



MACHINING MUSCLE BUILDING

PRECISION MACHINING PRODUCTIVITY PROGRAM

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Western Aerospace Expo 2013

Why is productivity important?

- ▶ Company
 - Competitiveness
- ▶ Industry
 - Market position
- ▶ Country
 - Standard of Living

What is productivity?

- ▶ Output / Input
- ▶ Throughput
- ▶ Revenue per employee

Is productivity 'the answer'?

- ▶ Value & Differentiation

- Value to Customers
- Differentiated against competitors

- ▶ Productivity

- Relentless improvement

- ▶ People

- Competencies (knowledge, skills & abilities)
- Attitudes

What technologies could help?

- ▶ Technical Presentations

- Not sales pitches
- Objective info
- Enable good Strategic Investment Decisions (SIDs)

- ▶ Case Studies

- ▶ Technology Demonstrations

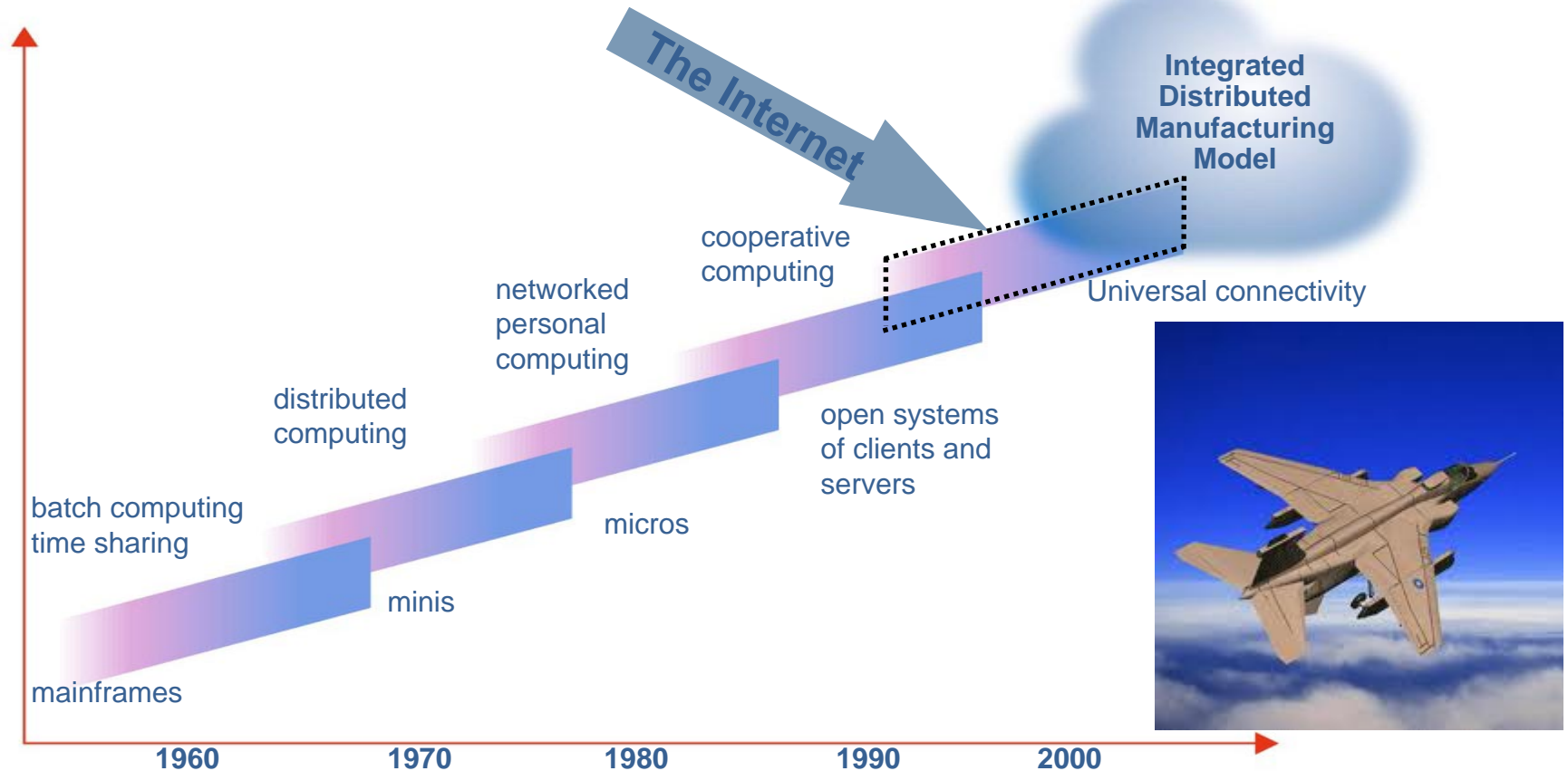
Making Smart Strategic Investment Decisions (SIDs) – 1

- ▶ Project Smarts
- ▶ Business & Management Smarts
- ▶ Financing Smarts
- ▶ Plan it
- ▶ Get good help
- ▶ Get funding & financing

Technical Presentations

Technology Area	Company	Represented By
Automated Metrology	Carl Zeiss	Elliott-Matsuura Canada
Flexible Manufacturing System (FMS)	Delcam	
Adaptable Machining	Delcam	
Networking of Machine Tools	Cimco	In-House Solutions Inc.
Knowledge Management	NexSys Group	
Networking of Machine Tools	Nexas Networks	
Automation with Robotics	Robotmaster	In-House Solutions Inc.
Bar Codes /QR Codes	Lynch Dynamics	
CAD/CAM Integration	GibbsCAM	Cam Solutions Inc.
Networking of Machine Tools	eNet	Cam Solutions Inc.
Automation with Robotics	Kuka Robotics	
Flexible Manufacturing Systems (FMS)	Magellan Aerospace (Chicopee)	
Electron-Beam Welding	Nu-Tech Metals	
Overview of Machining Technology Advances	McMaster Manufacturing Research Institute (MMRI)	
Future Advances in Machine Tool Technologies	Dekel Maho Gildemeister (Germany)	DMG Canada
Automated NDT	Utex	

E-Manufacturing Evolution



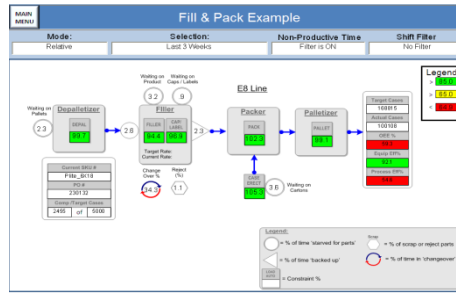
Today Everything Needs to Communicate

Company to Company | People to Machine | Machine to People | Machine to Machine

OEE & Production Reporting



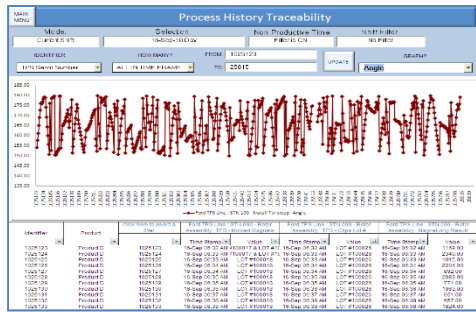
Constraint Analysis



Real Time Andon Display Boards

Shift 2					Sep-14 11:06 AM
Line	1.6 Line	2.2 Line	Lisec Line	TOTAL	
Target	400	214	312	926	
Actual	323	113	108	544	
% of Target	80.8	52.8	34.6	58.7	
This Unit	3:18	0:45	4:23	<div>LEGEND:</div> <div>> 80</div> <div>< 65</div> <div>></div>	
Last 30 Min.					
Last Shift	82%	45%	91%	73%	

Product and Process Traceability



Production & Inventory Tracking

MAIN MENU

Mode:

Selection:

Non-Productive Time:

Shift Filter:

Last 8 Weeks Starting:

20-Jun-10

Filter by:

Job Filter

Area:

