

Evaluating the Capabilities, Costs, Risks and Benefits of Green Products

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15th Workshop on Alternatives to Toxic
Materials in Industrial Processes

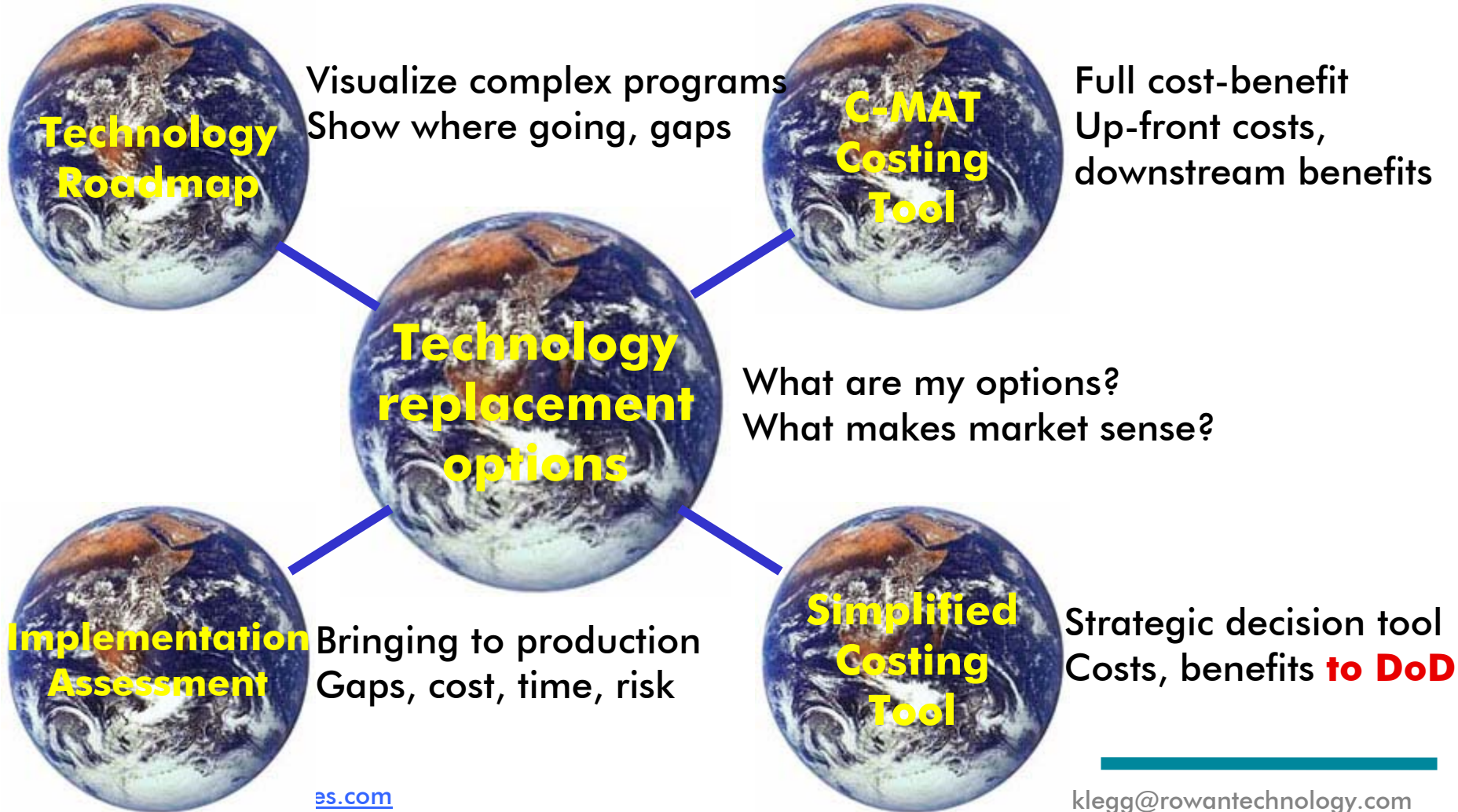
Phoenix, January 2005

The new technology dilemma

- ❑ What are the available options?
- ❑ How production ready is it, and what will it take to make it production ready?
 - Development, cost, risk
- ❑ What is the overall cost and benefit of this to DoD?
- ❑ What is the cost and benefit to our organization?

During the course of our work for HCAT, the Joint Strike Fighter and commercial clients we have developed a suite of tools for answering these

A suite of tools for evaluating alternative technologies



Technology Assessment

- ❑ What are the requirements?
- ❑ What technologies are out there today that will do the job (often in commercial use)
- ❑ What technologies are coming along, what is their TRL, and what will it take to bring them to production?
- ❑ Rack and stack the best options

