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14th Annual Conference
Sheraton Birmingham Hotel
October 22-25, 2006



How to Overcome the Maintenance Skills Shortage

Robert M. Williamson
Strategic Work Systems, Inc.
Columbus, North Carolina

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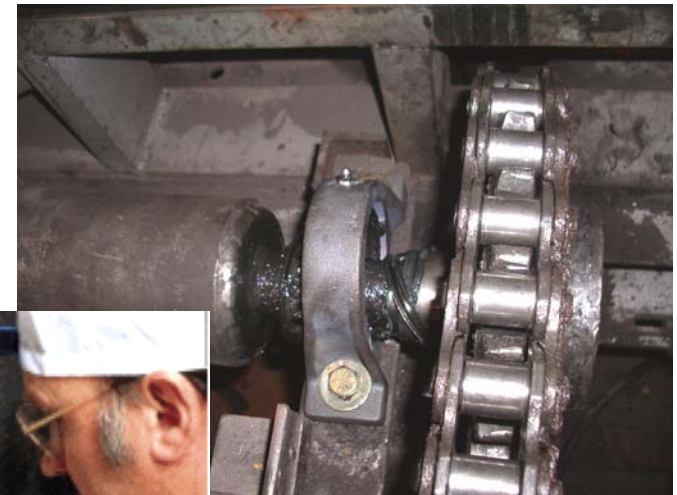
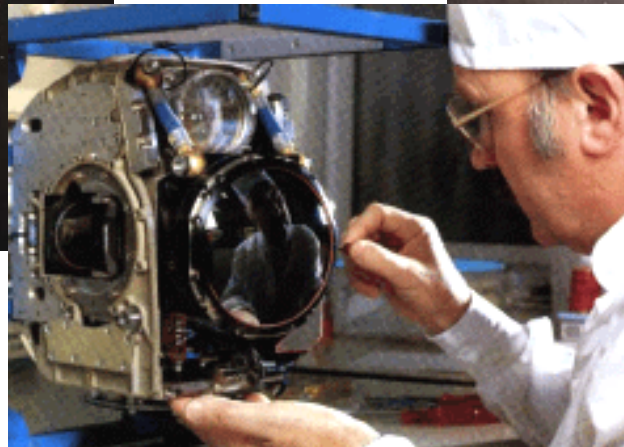
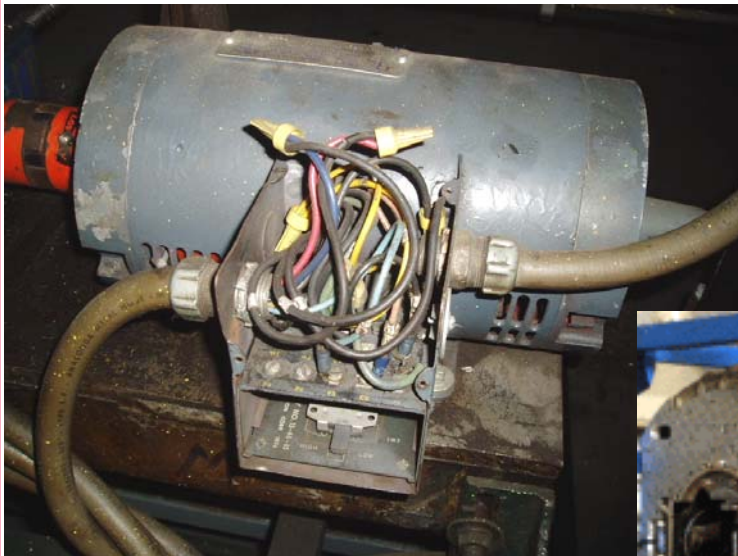
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“Maintenance is the least defined of all modern industrial activities in the world today”

March 2004 Robert M. Williamson



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We Are a Nation at Risk!

- **Baby-Boom Generation Retirement Age...**
 - Born 1946-1964
- **Vocational-Technical Education Programs Disappear**
- **Untrained Maintenance Workforce Emerges**
 - Apprentices, Craftsmen, Masters, Mentors/Protégé...
- **National Apathy: Manufacturing & Maintenance Jobs**
- **Skills and Labor Shortages**

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We are a Nation at risk!

Many equipment intensive operations will no longer be able to compete as the “Baby Boom” generation (born 1946 to 1964) retirements increase towards and after 2012 and competition for skilled maintenance & reliability workers increases.

Average retirement age rate: 11,247 per day for 19 years (2006-2024)

Unreliable, problem-prone equipment will increase costs, generate delays, frustrate employees, and force decision makers to take drastic actions.



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“Workforce Trends to Deliver Utility Industry a Knockout Blow”

A substantial number of mission-critical employees, from the executive suite down to linemen are rapidly approaching retirement age.

On average these employees are older than their counterparts in other industries and represent 50-60% of the industry’s knowledge assets.

40% of senior electrical engineers and 43% of shift supervisors will be eligible for retirement by 2009.

Hay Group report 2005
www.haygroup.com

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Skills Shortages...

The U.S Department of Labor is predicting that there will be a need for **776,000 new** Installation, Maintenance, and Repair workers between 2002 and 2012.