36th Furnace

Machine	Start Time	Production Order Number	Product	OEE % (EOI / Actual)	Total Run Time (min)	Actual (min)	Scrap (min)	Setup Time (min)	Target Run Time	Actual Run Time
36 th Furnace	26-Aug-10 01:30	989700-AUG-01	517900	100.0%	0.0	0.00	0.00	0.00	0.00	0.00
36 th Furnace	23-Aug-10 21:30	100800-AUG-01	517900	100.0%	0.0	0.00	0.00	0.00	0.00	0.00
36 th Furnace	22-Aug-10 17:00	100800-AUG-01	517900	100.0%	9.7	9.60	0.00	0.00	279.00	57.60
36 th Furnace	19-Aug-10 05:30	100800-AUG-01	517900	100.0%	30.6	30.50	0.00	0.00	228.00	82.20
36 th Furnace	18-Aug-10 01:30	100800-AUG-01	517900	100.0%	113.0	113.00	0.00	0.00	1076.70	113.00
36 th Furnace	15-Aug-10 13:30	100800-AUG-01	517900	100.0%	30.6	30.60	0.00	0.00	228.00	84.90
36 th Furnace	17-Aug-10 01:30	100800-AUG-01	517900	100.0%	29.3	29.30	0.00	0.00	216.00	118.70
36 th Furnace	16-Aug-10 23:30	100800-AUG-01	517900	100.0%	119.2	119.20	0.00	0.00	1080.00	119.20
36 th Furnace	16-Aug-10 01:30	100800-AUG-01	517900	100.0%	30.6	30.60	0.00	0.00	228.00	109.00
36 th Furnace	16-Aug-10 13:30	100800-AUG-01	517900	100.0%	40.7	40.70	0.00	0.00	300.00	110.00
36 th Furnace	02-Aug-10 01:30	100800-AUG-01	517900	100.0%	102.8	102.80	0.00	0.00	1197.00	102.80
36 th Furnace	28-Jul-10 15:30	100800-AUG-01	517900	100.0%	63.0	63.00	0.00	0.00	420.00	140.00
36 th Furnace	26-Jul-10 05:30	100770-AUG-01	517900	100.0%	18.7	18.60	0.00	0.00	144.00	53.00

Main Menu

Production Run History

Mode: Selection: Non-Productive Time: Shift Filter:

Last 5 Weeks (00:00)20-11-202400:00 to 23:59All Shifts

Area: 35F Furnace

Machine	Start Time	Production Order Number	Product	QEE %	Total Run Time	Actual Run Time	Scrap Time	Temp Time	Temp/Run Time	Actual Run Time	Temp Time
35F Furnace	18:40:00 (08/11/24)	180002-0000	180000	100%	00:00	00:00	00:00	00:00	00:00	00:00	00:00
35F Furnace	23:40:00 (08/11/24)	180002-0047	180000	100%	00:05	00:05	00:00	00:00	00:00	00:05	00:00
35F Furnace	22:40:00 (09/11/24)	180004-0100	180000	100%	00:07	00:06	00:00	00:00	00:00	00:06	00:00
35F Furnace	18:40:00 (09/11/24)	180004-0000	180000	100%	00:05	00:05	00:00	00:00	00:00	00:05	00:00
35F Furnace	18:40:00 (10/11/24)	180004-0000	180000	100%	00:07	00:06	00:00	00:00	00:00	00:06	00:00
35F Furnace	18:40:00 (11/11/24)	180004-0000	180000	100%	00:07	00:06	00:00	00:00	00:00	00:06	00:00
35F Furnace	18:40:00 (12/11/24)	180004-0000	180000	100%	00:05	00:05	00:00	00:00	00:00	00:05	00:00
35F Furnace	18:40:00 (17/11/24)	180004-0000	180000	100%	00:07	00:06	00:00	00:00	00:00	00:06	00:00
35F Furnace	18:40:00 (23/11/24)	180004-0000	180000	100%	00:07	00:06	00:00	00:00	00:00	00:06	00:00
35F Furnace	18:40:00 (08/11/24)	180004-0000	180000	100%	00:07	00:06	00:00	00:00	00:00	00:06	00:00
35F Furnace	18:40:00 (09/11/24)	180004-0000	180000	100%	00:07	00:06	00:00	00:00	00:00	00:06	00:00
35F Furnace	18:40:00 (10/11/24)	180004-0000	180000	100%	00:07	00:06	00:00	00:00	00:00	00:06	00:00
35F Furnace	18:40:00 (11/11/24)	180004-0000	180000	100%	00:07	00:06	00:00	00:00	00:00	00:06	00:00
35F Furnace	18:40:00 (12/11/24)	180004-0000	180000	100%	00:07	00:06	00:00	00:00	00:00	00:06	00:00
35F Furnace	18:40:00 (17/11/24)	180004-0000	180000	100%	00:07	00:06	00:00	00:00	00:00	00:06	00:00
35F Furnace	18:40:00 (23/11/24)	180004-0000	180000	100%	00:07	00:06	00:00	00:00	00:00	00:06	00:00
35F Furnace	20:40:00 (20/11/24)	180010-0000	180000	100%	00:07	00:06	00:00	00:00	00:00	00:06	00:00

Downtime, Scrap & Other Manual Entry

[illegible]

Automated Metrology Feedback systems to CNC FMS

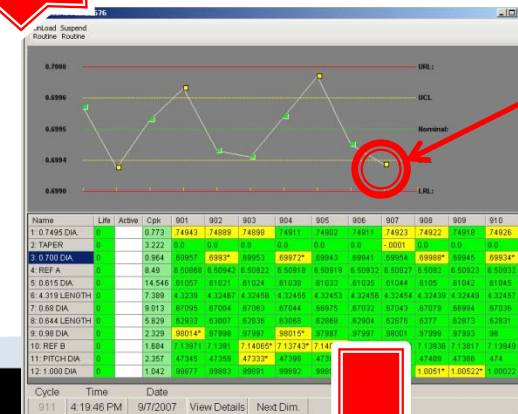


2 Part is measured

1 Part is machined

3 Variation determines if compensation is required

4 Tool offsets are adjusted



TOOL OFFSET				NOSE-R. COMPENSATION				ACTUAL POSI.			
	X	Z	P		X	Z	P		X	Z	P
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000		X	-161.440	
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000		Z	0.000	
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000		C	0.000	
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000		W	300.000	
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000		Fr	0.000	
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000		V	0	
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000		S	0	
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000				

Automated Metrology The Future



Fixture Plate(Pallet) Pool – 112 plates

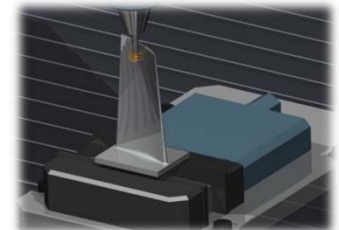
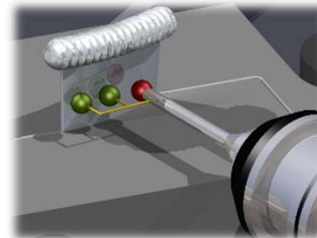
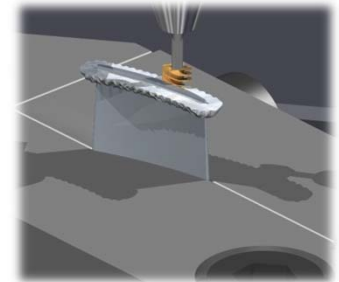
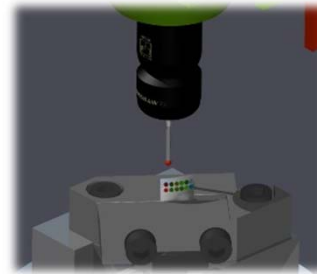
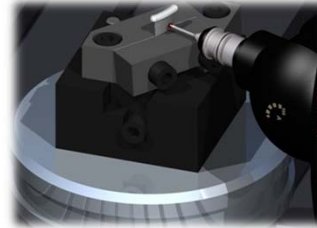


2 Part Load Unload Stations



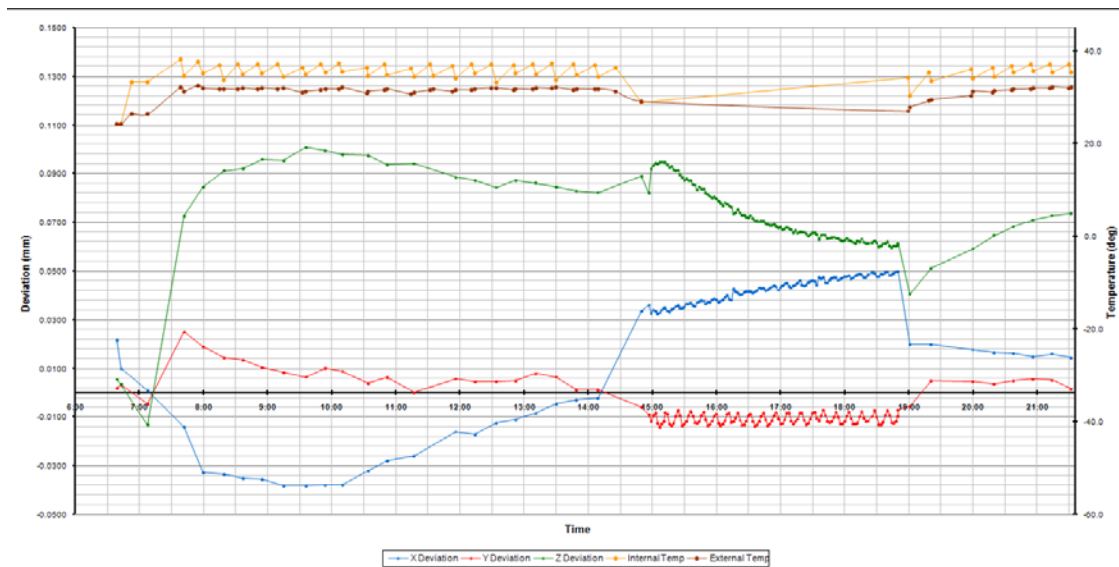
Adaptive Machining

- ▶ Probe part to determine true shape/location of the part
- ▶ Using morphing of the model to bring nominal CAD data into alignment with actual part geometry
- ▶ Regenerate toolpaths for area to be machined based on new CAD data
- ▶ Eliminates blending issues, hand finishing operations, and wasteful air cut time