**We do a lot of these
assessments for the JSF ESOH
Working Group
Some short and sweet**

C-MAT Decision Tool



C-MAT Costing Tool

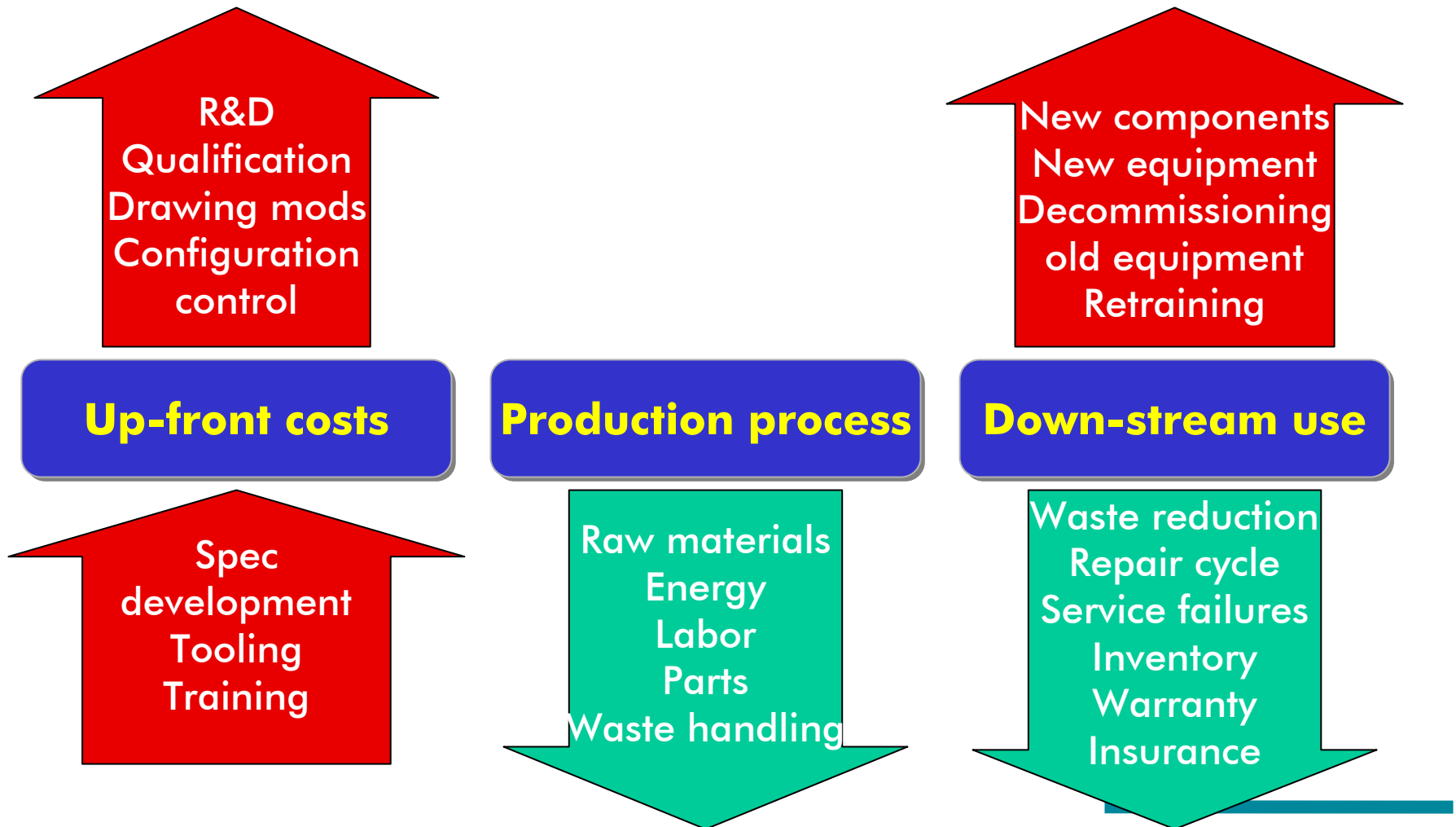


- ❑ Calculation for Material Alternative Technologies
- ❑ Decision Tool funded by SERDP for Stainless Steel Landing Gear program
 - Designed for analysis of materials and process substitutions
 - Very extensive inclusion of up-front costs and down-stream benefits
 - Inclusion of data accuracy estimates to assess financial risk
 - Standard financial measures (Cash Flow, NPV, ROI, Payback Period)
- ❑ C-MAT does not just measure the cost/benefit of using the new technology vs the cost of using the old – it measures what you really do:
 - **It measures the full costs and benefits of moving to the new technology vs the costs and benefits of continuing to use the old**

What does the typical analysis leave out?

- ❑ Pretty much all the big stuff!
 - Cost of developing the technology
 - Full cost of qualifying it and putting it into production
 - All the savings derived from performance improvements
 - Changes in (reduction of!) service failures
 - ◆ With all collateral costs involved
 - Reduction of component condemnation
 - ◆ With all collateral costs involved
- ❑ They also give no idea of the true range of likely outcomes, given the uncertainties in the data
- ❑ C-MAT is designed to go beyond ECAM to incorporate all these factors