In addition they forecast the need for **1 million *replacement workers*** in the same occupations. Auto service technicians, mechanics, general maintenance, and repair workers will account for more than 40-percent of these jobs. ⁽²⁾

(2) Bureau of Labor Statistics, Occupational Outlook Handbook 2004-2005

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Maintenance Jobs Pay Well!

SOC Code Number	Occupation Title	Employment	Mean Hourly Wage	Mean Annual Wages	% of Total (49-0000)
49-0000	Installation, Maintenance, and Repair Occupations	727,460	\$19.61	\$40,790	100.00%
49-9042	Maintenance and Repair Workers, General	276,290	\$17.95	\$37,340	37.98%
49-9041	Industrial Machinery Mechanics	154,570	\$19.41	\$40,380	21.25%
49-1011	First-Line Supervisors/Managers of Mechanics, Installers, and Repairers	64,440	\$27.74	\$57,700	8.86%
49-9043	Maintenance Workers, Machinery	47,380	\$17.13	\$35,640	6.51%
49-9044	Millwrights	28,780	\$23.52	\$48,930	3.96%
49-2094	Electrical and Electronics Repairers, Commercial and Industrial Equipment	26,040	\$21.73	\$45,190	3.58%
49-3011	Aircraft Mechanics and Service Technicians	18,840	\$21.51	\$44,730	2.59%
49-9099	Installation, Maintenance, and Repair Workers, All Other	17,600	\$19.43	\$40,400	2.42%
	Sub Totals	633,940	\$21.00	\$43,788	87.14%

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High School Dropout Rate...

“America’s 30-percent high school dropout rate!”

The article also stated that ...

The Bush Administration was planning on diverting the Federal *Carl Perkins Vocational Education* funding to

“pay for No Child Left Behind high school initiatives which are geared toward a pre-college curriculum.”



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2006 Time/Oprah Winfrey poll...

1,000 adults surveyed:

“Should a student have the option of taking vocational education in high school to prepare for work rather than pursuing a college track?”

Eighty-eight (88) percent responded “Yes.”

Where were these votes what local and state boards of education cut vocational programs?

April 17, 2006 Time Magazine cover story

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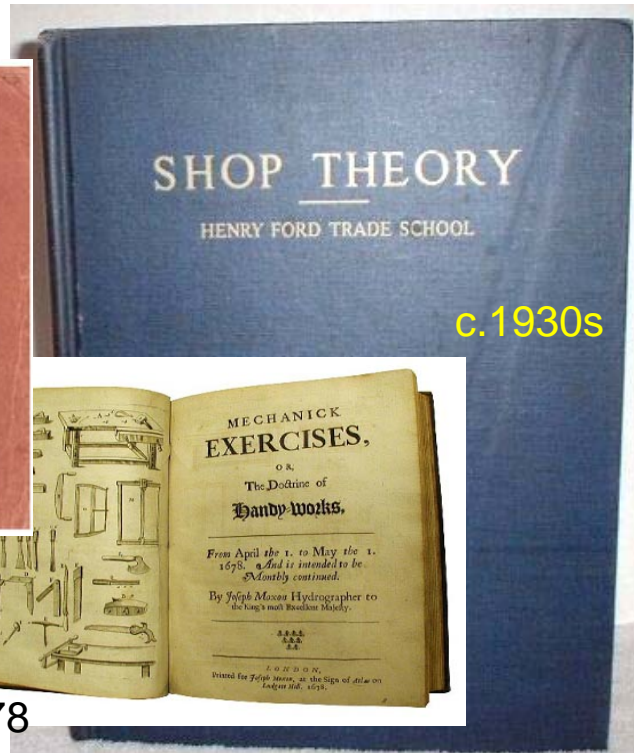
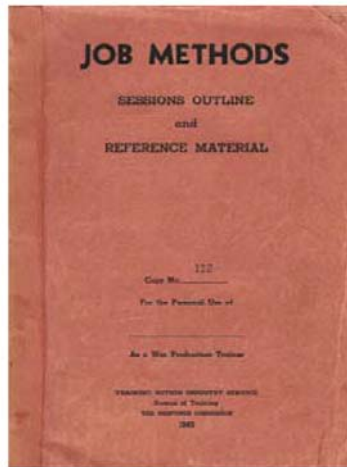
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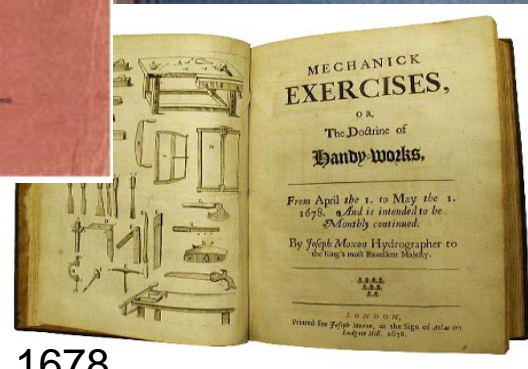
We are a Nation at risk!

