Fundamentals
- LOG 206 Intermediate System Sustainment Management
- LOG 211 Supportability Analysis
- LOG 235 Performance Based Logistics
- LOG 340 Life Cycle Product Support
- LOG 350 Enterprise Life Cycle Logistics Management
- LOG 465 Executive Product Support Manager's Course
- ACQ 405 Executive Refresher Course

Communities [\[Suggest Change\]](#)

- Better Buying Power
- Life Cycle Logistics
- Naval Open Architecture
- Performance Based Logistics
- Program Management
- Reliability, Availability & Maintainability
- Risk Management

[Related Articles](#) [[Suggest Change](#)]

Continuous Process Improvement (CPI) and Lean Six Sigma (LSS)
Continuous Process Improvement (CPI) and Lean Six Sigma (LSS)
Integrated Product Support (IPS) Element - Sustaining Engineering
Funding Product Support Strategies - Working Capital Funds (WCF)
Integrated Product Support (IPS) Element - Supply Support
Integrated Product Support (IPS) Element - Product Support Management





<http://www.osti.gov/scitech/servlets/purl/10148487-KKvyCq/native/>

**Using Benchmarking to Minimize
Common DOE Waste Streams**

**Volume I. Methodology
and Liquid Photographic Waste**

Prepared for
**U.S. Department of Energy
Environmental Restoration and Waste Management
Office of Waste Management
Waste Minimization Division**

Prepared by
Victoria Levin
Environmentally Conscious Life Cycle Systems Department
Sandia National Laboratories
Albuquerque, NM 87185 and Livermore, California 94550

April, 1994

<http://unpan1.un.org/intradoc/groups/public/documents/aspa/unpan002509.pdf>

**The Department of the Navy
Benchmarking Handbook:**

A Systems View

EXAMPLES



by Joan Kraft
Department of the Navy
Total Quality Leadership Office



Do an internet search



AIR FORCE SMART OPERATIONS FOR THE 21ST CENTURY PLAYBOOK



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EXAMPLE



<http://results.wa.gov/what-we-do/learn-about-lean>

[Home](#)[What We Do](#)[Resources](#)[Public Dashboard](#)[home](#) / [what we do](#) / [learn about lean](#)[Measure results](#)[Learn about Lean](#)[Lean Conference](#)[Lean Fellowship Program](#)[Lean in government](#)[Lean Practitioner Community of Practice](#)[Foster performance audits](#)[Results reviews](#)

Learn about Lean

Lean provides proven principles that are helping Washington state government to:

- create a culture that encourages respect, creativity and innovative problem solving
- continuously improve and eliminate waste from government processes
- align efforts across state agencies
- deliver results that matter to Washingtonians

Our approach

Results Washington calls on state agencies to apply Lean thinking and tools, report regularly on their progress on the Governor's five goals and be accountable for making improvements and delivering results for the citizens of Washington through regularly held review meetings.

Resources

Find the resources you need to learn more about Lean:

- [Lean resources](#) – discover tools, videos, articles, and other Lean resources
- [Lean Conference](#) – attend our annual conference and see past conference materials
- [Learning communities](#) – learn about and join Lean Practitioner Community of Practice
- [Lean Fellowship Program](#) – learn more about our Lean Fellowship Program members
- [Lean in government](#) – learn what other state and government entities are doing
- [Lean cafe blog](#) – take a break, sip some coffee, and learn about Lean
- Read the Governor's [Executive Order 13-04 \(PDF\)](#) on Lean

EXAMPLE



No Barriers

2 min



Source: Raytheon YouTube



Thank You!

Your opinion is important to us!
Please take a moment to complete the
survey using the conference mobile app.

Session: ThP/52
Lean Journey to Excellence - 65 Years at the
Tucson Facility

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