Costs and Benefits



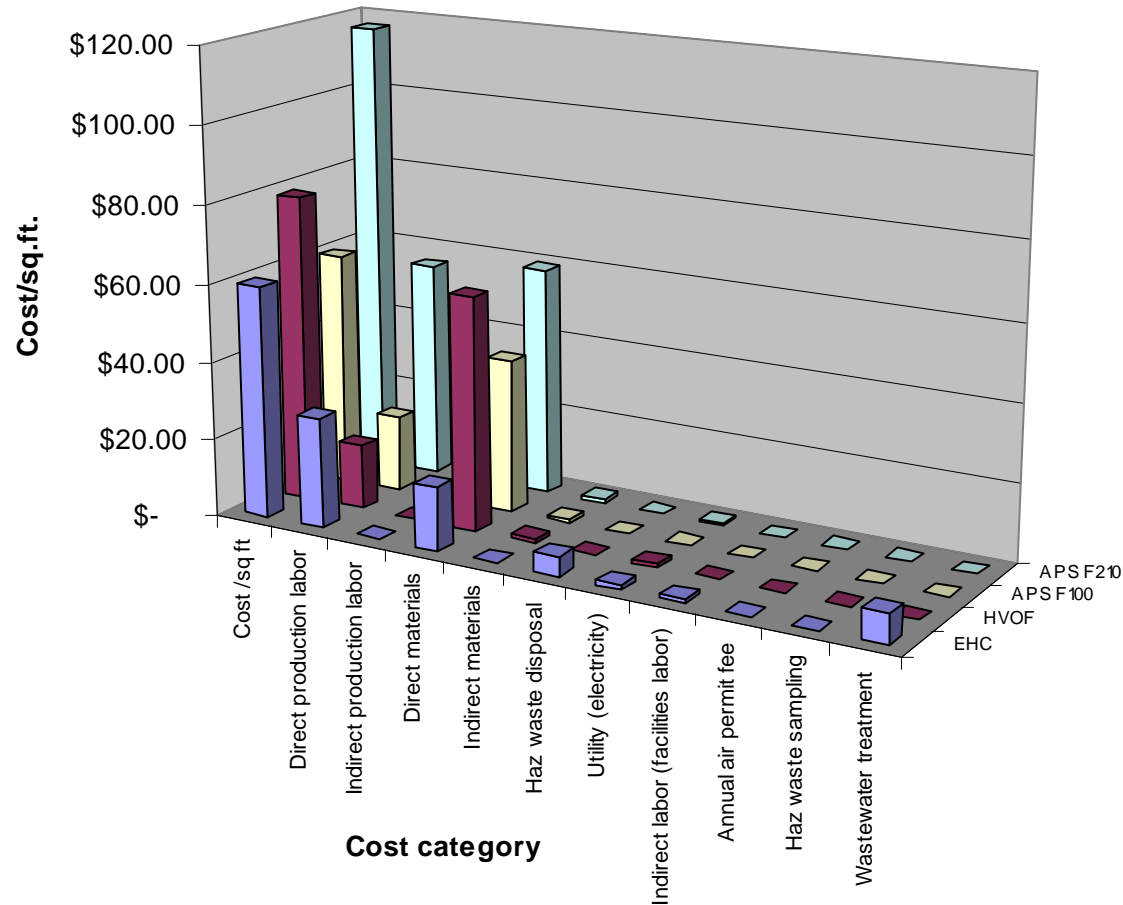
The critical question

□ Why do people want to change technologies?

- The real answer is rarely “Because Cr/Cd/[name-your-poison] is bad and we want to quit using it”
- It is usually an engineering, cost, worker safety, availability , or readiness issue:
 - ◆ Ogden would like to replace Cd-plated landing gear because of the frequent corrosion and stress corrosion cracking failures associated with Cd-plated 300M
 - The primary driver is service failure cost, with all its collateral damage costs and risks to personnel
 - ◆ NADEP Cherry Point would like to replace chrome-plated prop hub parts with HVOF-sprayed parts because it will extend the service life of parts that are no longer made
 - The primary driver is avoiding part condemnation and ensuring readiness – keeping planes flying
 - ◆ NADEP Jacksonville would like to replace ID chrome plate to reduce time-in-process and get faster turnaround back to the fleet
 - Improves readiness and war-fighting capacity

Example – replacement of ID hard chrome with ID plasma spray at NADEP-JAX

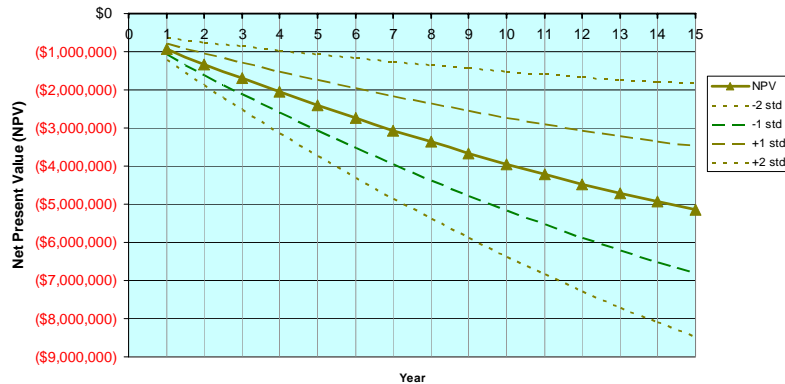
- ❑ Raw production cost break out differently
 - EHC – labor, materials waste management
 - HVOF – primarily materials (powder)
 - ID APS – labor and materials (slower deposition)
 - ID APS is higher cost than HVOF
 - ◆ OD APS is usually cheaper than HVOF as similar deposition rate but less gas