Most maintenance employees in “small to midsized” companies have not been formally trained to perform the jobs they do every day: **Some estimate 80%!**

The vocational-technical and industrial education programs in junior high, high school, and post secondary schools have declined at an alarming rate over the past 20 years.



c.1930s



1678

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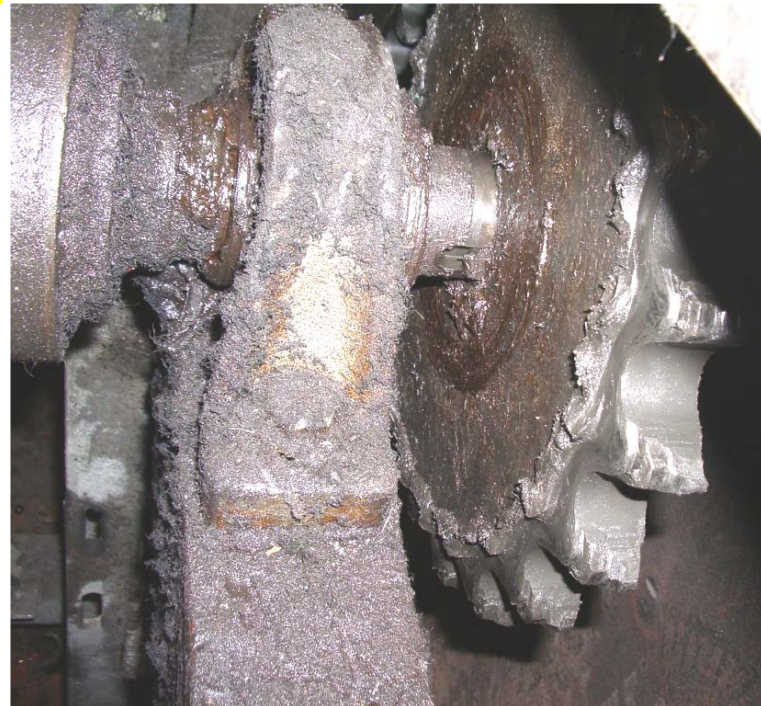
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We are a Nation at risk!

Most of tomorrow's maintenance employees will not have benefited from formal job-specific skills & knowledge training at any point in their lives...



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Capital-intensive businesses most at risk...

Gross output and Total Employment year ending 2004:

Industry	% of Gross Output	Gross Output Dollars (2004)	% of Workforce	Full time Employees (equivalents)(2004)
Manufacturing	20.20%	\$4,311,624,000,000	11.33%	14,112,000
Accommodation and food services	3.80%	\$596,596,000,000	6.82%	8,491,000
Broadcasting and telecommunications	3.02%	\$645,152,000,000	1.07%	1,327,000
Transportation and warehousing	3.00%	\$640,421,000,000	3.25%	4,052,000
Hospitals & nursing residential care facilities	2.68%	\$571,571,000,000	5.22%	6,494,000
Utilities	1.73%	\$368,508,000,000	0.45%	562,000
Agriculture, forestry, fishing, and hunting	1.49%	\$319,003,000,000	1.06%	1,319,000
Publishing industries	1.19%	\$254,935,000,000	0.68%	844,000
Oil and gas extractions	0.89%	\$189,521,000,000	0.10%	121,000
Waste management and remediation services	0.28%	\$59,558,000,000	0.25%	314,000
Mining, except oil & gas	0.26%	\$55,150,000,000	0.16%	204,000
	38.54%	\$8,012,039,000,000	30.39%	37,840,000