Machine Monitoring

- 5 axis calibration
 - Identifies problems before they affect part quality
 - Monitors system stability
- Reporting and traceability
 - Generates performance reports for archiving



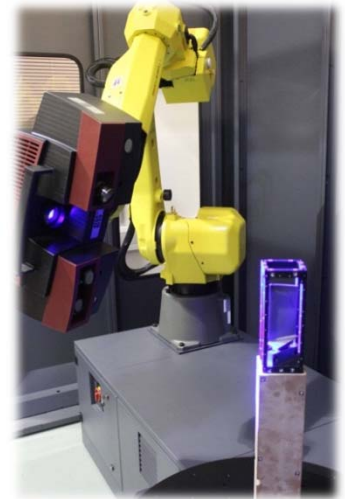
In-Process Inspection

Offline programming System



Enables manufacturing decisions to be made

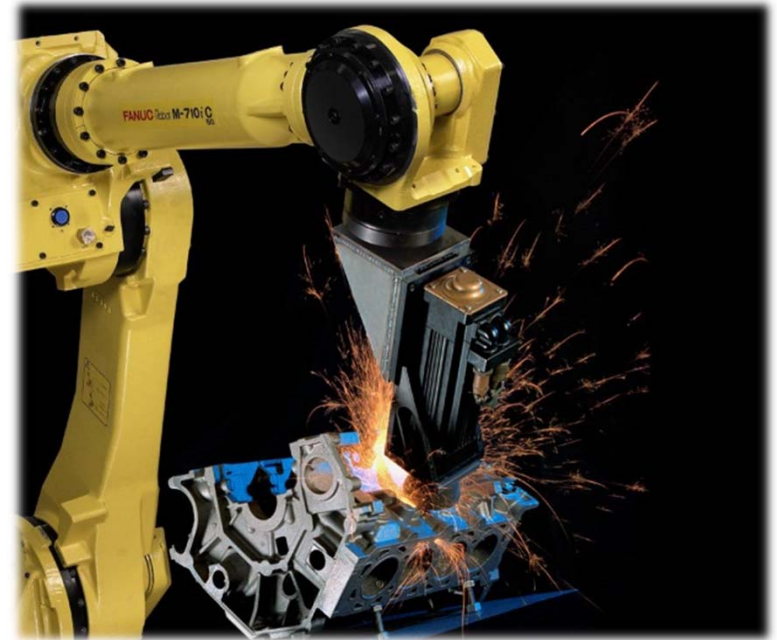
- In the midst of manufacturing
- In real time
- Without human intervention



Robotics

Experience in a wide range of applications

- ▶ Advanced CAM system to drive robots allow robots to:
 - Machining
 - Greater flexibility and access to part
 - Grinding and polishing
 - Removal of manual labor
 - Drilling and trimming
 - Increased dexterity of robot vs. machine tool
 - Vision and Ultrasonic Inspection
 - Exploit positional flexibility and reach



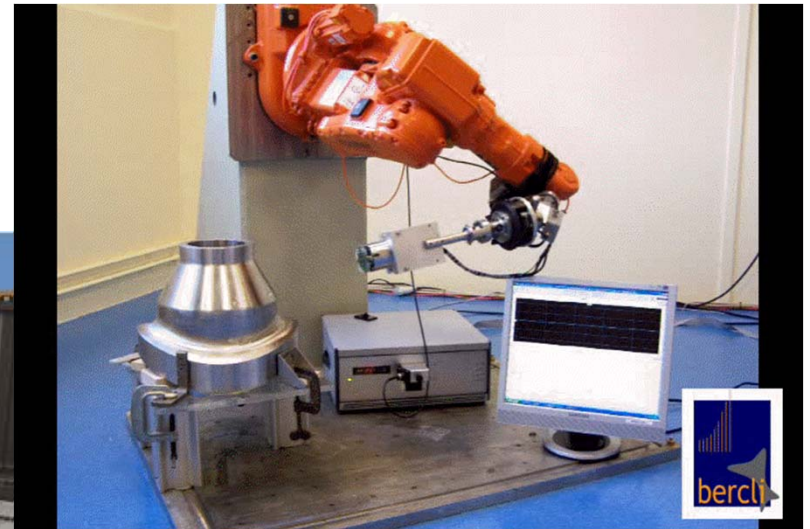
Automation of In-service Inspections Today



Automated
Sweeps with
Manual Scanning



Automated Scanning and Recording



Automated Following
and Recording

These inspections are partially automated, with plenty of manual tasks remaining for operators to mess up.