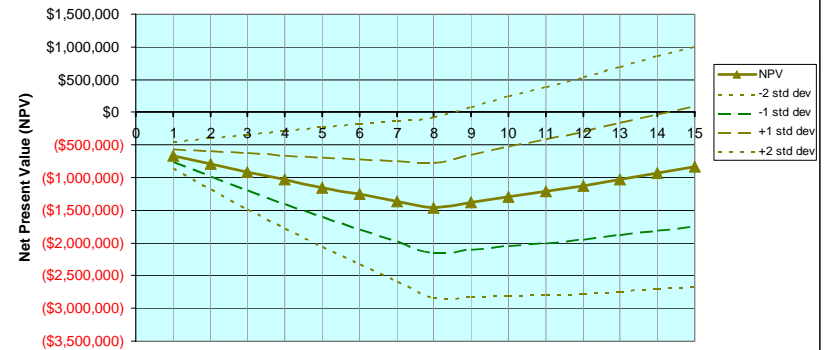
Some simple calculations

F210 gun

NPV - Cost based

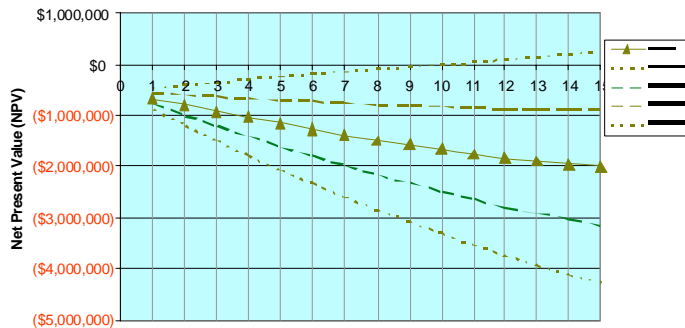


F-100 gun lower wear rate



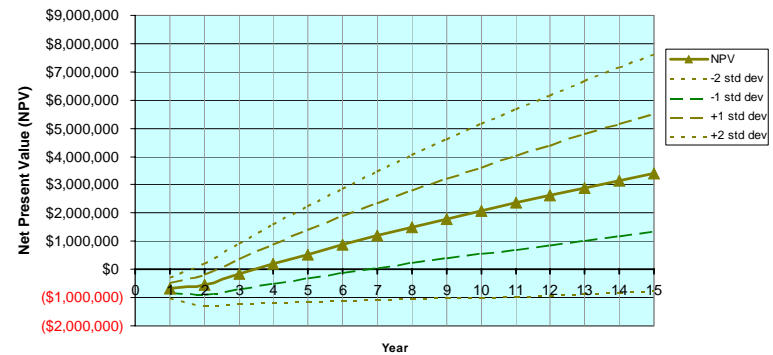
F-100 gun

NPV - Cost based



F-100 gun lower PEL

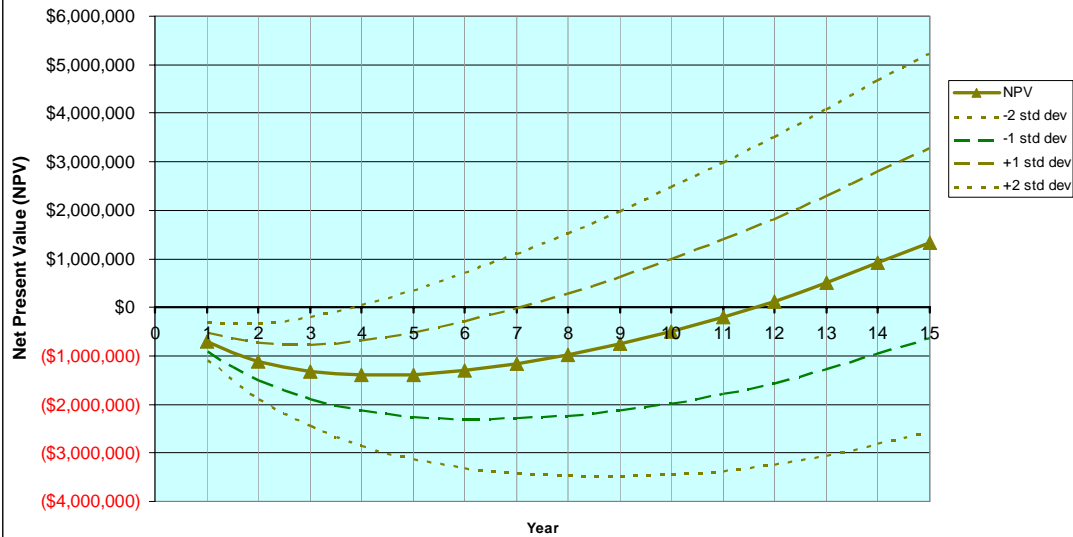
ost based



NPV as function of how far out you look for simple process cost comparisons

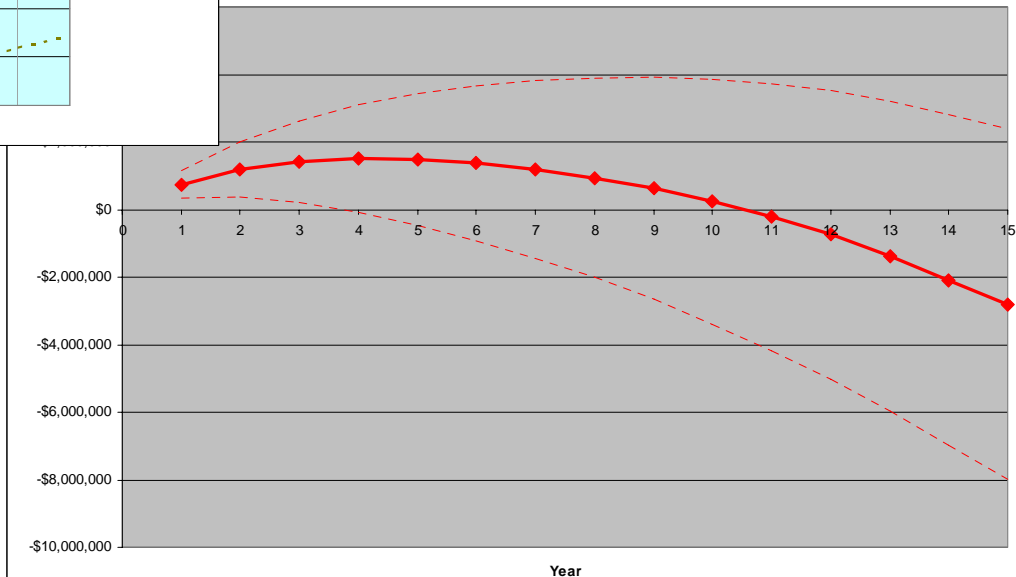
Realistic calculations

NPV - Cost based



15 year	-2 sigma	Value	+2 sigma
NPV	(\$2,588,124)	\$1,321,544	\$5,231,211
IRR		9%	26%
ROI	24%	42%	61%
Payback period	>15 years	10.5	3.7

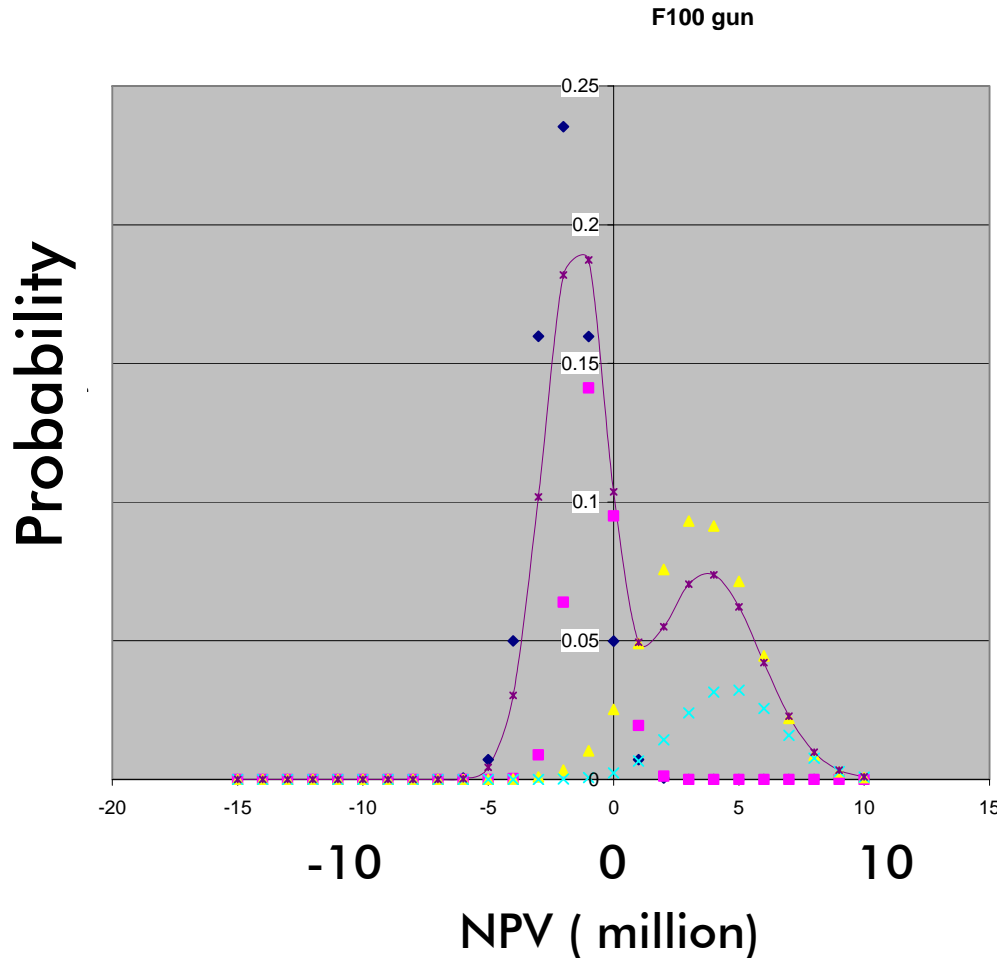
Cumulative cost, with 2-sigma lines



Assumes:

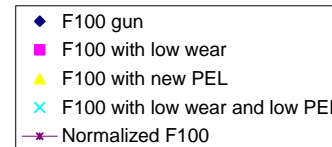
1. Coating is more wear resistant
2. OSHA PEL is adopted and costs as much as expected

So, what is the likelihood it will really be cost-effective?



Can predict probability of a particular NPV, e.g.