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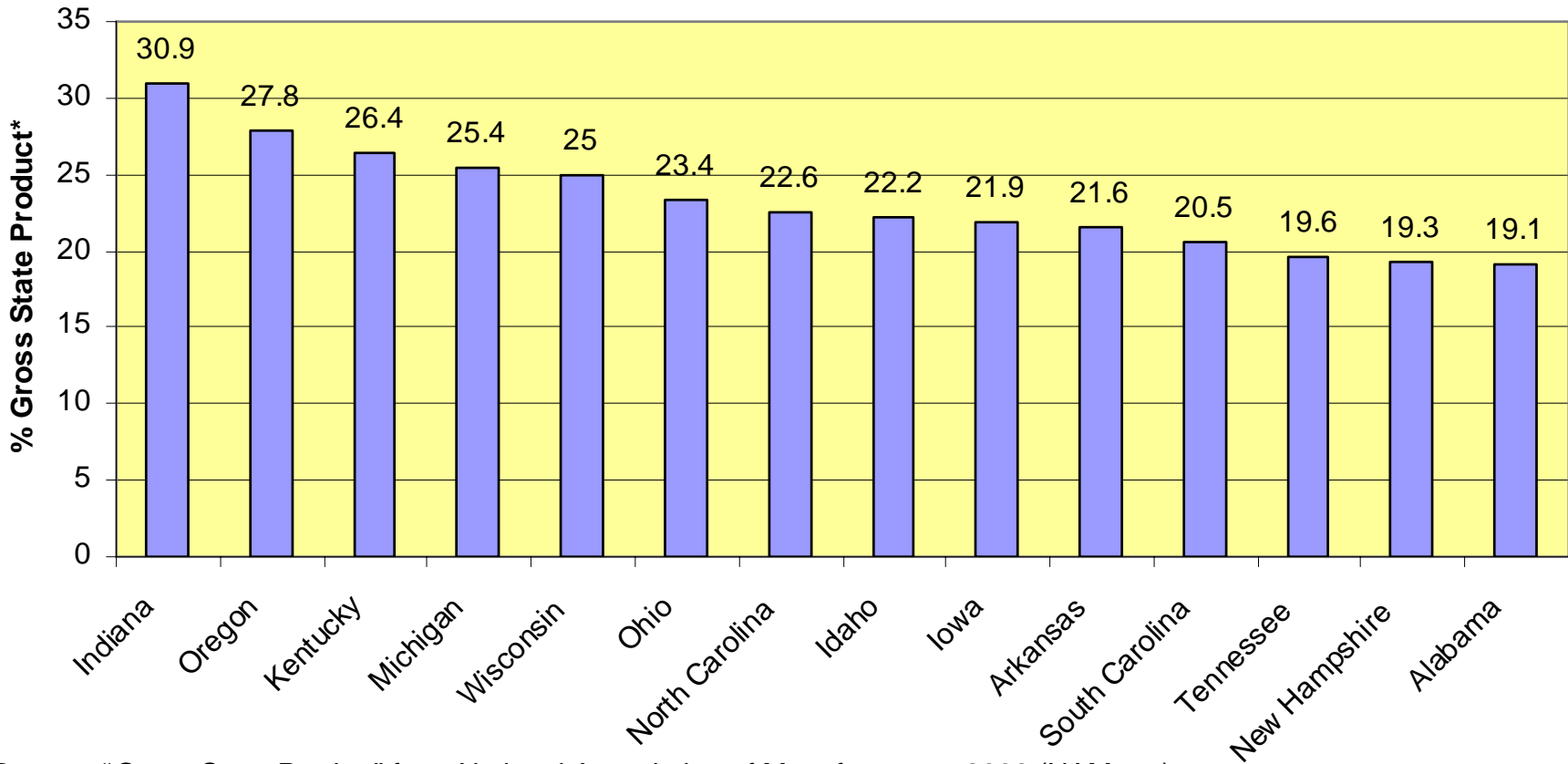
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States in the U.S. with the Most to Gain (or risk losing!)

Largest Share of Manufacturing GSP*



* Data on "Gross State Product" from National Association of Manufacturers, 2006 (NAM.org)



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Bird Flu Outranks Our Biggest Looming Economic Crisis 37 to 1 (172 to 1)...

9 Aug 2006 Google hits:

- Bird Flu 47,300,000
- Industrial maintenance 1,260,000
- Equipment Reliability 275,000

Dec 2003 - Apr 2006: 113 Bird Flu deaths worldwide (avg. 48/year)...

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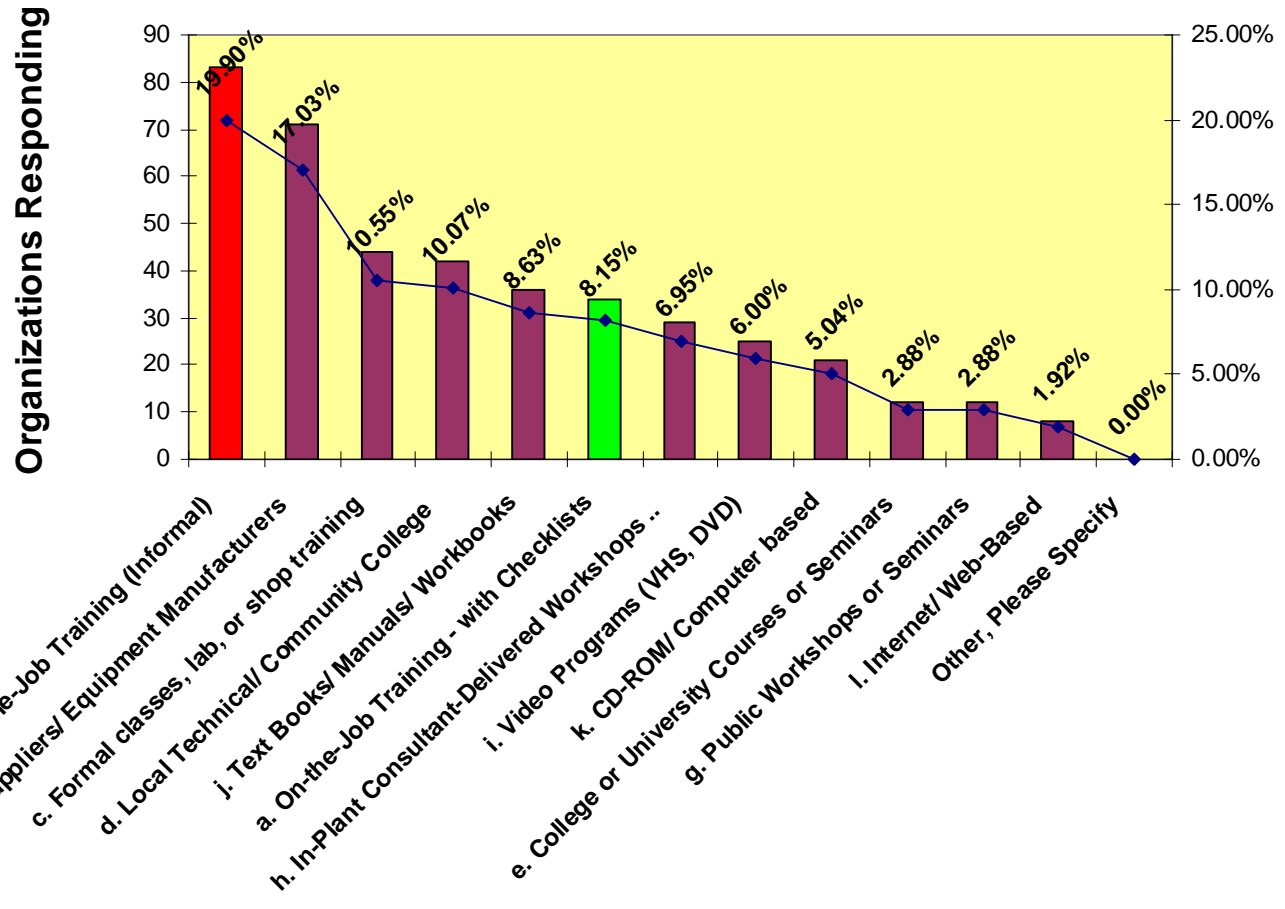