Automation of Factory Inspections Today



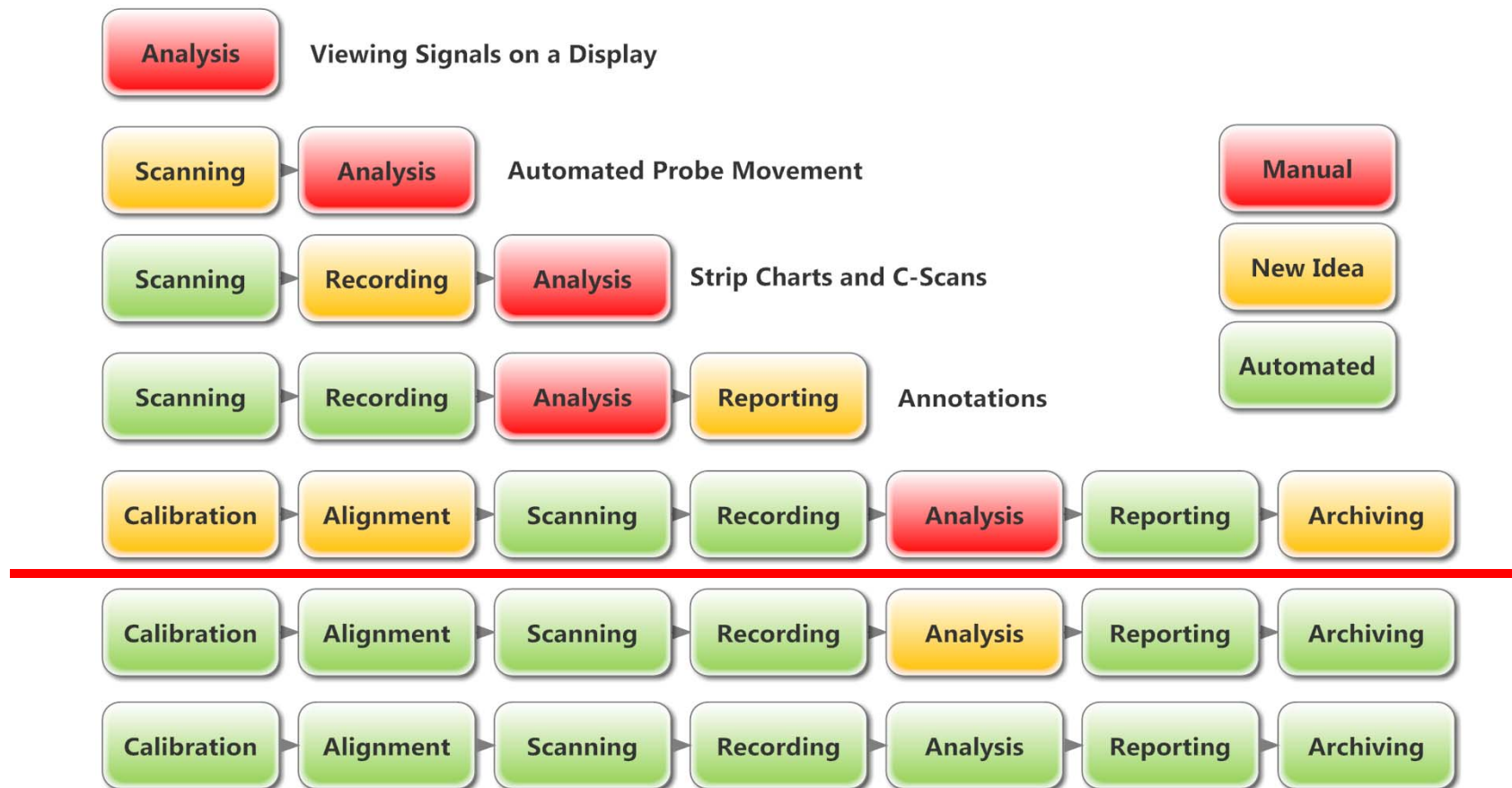
Automated Blade Inspection



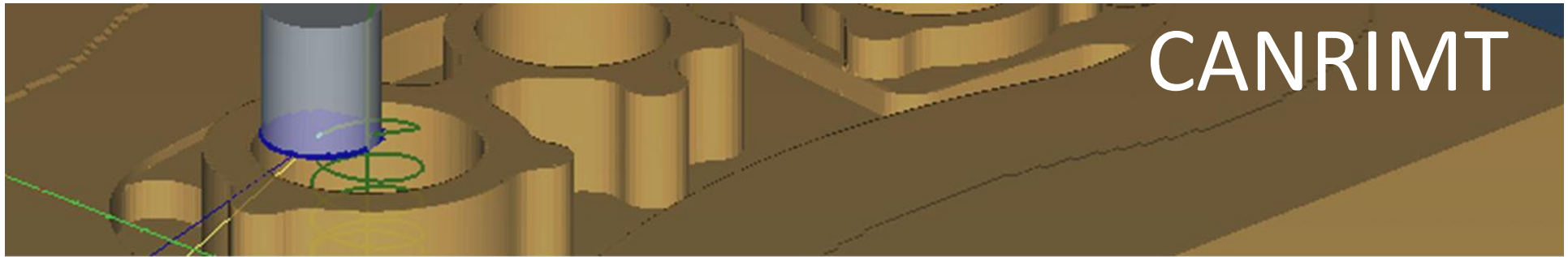
Automated Composite Inspection

These inspections are fully automated, with occasional unforeseen states to mess things up.

A Brief History of Automation in NDT

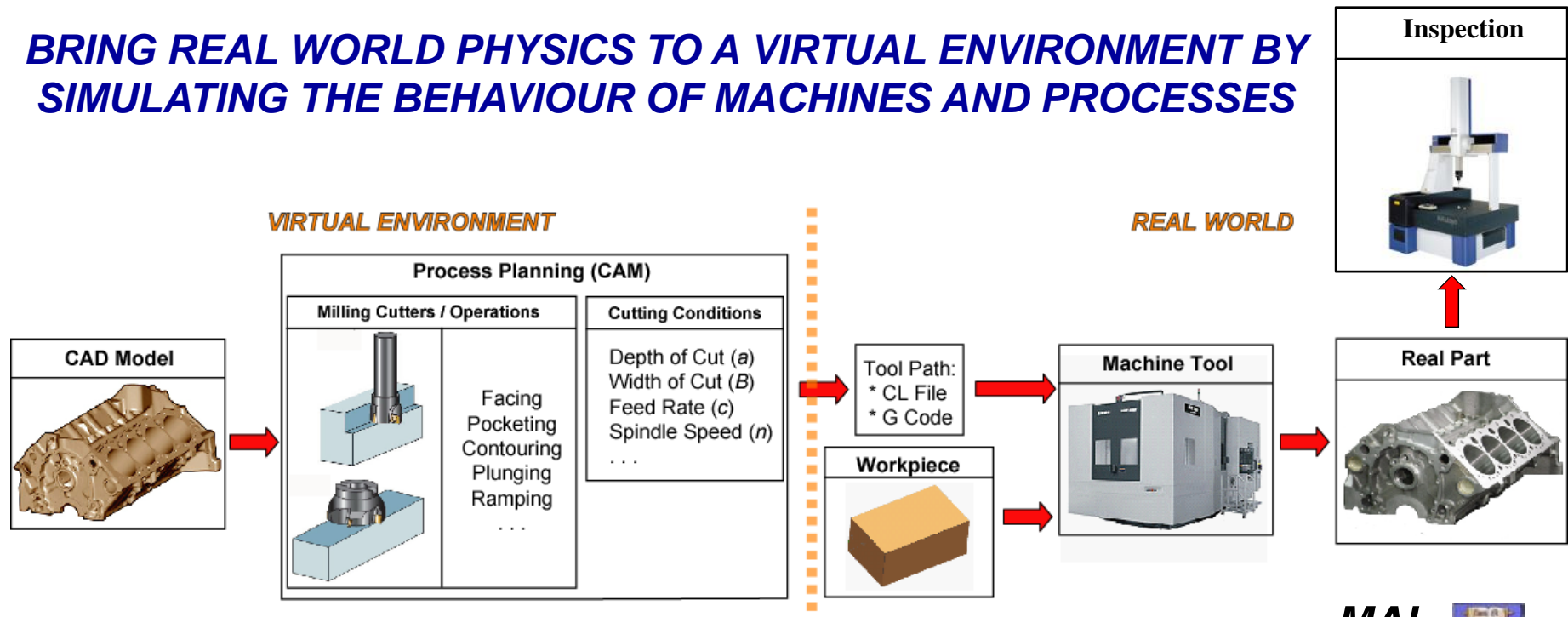


NDT professionals welcomed change, until they got out of their comfort zone

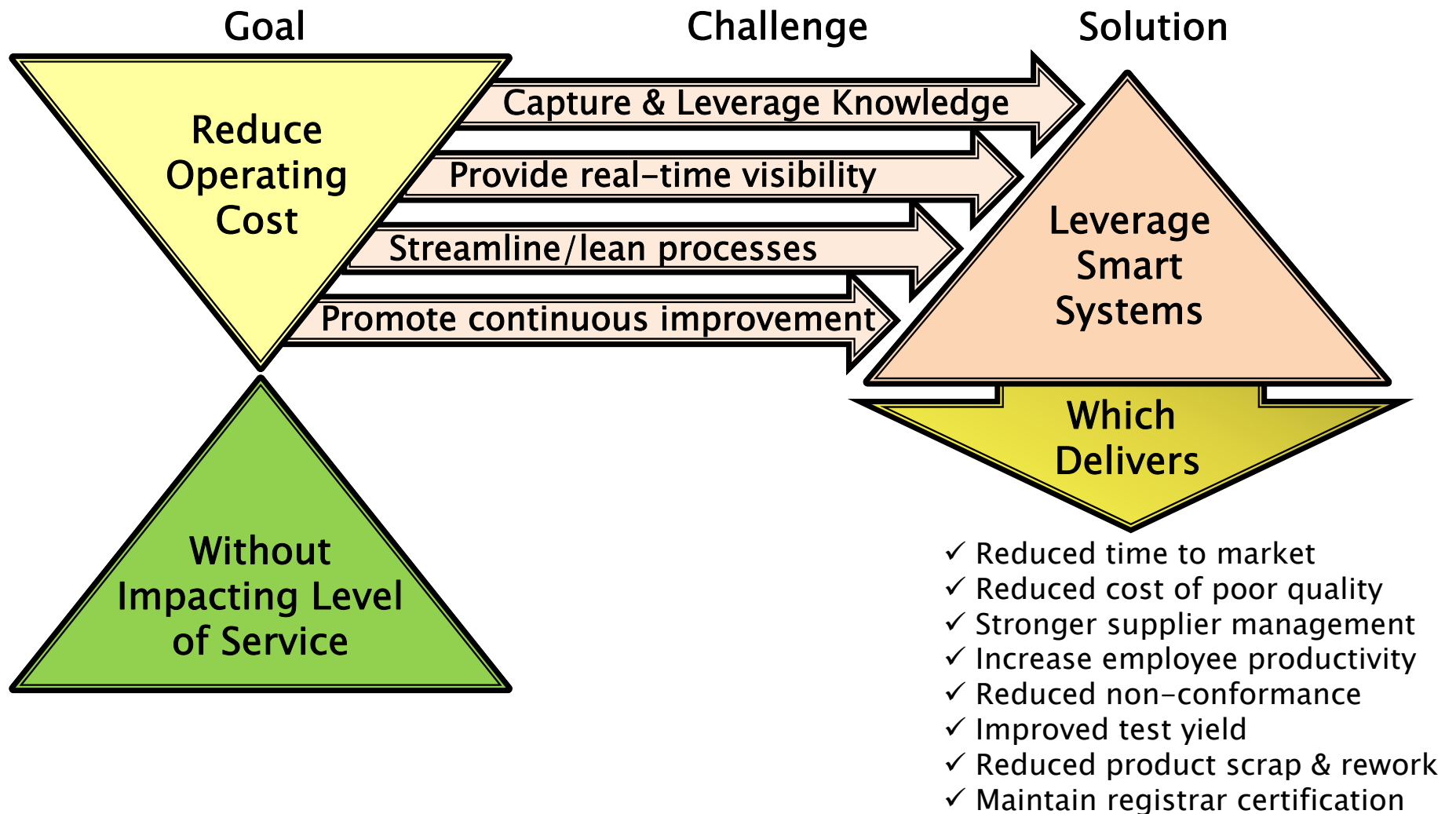


Role of Virtual Machining Technology

BRING REAL WORLD PHYSICS TO A VIRTUAL ENVIRONMENT BY SIMULATING THE BEHAVIOUR OF MACHINES AND PROCESSES



Operational Excellence



Making Smart Strategic Investment Decisions (SIDs) – 1

▶ PROJECT SMARTS

- Real cost reductions, not numbers games
- Reducing the risks
- Getting the big payoffs

▶ BUSINESS & MANAGEMENT SMARTS

- Making good strategic investment decisions
- Selling your project up the ladder
- Making cash flow work

Making Smart Strategic Investment Decisions (SIDs) – 2

▶ FINANCING SMARTS

- What are financial decision-makers looking for?
- Using money to make money
- Best value financing

▶ PLAN IT!