- Assume 33% chance wear rate will really be $\frac{1}{2}$
- Assume 50% chance of PEL adoption and cost



Areas under curves – 50% probability of coming out ahead

Conclusion:

1. Life is uncertain
2. Eat dessert first

So, why do it?

- ❑ Turnaround has become critical issue
 - Readiness and maintaining combat operations
 - Leaning and greening of MRO operations
- ❑ Logistics
 - The longer maintenance takes the more spares you need in the theater of operations
- ❑ Efficiency
 - Makes most logical sense when already using HVOF on other components or OD areas of same component (e.g. landing gear cylinder)



C-MAT is available at <http://www.rowantechnology.com/c-mat.htm>

Simplified Cost Modeling

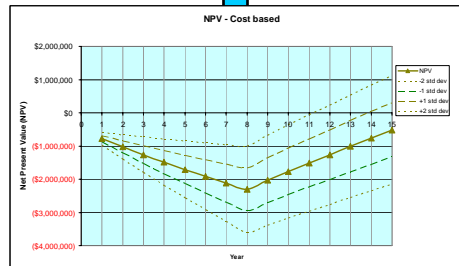
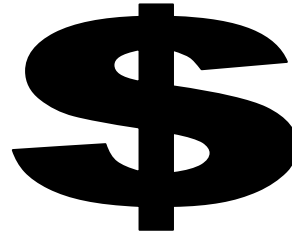
Under development based on OC-ALC
Collaboration with PEWG and P&W
Should be ready by mid 2005

Green Material Benefit – Linking hazmat reduction with cost savings...