Status of *Maintenance Training in America*

- **8-percent** of the responding companies have formal equipment/task specific training
- **27-percent** stated that they have a formal list of duties and tasks (job-performance requirements)
- **16-percent** qualify their maintenance personnel with a formal skills demonstration
- **47-percent** report a maintenance skills shortage exists at their business now
- **Another 22-percent** anticipate a skills shortage within three to five years
- **A troubling 14-percent** don't know if they have a skills shortage
- **The reported skills shortages** where training needs are NOT being met:
 - #1 – Electrical maintenance
 - #2 – Mechanical maintenance
 - #3 – Instrumentation and Controls maintenance



Training Resources or Methods Most Often Used



Mid 2005 – February 2006 *Maintenance Technology Magazine* survey of 30 different U.S. industries (unpublished)

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Hierarchy of maintenance & reliability training/qualification:

- 1. Aptitude, ability, literacy** (family, schooling)
- 2. Basic skills and knowledge** (schooling)
- 3. Core skills and knowledge** (job specific duties-tasks)
- 4. Equipment-specific skills & knowledge**
(plant-specific methods, procedures)

What level of qualification assures M&R results?



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What is the future of manufacturing?



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Think outside the box!

The business case is NOT about improving maintenance...

But rather improving equipment performance & reliability

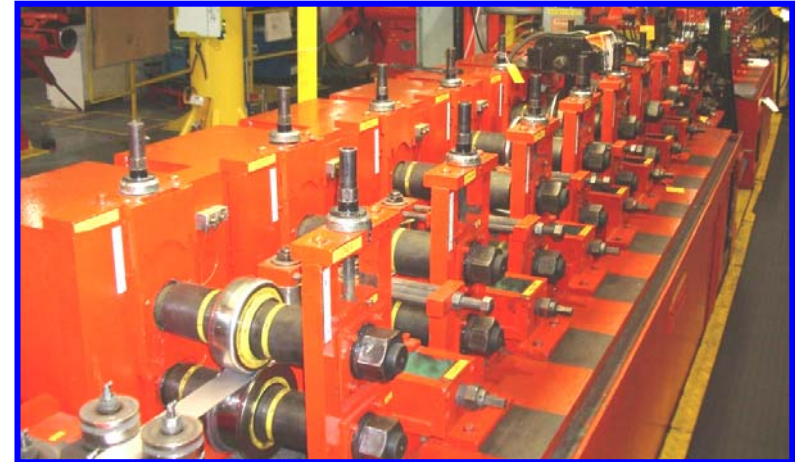


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Equipment-Related Losses...

Availability

- A. **Planned shutdown losses:**
 - 1. *No production, breaks, shift change, etc.*
 - 2. *Planned Maintenance*
- B. **Downtime losses:**
 - 3. *Waiting for Operators*
 - 4. *Failure or breakdowns*
 - 5. *Setups & Changeover*
 - 6. *Tooling or Part Changes*
 - 7. *Startup & Adjustment*
 - 8. *No room for output*
 - 9. *No incoming materials*
- C. **Performance efficiency losses:**
 - 10. *Minor stops (less than 6 minutes)*
 - 11. *Reduced speed or cycle time*
- D. **Quality losses:**
 - 12. *Scrap product / output*
 - 13. *Defects, rework*
 - 14. *Yield / Transition*