- Load the front end
- Stage-Gate process
- Plan 'D'

Making Smart Strategic Investment Decisions (SIDs) – 3

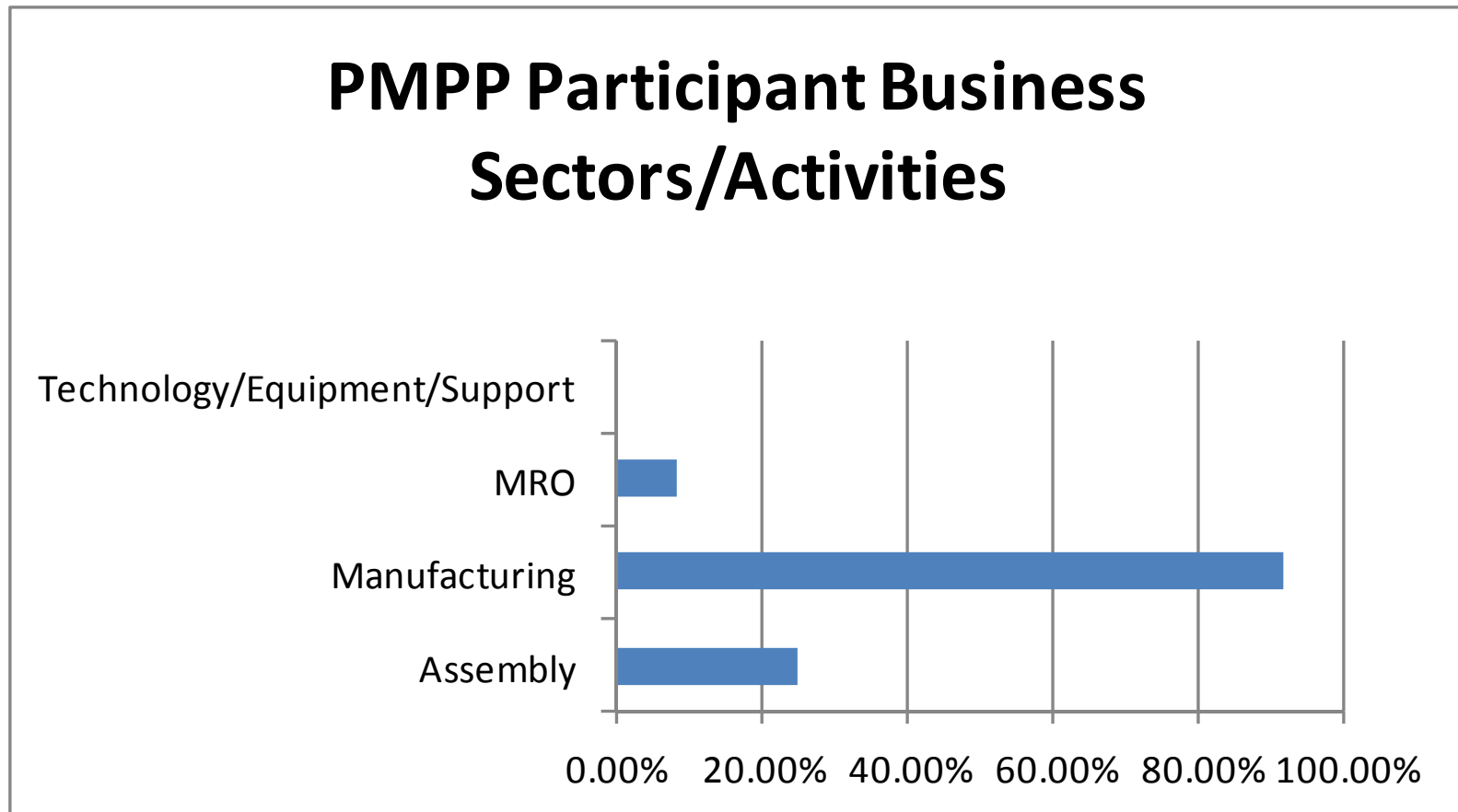
▶ GET GOOD HELP!

- Talk to peers
- Ask experts
- Find the right systems/equipment/software companies