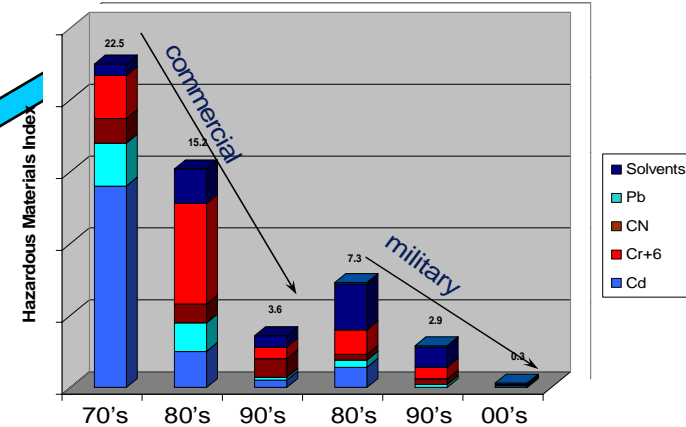
Environmental Program Budget Costs

Category	Labor	Materials
Manpower	6.35%	2.64%
Education & Training	0.70%	0.29%
Permits & Fees	0.21%	0.09%
Sampling, Analysis & Monitoring	1.30%	0.54%
Waste Disposal	0.85%	0.35%
Other Recurring Costs	4.33%	1.80%
TOTAL RECURRING COSTS	13.75%	5.71%
RCRA C-Hazardous Waste	1.55%	0.64%
RCRA D-Solid Waste	0.33%	0.14%
RCRA I-Underground Storage Tanks	0.25%	0.10%
Clean Air Act	2.48%	1.03%
Clean Water Act	2.60%	1.08%
Planning	1.41%	0.58%
SDWA	1.25%	0.52%
Hazardous Material Reduction	0.75%	0.31%
T&E Species	0.37%	0.15%
Wetlands	0.03%	0.01%
Other Natural Resources	0.13%	0.05%
Historical & Cultural Resources	0.56%	0.23%
Other Non-Recurring	1.15%	0.48%
TOTAL NON-RECURRING COSTS	12.85%	5.34%
TOTAL	27.08%	11.25%

Annual environmental budget from US Air Force \$500M, 27% depot labor, 11% depot materials



Existing C-MAT tool for Hazmat costs



Environmental Hazmat Index (HMI) metrics by product vintage/source

- Setting priorities for clean technology
- Justifying insertion of clean technology at maintenance facilities
- Communicating DoD global cost savings with Pentagon

Standard CBAs never show true total cost of dealing with hazmats

- ❑ For almost any CBA the environmental cost is minuscule (<5%), yet according to the Air Force budget the cost is 27% of labor and 11% of materials
 - The CBA is narrowly focused and can only consider hazmat costs associated with the specific, narrow issue
 - Rarely consider impact of total replacement of a hazmat across all platforms or a complete engine line
 - ◆ They do not consider the cost of building and running a wastewater treatment plant, employing a full environmental office, replacing an entire plating shop to every 15-20 years
 - ◆ **But those are the real costs for depots and for DoD**

What do we want to do that is different from the standard CBA?