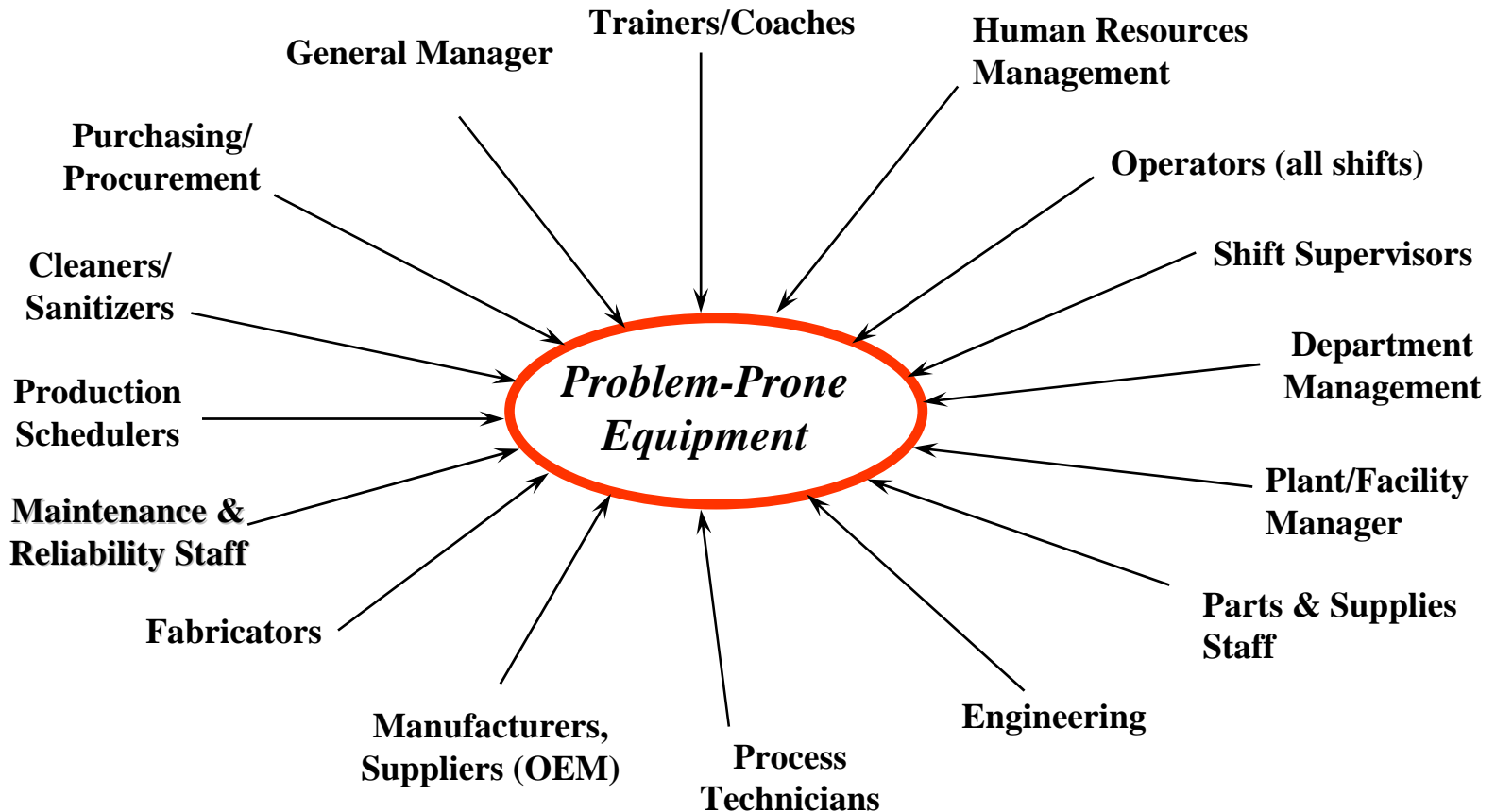


“Maintenance cannot do it alone!”

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More than 90% of the reasons for equipment-related losses are *OUTSIDE* of the direct control of the maintenance organization.



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We CAN pursue perfection in America

29 Foreign nameplate Auto Manufacturing facilities employing nearly 70,000 American employees and hundreds of foreign-owned automotive suppliers employing over 200,000 American employees operating in the U.S. are PROOF that we can operate, maintain, and grow world-class manufacturing plants.

So, what's the problem at GM, Ford, Delphi, Visteon...?

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How to overcome the skills shortages:

6 recommendations...

1. Top level business leadership, decision makers must recognize the breadth and depth of the skills shortage

- Quantify the impact unreliable equipment in terms of costs, lost revenue (lost production)
- A “skills shortage” is not the same as a “labor shortage”



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How to overcome the skills shortages:

2. Top level business leadership must LEAD the necessary change...

- Focusing on the “business case for change”
- Recognizing that most “equipment-related losses” are outside the direct control of the maintenance department

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How to overcome the skills shortages:

3. Focus all improvement efforts on specific measurable business results

- **Specific business losses**
 - Sales, revenues, on-time delivery, product growth, competition...
- **Target specific BIG losses for improvement**
 - Use the “Theory of Constraints”
 - Use “Lean” waste elimination scenarios

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How to overcome the skills shortages:

4. Identify the “root causes” of the BIG losses (Focus on results...)

- Eliminate the causes QUICKLY with specific countermeasures
- Reinforce the new, desired behaviors and results for sustainability
- AVOID “programs” and “activities” in the hopes of improving performance long term

(continued)