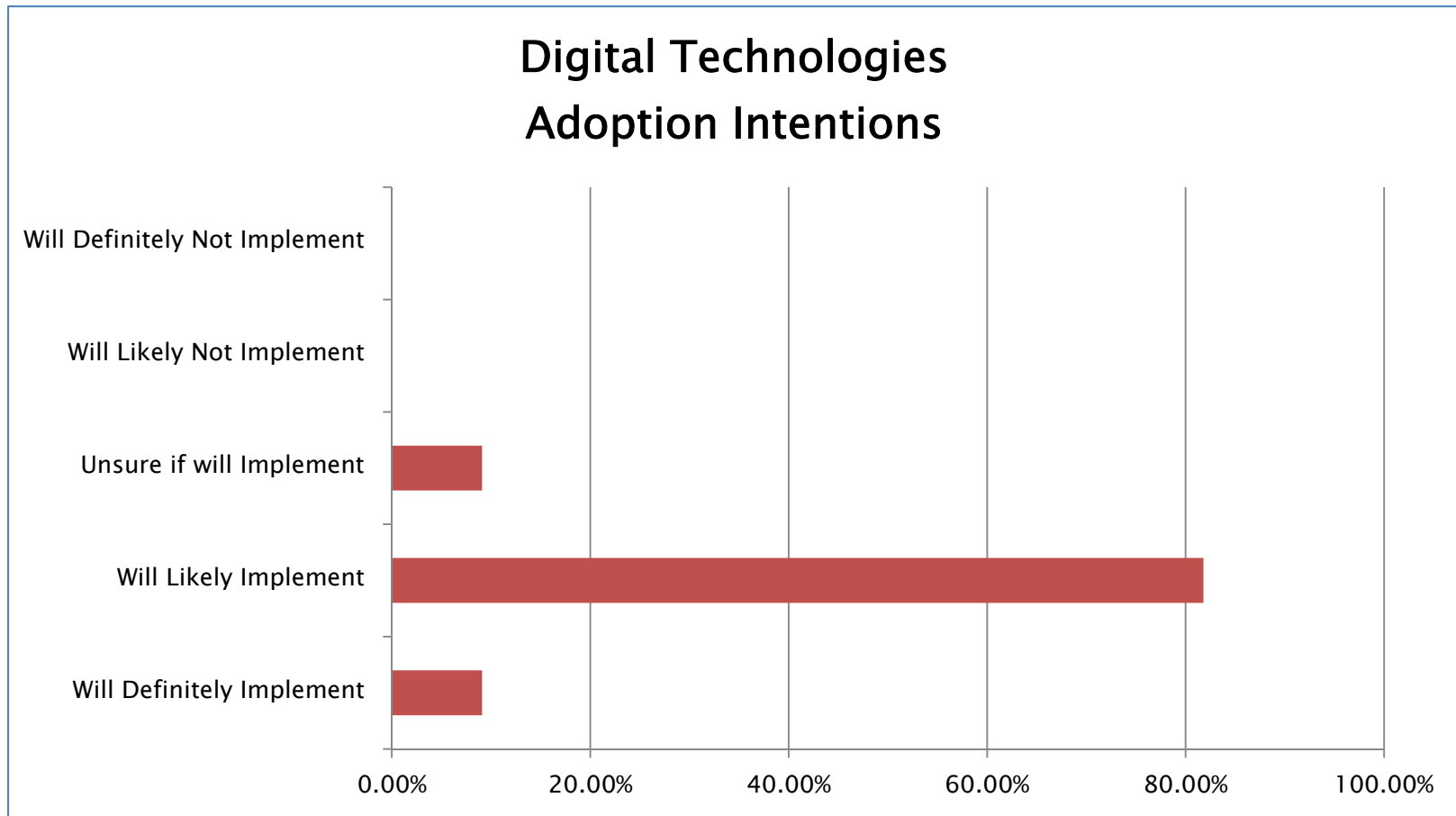
▶ GET FUNDING & FINANCING

- Money is money
- Cash flow is king

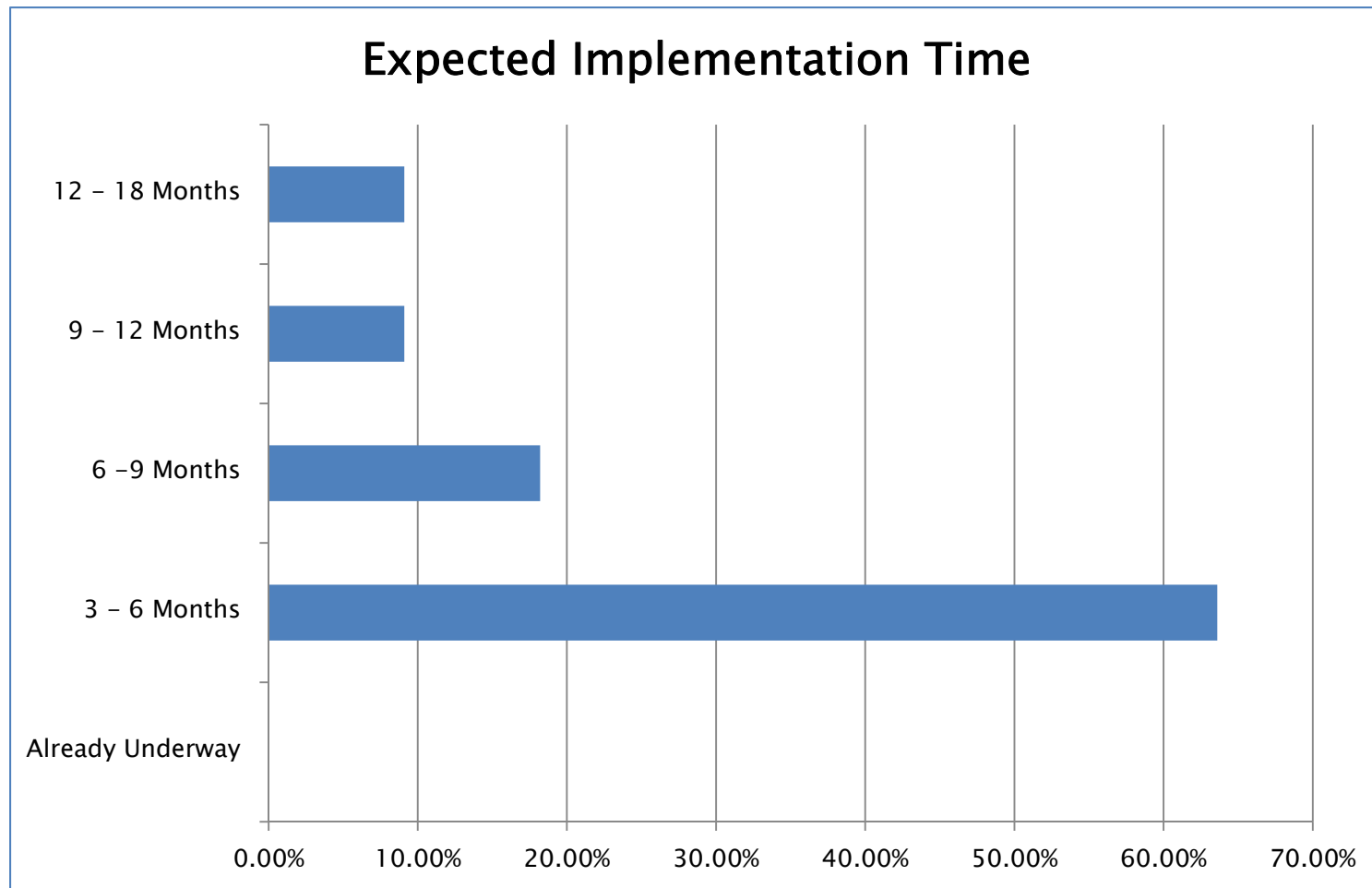
Findings



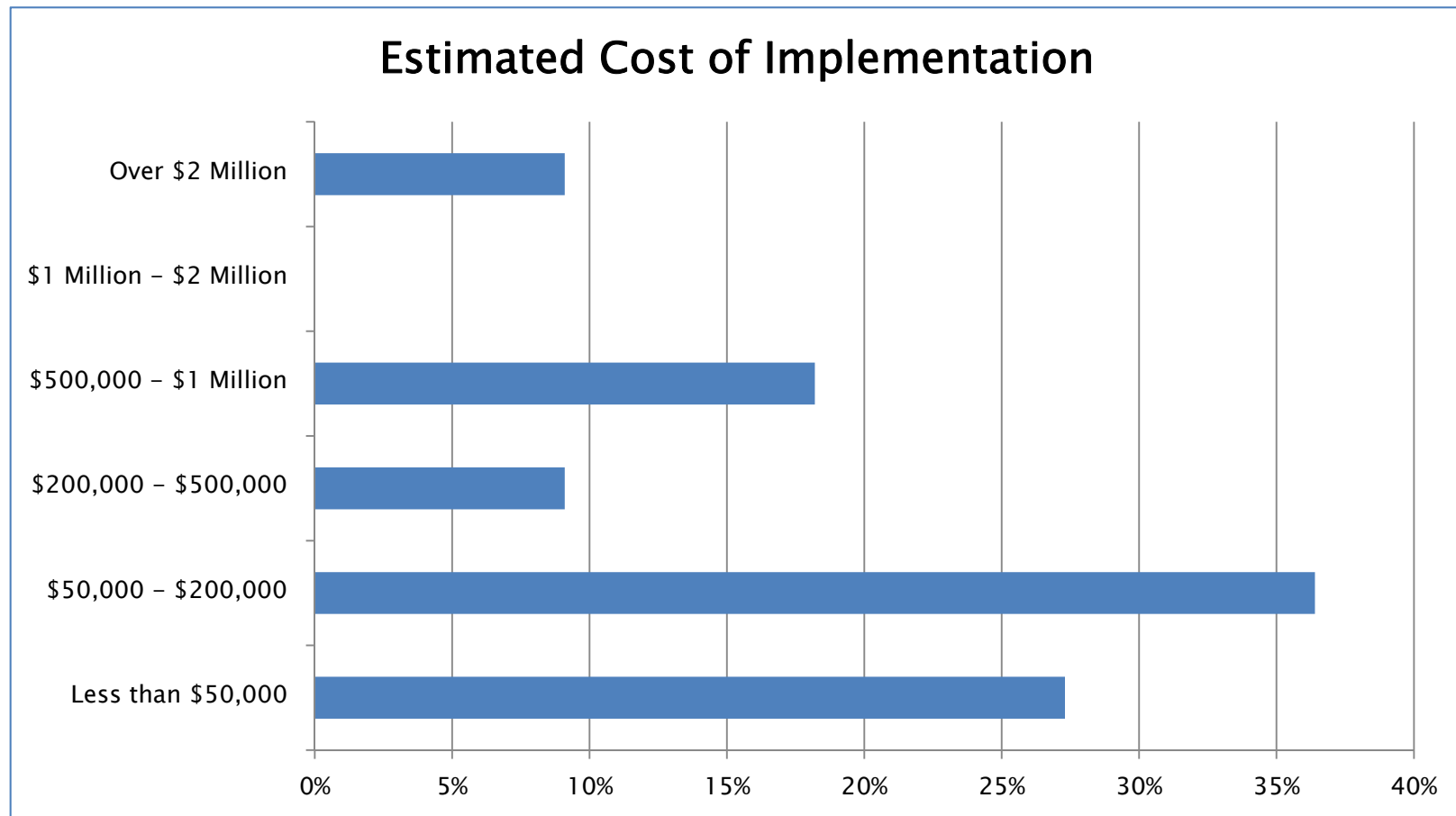
Findings



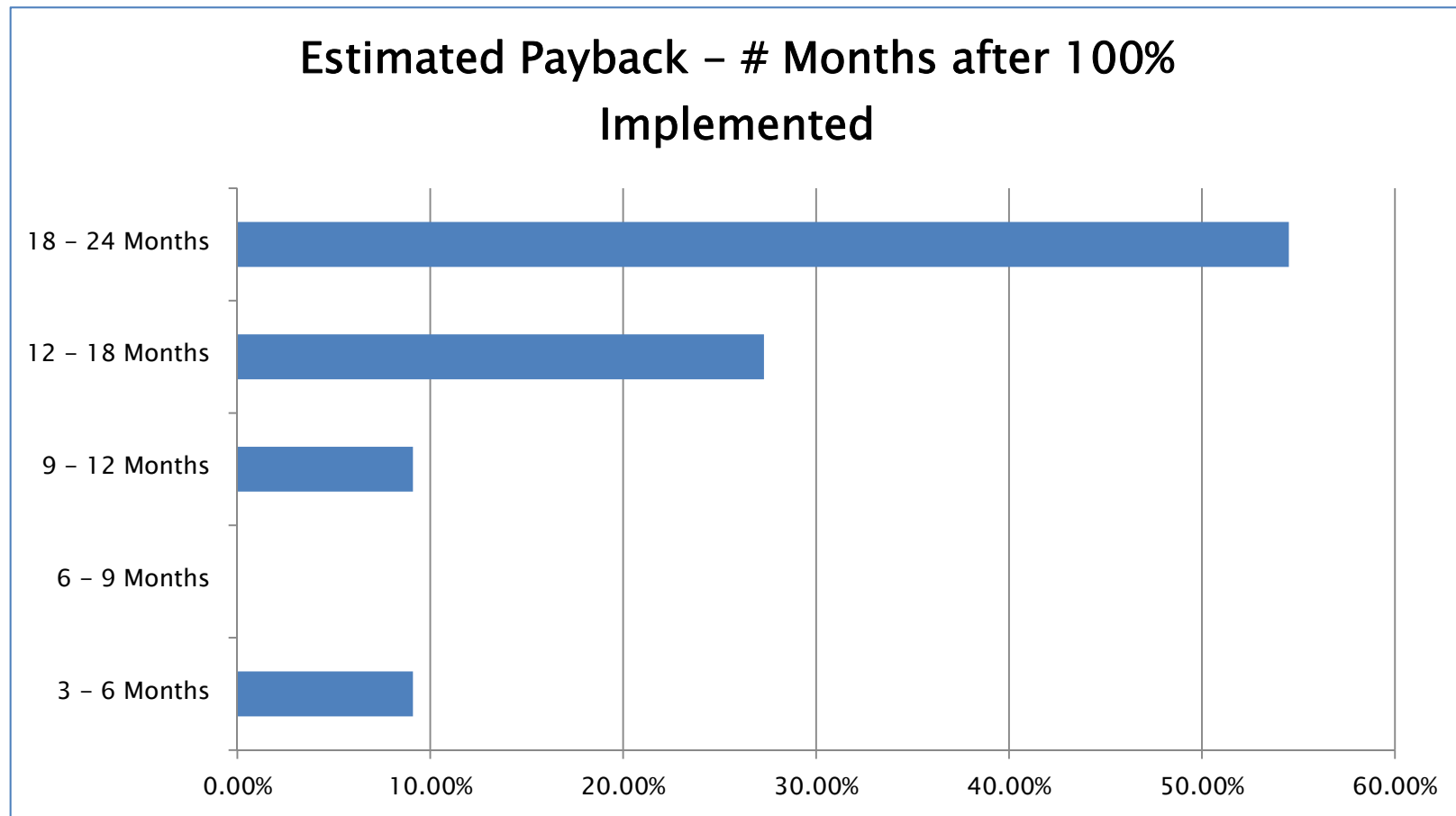
Findings



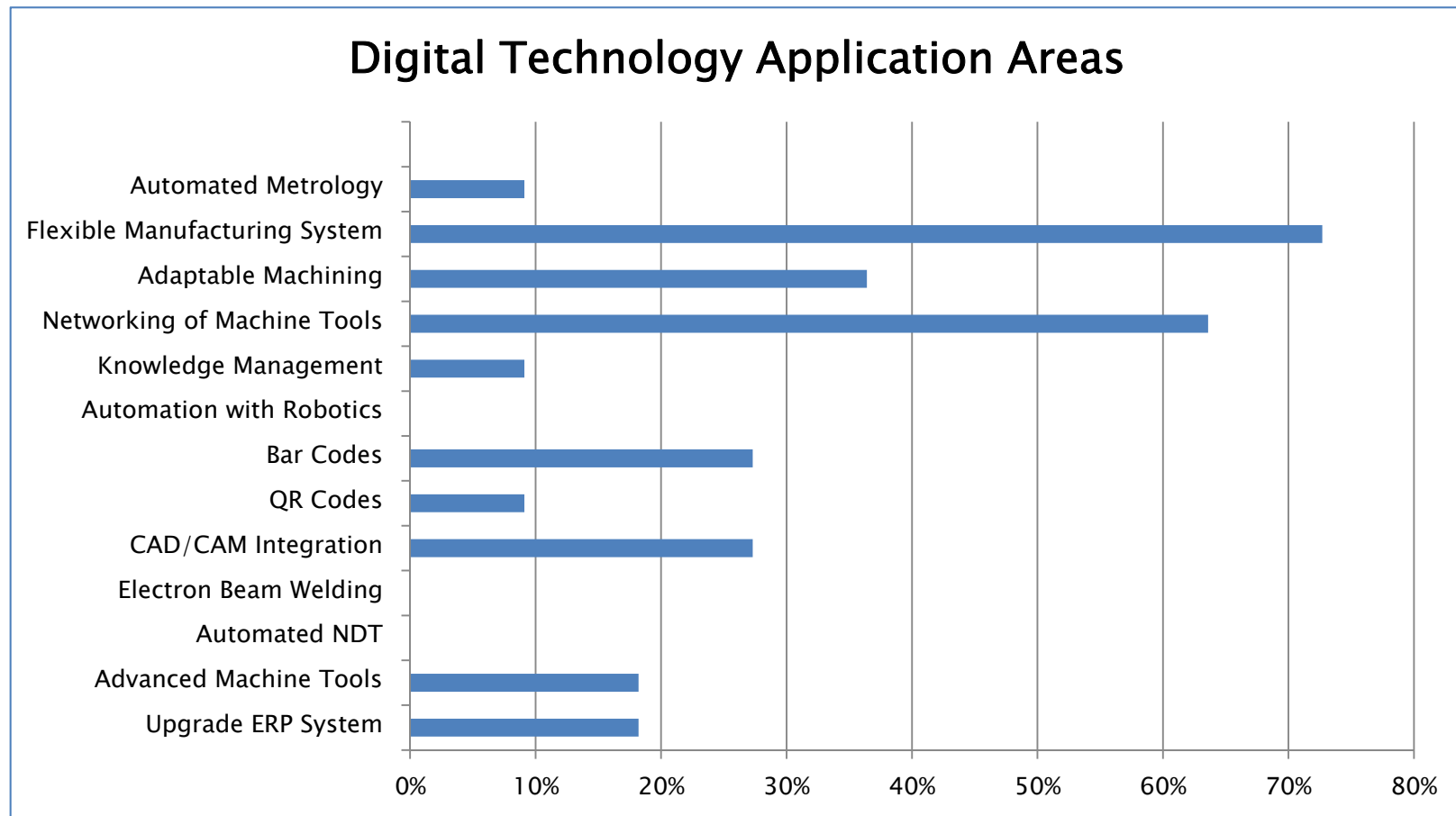
Findings



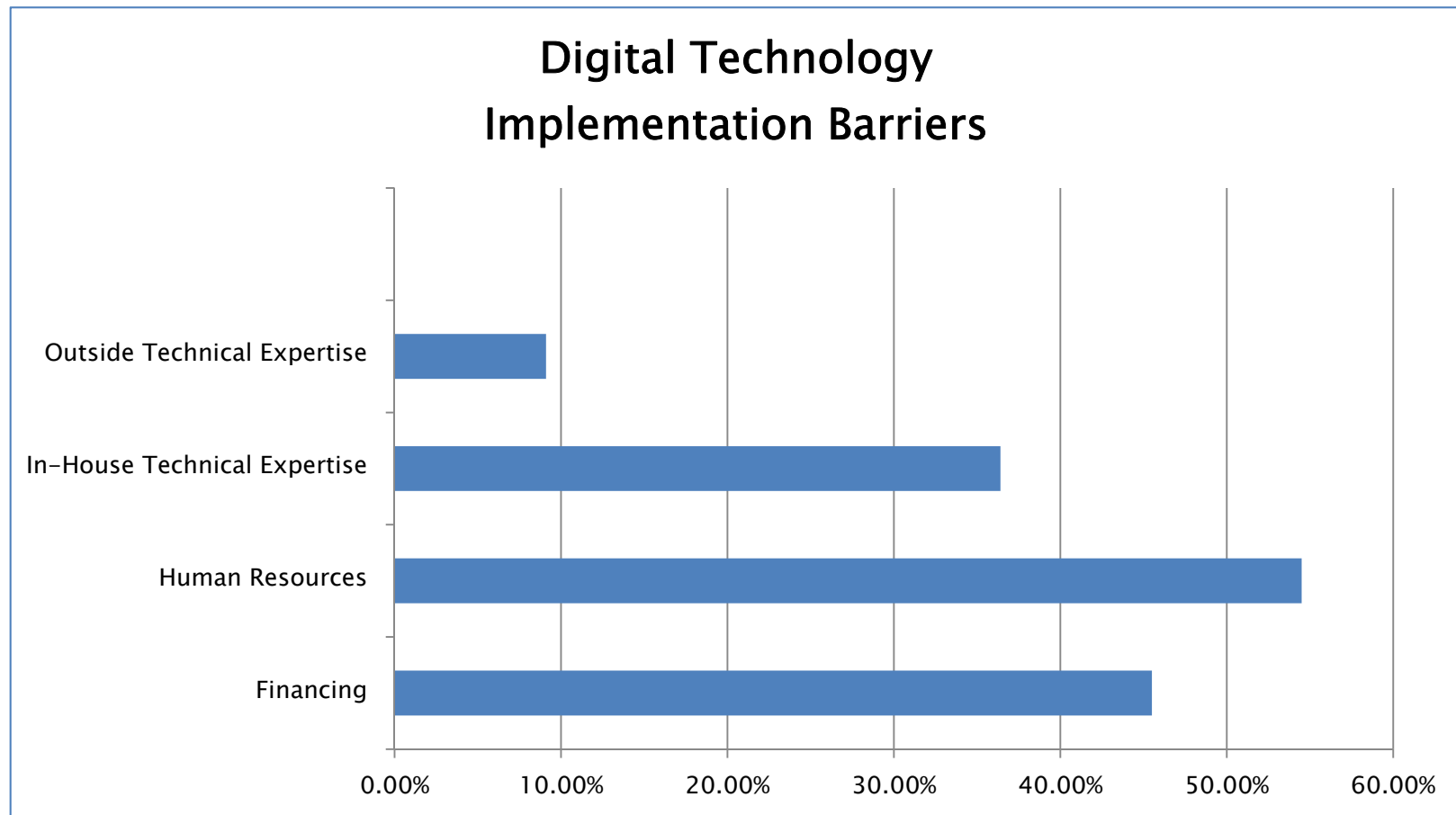
Findings



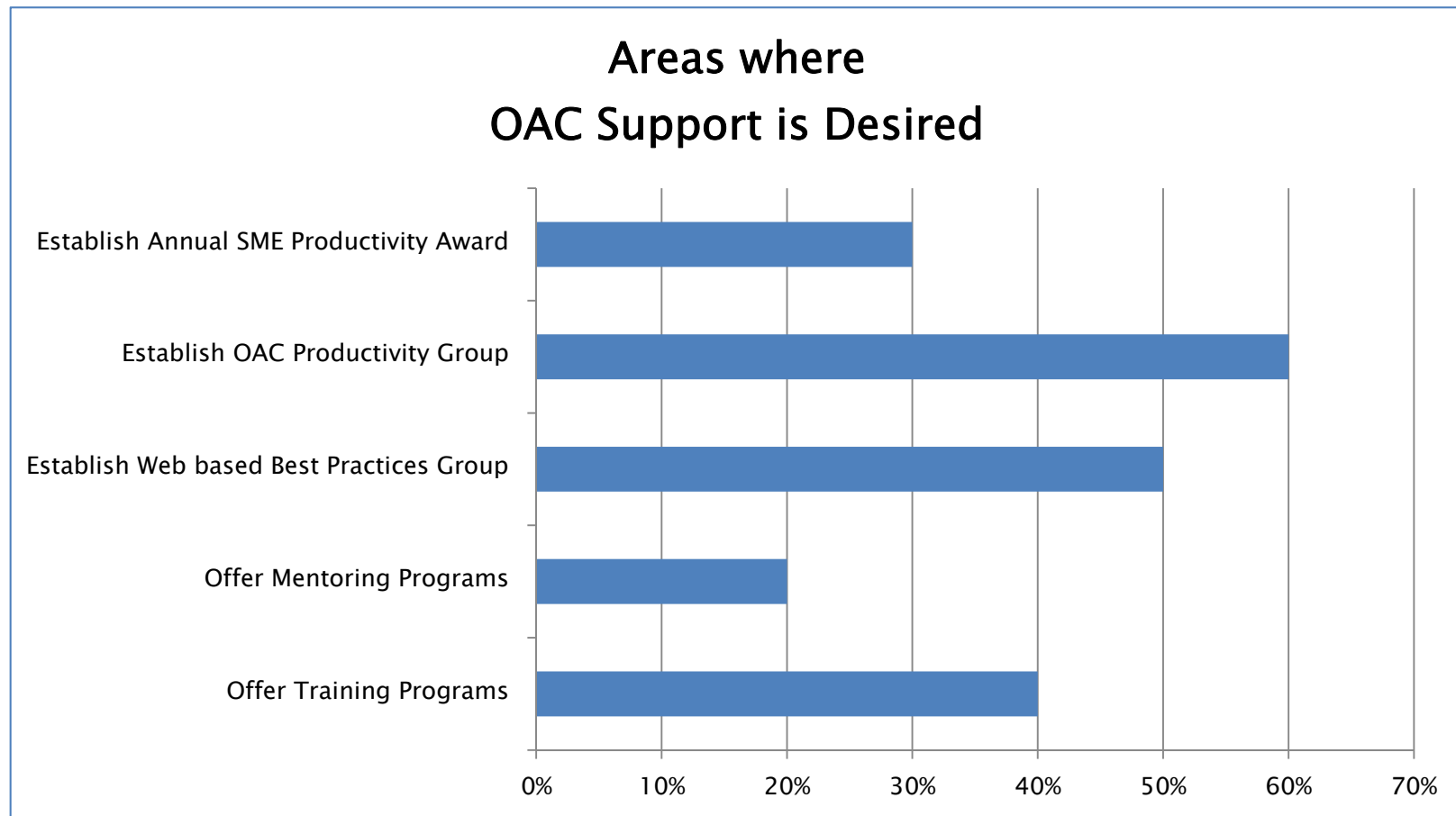
Findings



Findings



Findings



Lessons Learned

1. The interactive workshop and demonstration format was very successful in facilitating direct engagement among stakeholders – all stakeholders realized significant value from their participation.
2. Integrated perspectives, covering project, business & management and financing considerations, are critical in ensuring the SME firms make smart strategic investment decisions that will reliably achieve productivity gains through implementation of digital technologies.
3. Follow-on programs and communications are essential in order to ensure that the momentum achieved within the aerospace industry for implementation of digital technologies is sustained and widened.

Recommendations

Focus on sustaining and building SME profitability, global competitiveness and growth through:

- ▶ increasing SME awareness about the importance of making productivity improvements and about the value of digital technologies in achieving higher productivity,
- ▶ improving their abilities to make smart strategic investment decisions in selecting digital technologies that will yield real productivity gains in precision machining operations, and
- ▶ using sound practices to implement successfully the digital technologies in which they have chosen to invest.