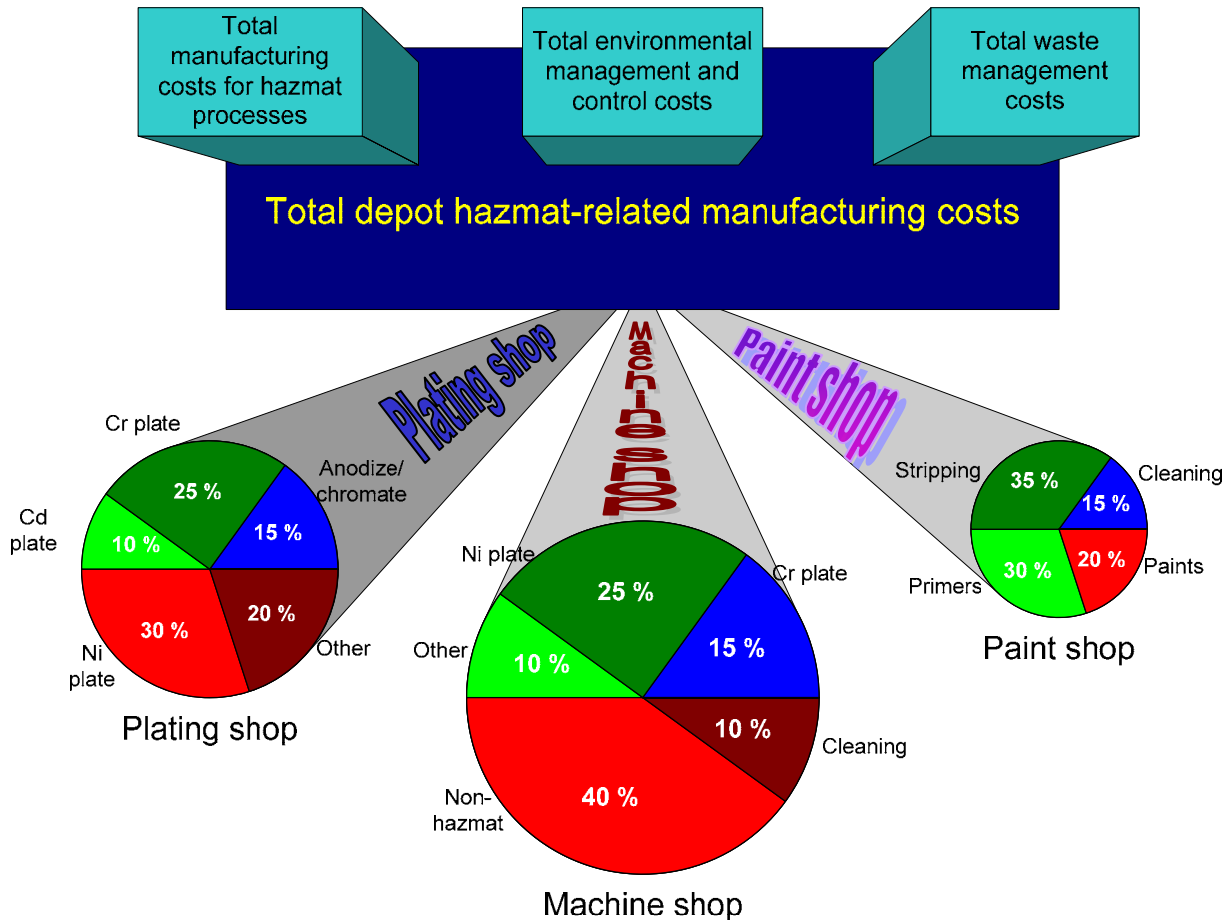
Standard CBA

- ❑ Purpose is to provide a detailed estimate of costs and benefits for a specific situation
 - Tactical – used to provide ROI, NPV, etc to justify a limited change
- ❑ Purely monetary – no correlation with hazmat level
- ❑ Hazmat costs – measures cost to shop, not to DoD
 - Charge/gal of wastewater, etc.

Simplified analysis

- ❑ Purpose is to provide a quick estimate of true cost to depot/DoD
 - Strategic – use as a tool to assess value to organization of globally reducing hazmats
- ❑ Link **total facility cost** with the **degree of hazmat reduction**
- ❑ Quick and easy
 - Goal is 1 hr engineer time
 - Built-in default costs for processes and materials
 - Will work from **web**

Information being assembled



- ❑ Top-down depot costs to capture **full** manufacturing and environmental costs
- ❑ Bottom-up partitioning of waste streams and production costs between hazmat processes
- ❑ Approx process cost breakdown
- ❑ Partition # parts among engine lines

What will this allow you to do?

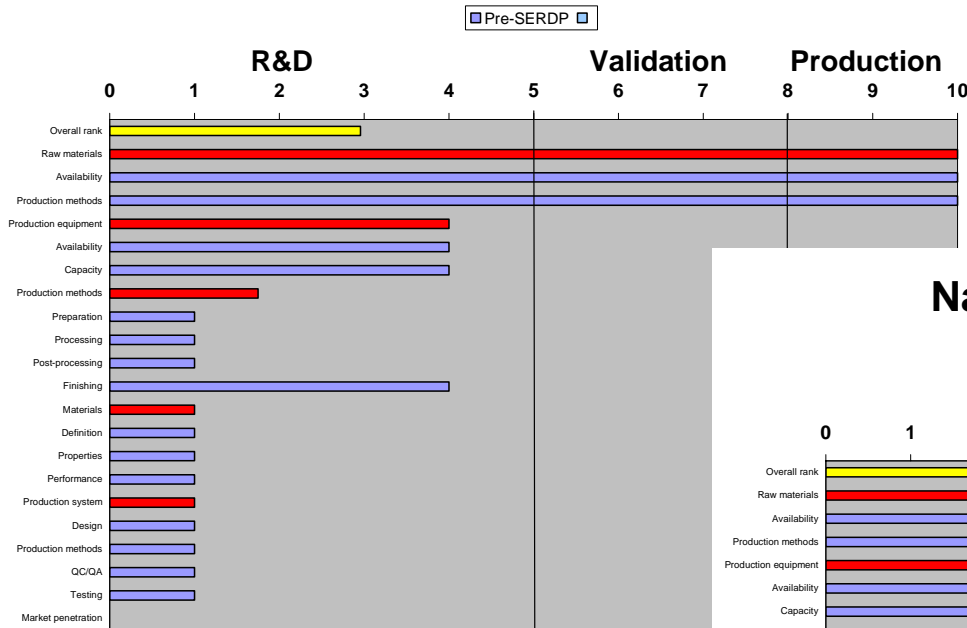
- ❑ Work out the benefit in cost and hazmat reduction when changing out a process depot-wide
- ❑ Work out approximate cost and hazmat impact of replacing a process across an engine line
 - Hence prioritize technology changes
- ❑ Demonstrate to the Pentagon the total strategic value of a material or process change
 - Helps acquire the funding to carry out the change

This does not obviate the need for full CBAs, but gives a way of quickly prioritizing options by identifying the biggest bang for the buck and clearly demonstrating it