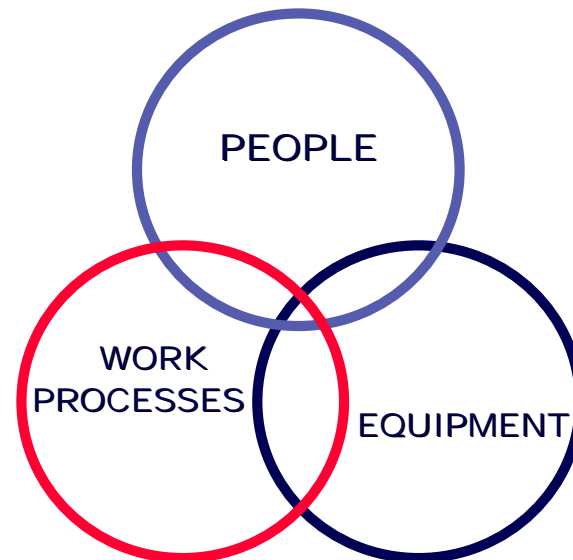
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How to overcome the skills shortages:

4. *Continued: Focus on results...*

- Three elements of productivity
- 1st: Equipment data
- 2nd: People
(skills, knowledge, abilities)
- 3rd: Work Processes:
(methods, procedures, systems, best practices...)





How to overcome the skills shortages:

5. *Formal Training & Qualification*

- Address applied skills & knowledge gaps
- “Formal” means *documented, instructionally sound, outcome-based learning of job-related skills and knowledge that can be immediately applied*
- Focus all training on specific results
- Train and qualify for 100% mastery
- Periodic re-qualification/re-certification

(continued)

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How to overcome the skills shortages:

5. Formal Training & Qualification (continued)

- a. Identify targeted problematic equipment
- b. Identify causes or contributing factors
- c. Verify the accuracy & completeness of the equipment “work processes”
- d. Three levels of training & qualification
 - Process & job overview
 - Core job skills and knowledge
 - Equipment & task specific procedural training

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How to overcome the skills shortages:

5. Formal Training & Qualification (continued)

- e. Determine process & job overview training prerequisites for equipment tasks
- f. Determine core job skills and knowledge prerequisites...
- g. Procure or develop process & job overview and core skills & knowledge training programs/materials



How to overcome the skills shortages:

5. Formal Training & Qualification (continued)

h. Assess all perspective trainee's related core and procedural skills/knowledge

- Prepare individual training & qualification plans

i. Train and Qualify

- Classroom training (small group, instructor led)
- Formal OJT (on-job training) with checklists*
- Web-based training
- Self-study training with coach/mentor
- Workshops/seminars

* Most effective for adults and maintenance/reliability jobs



How to overcome the skills shortages:

5. Formal Training & Qualification (continued)

- j. Train in equipment-specific tasks, work processes, best-practice procedures
- k. On-job performance demonstration/qualification
- l. Audit job performance. Re-train and qualify as needed



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How to overcome the skills shortages:

6. Error-proof operations and maintenance by applying “visuals”

- Visual cues (training reminders)
- Critical information ON the equipment
- Makes operations and maintenance easier
- Facilitates Troubleshooting/problem solving
- Reduces equipment-specific training time by 60% to 80%

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Process X
Temperature
Set Point 74°F



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Summary...

- **Typical barriers...**
 - Resource constrained (people, time, & money)
 - Increasing reactive repair work
 - **Typical training approaches too cumbersome:**
 - Time consuming (inefficient)
 - Not directly related to our workplace (ineffective)
 - Class sizes
 - Inconvenient schedules
 - Disinterested (& fearful) training participants



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Summary...

- **Training is only part of the solution...**
 - **Maintenance cannot improve M&R alone!**
 - Partnering with all who affect equipment reliability is key
 - **All training must (MUST) focus on measurable improvements... business results**
 - **Traditional approaches to maintenance may no longer be effective**
 - **Skills and labor shortages are the wave of the future! And, the future is upon us, now!**



Summary...

– Change the work culture

- *“Focus on results and change the culture along the way”SM*
- Culture change requires a “compelling business case for change”
- Culture change requires fast and sustainable gains
- Culture change requires consistency of purpose
- Culture change is required to improve M&R in many equipment-intensive businesses



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How to Overcome the Maintenance Skills Shortage
Shift the focus from improving maintenance to improving equipment performance and reliability



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Suggested Resources:

Dinero, Donald A. 2005. *Training Within Industry*, Productivity Press, New York

“Warning: Vocational Classes Falling out of Favor,” *Maintenance Technology Magazine* (Viewpoint column).

Williamson, Robert M. March 2005.

“The Biggest Threat to Equipment Reliability: Skills Shortage.” *Maintenance Technology Magazine* (Viewpoint column). Williamson, Robert M. June 2005.

“Lessons Learned from the Busted Knuckle Garage.” *Maintenance Technology Magazine* (Viewpoint column). Williamson, Robert M. September 2005.

“Part 1- Skills Training Approaches for Fast & Sustainable Equipment Reliability: Recommendations for Survival” *Maintenance Technology Magazine*. Williamson, Robert M. January 2006.

“Part 2 – Skills Training Approaches for Fast & Sustainable Equipment Reliability: Focus-on-Results Training & Qualification Process *Maintenance Technology Magazine*. Williamson, Robert M. February 2006.