Recommendations

1. Disseminate this report widely – post on OAC website, link with NRC-IRAP, distribute to other industry organizations across Canada
2. Develop a follow-up program to determine whether companies actually achieved successful implementations, what barriers they are facing, etc.
3. Develop a follow-up survey to help define training that will enable highly successful implementations by SME firms.
4. Develop and deliver training sessions based on survey results for SME managers to enable them to evaluate productivity opportunities with strategic investment decision considerations and metrics; training, mentoring and peer-to-peer interactions are important mechanisms for these education sessions.

Recommendations

5. Establish training and mentoring programs (involving larger aerospace firms, potentially) to bring credible and compelling support to SME firms.
6. Develop and facilitate opportunities for various relevant groups to support industry implementations e.g. systems and equipment providers, project management consultants, financial services providers, management accountants.
7. Establish a Canadian Aerospace Productivity group.
8. Develop a 'Tool Kit' of SME implementation support forms, templates etc.

Recommendations

9. Establish a web-based productivity communication tool to:
 - a. Gather and communicate Best Practices
 - b. Communicate Training
 - c. Deliver the SME Tool Kit (see Item 8 above)
 - d. Include a Repository of Support Services for project management, management accounting, etc.
 - e. Include a Repository of Technical Experts in Productivity, Digital Technologies, etc.
 - f. Link with other agencies
10. Develop a Strategic Investment Decision-Making guide.

Recommendations

11. Develop promotional strategies that recognize the value of opinion leaders as opposed to sales representatives.
12. Identify and make use of champions in companies as agenda setters, matchmakers and refiners in the adoption process.
13. Recognize that time, resources and facilitation are needed to reach the various types of companies and move them to the point of actual implementation of digital technologies.
14. Work with firms who provide digital technology equipment and software to facilitate trials of digital technologies with a few leading SMEs to build credibility, and capture the results via case studies.

Recommendations

15. Establish an OAC Annual Productivity Award to recognize companies who have made significant improvement in their Productivity through digital technologies or other means.
16. Establish and include consistent definitions of the digital technologies included in Surveys or information materials.
17. Provide real examples of applications of digital technologies in differing subsectors / types of companies.
18. Utilize additional subject-matter experts for future mentoring or training.
19. Expand this initiative to all aerospace SMEs across Canada, building on the OAC experience and engaging other Provincial aerospace associations as the best channels for reaching aerospace SMEs in each province or region.

Discussion

- ▶ What could / should be done with SME Precision Machining firms in Western Canada?
- ▶ Who should be involved?
- ▶ Who should take the lead?
- ▶ Next steps?

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