“Procedure Based Maintenance” Conference paper by Jack R. Nicholas at IMC 12/6/2004 and Reliability World Conference 4/27/2005 (<http://www.reliabilityweb.com>)

“2005 Skills Gap Report – A Survey of the American Manufacturing Workforce.” National Association of Manufacturers, Manufacturing Institute, DeLoitte Consulting LLP, November 22, 2005

Williamson, Robert M. 2006. *Lean Machines: A Definitive Guide for Improving Equipment Operability & Maintainability Through Visuals and Minor Modifications*. SWS Press, PO Box 70, Columbus, NC 28722. On line www.swspitcrew.com

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Other resources:

“**Manufacturing Now**” (3M/NAM video) 12 minutes, facilitator guide, student guide, resource list. For grades 7-12. 86/468-TECH (www.gettech.org) produced by US Dept of Commerce & NAM Center for Workforce Success. 2002

Book: “**Facts About Modern Manufacturing**” (7 Adobe PDF files free online) www.nam.org (Produced with a grant from Toyota)

MSSC (Manufacturing Skills Standards Council) www.msscusa.org
“Tools for Workforce Excellence” – “Training the Industrial Athlete of the Future”

- Book: “**High-Performance Manufacturing: Portable Production Skills**” \$35.97

- CD-Rom: “**Blueprint for Workforce Excellence**” (The original federally-endorsed skills standards) \$80.00

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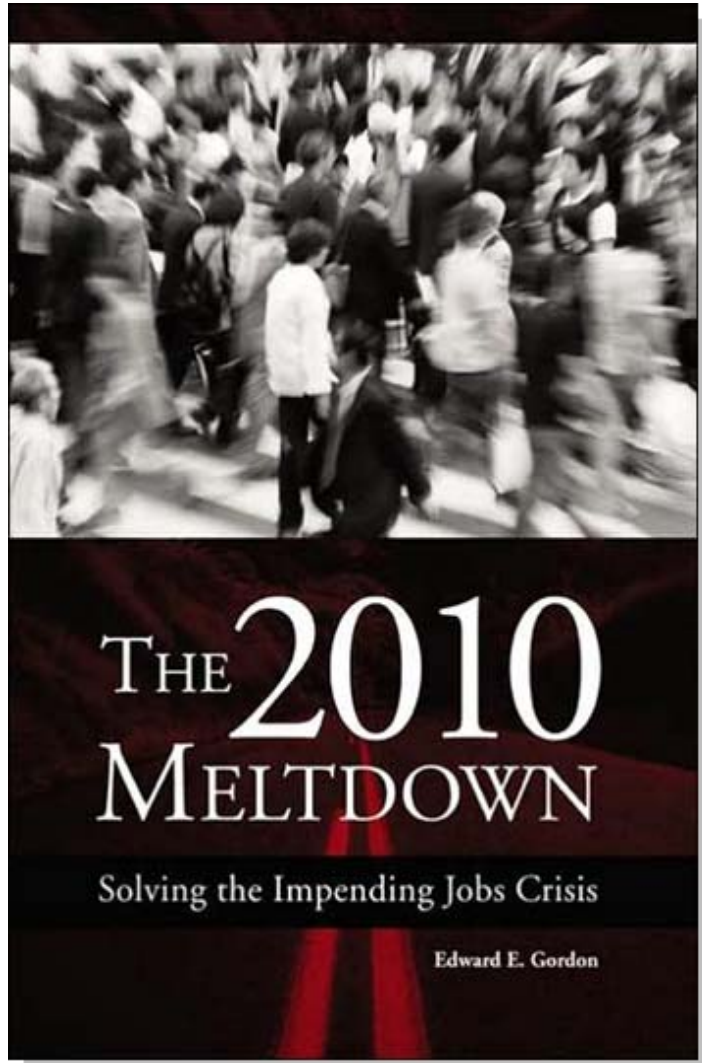
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The problem Chicago-based consultant **Edward E. Gordon** sees is not a lack of jobs, but a lack of people to do them as baby boomers retire and the next generation has not been properly educated or trained for the high-skill, technology-related jobs that will be available. He describes how the US came to where it is, the current situation and its implications, and solutions for structuring renewal. (Sept 2005)

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How to Overcome the Maintenance Skills Shortage

Robert (Bob) Williamson is a workplace educator with more than 35 years of experience helping companies and workgroups improve the performance of their equipment and work processes through applied education and training. His background in maintenance mechanics, special machine and tooling design, and teaching vocational/technical courses has prepared him for a career that has taken him into well over 400 plant and company locations developing operations and maintenance training, Total Productive Maintenance development, multi-skill maintenance job design, pay-for-applied skills design, and “Lean Equipment Management.” After 24 years in post-secondary technical education and plant engineering/construction he formed Strategic Work Systems, Inc. in 1993 to focus on the people-side of world class manufacturing and maintenance. He has also studied and taught the “team-based reliability” principles from *NASCAR Racing* for nearly 10 years. His hundreds of articles and conference papers since the mid 1980s have addressed the “people-side of manufacturing and maintenance reliability.”

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