Implementation Assessment

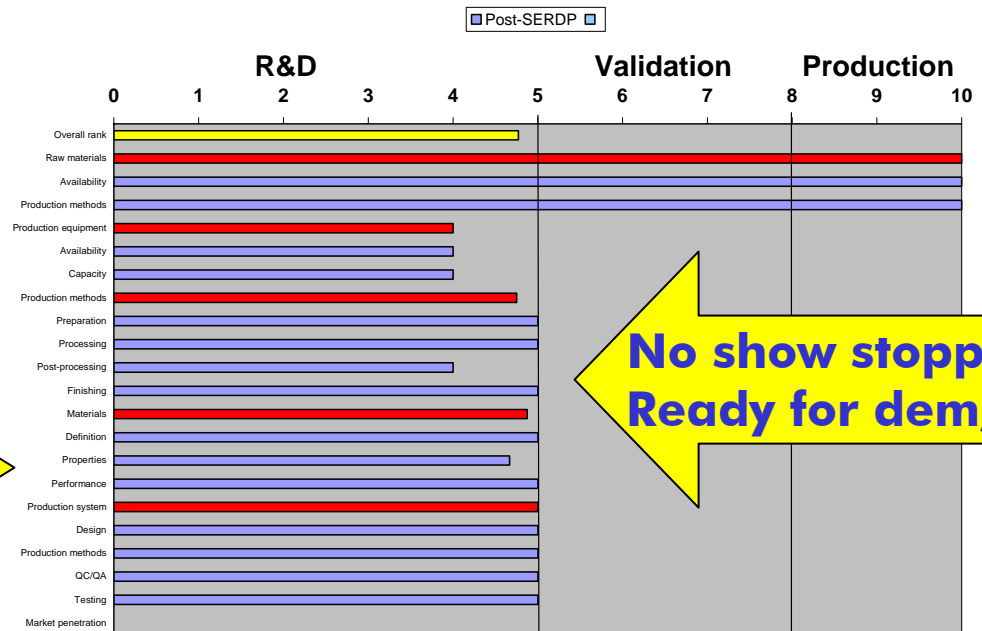
nCo-P development – SERDP Project #1152

Nanophase Co alloy electroplate



Pre-SERDP

Nanophase Co alloy electroplate



No show stoppers!
Ready for dem/val

Post SERDP

An Implementation Assessment



Implementation Assessment

Replacement of Internal Diameter Hard Chrome with Plasma Spray Coatings at NADEP Jacksonville

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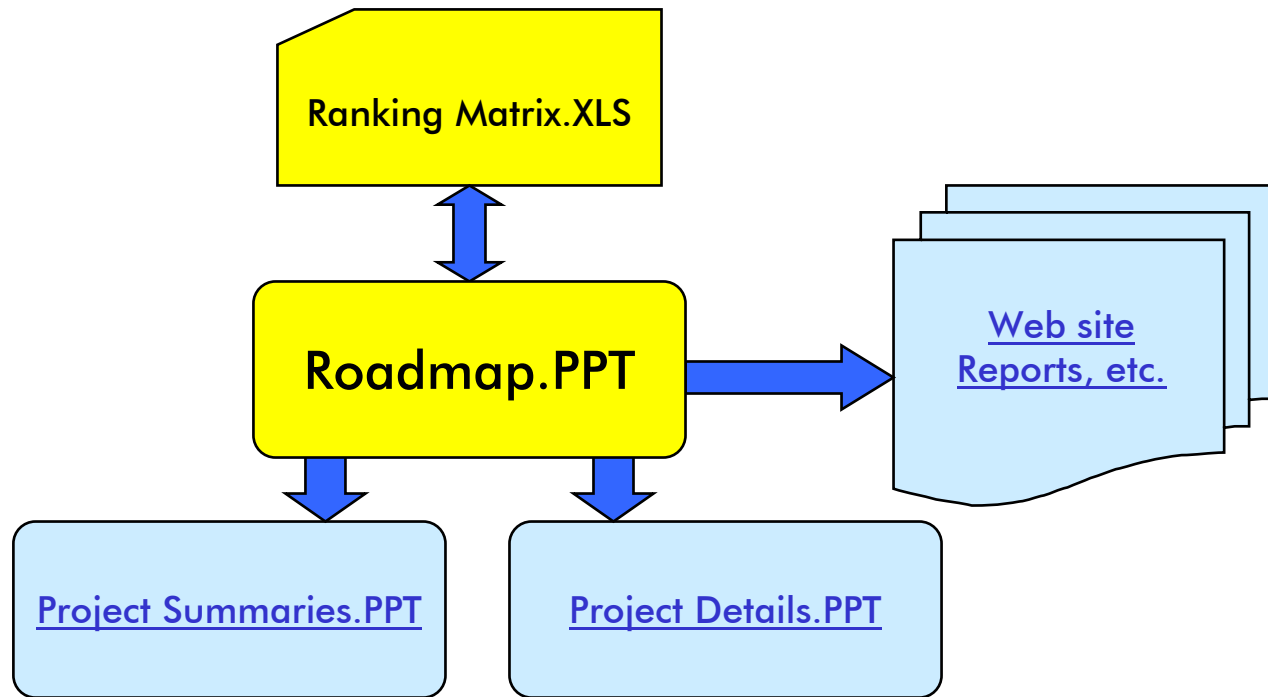
[Appendix 1. TRL Definitions](#)

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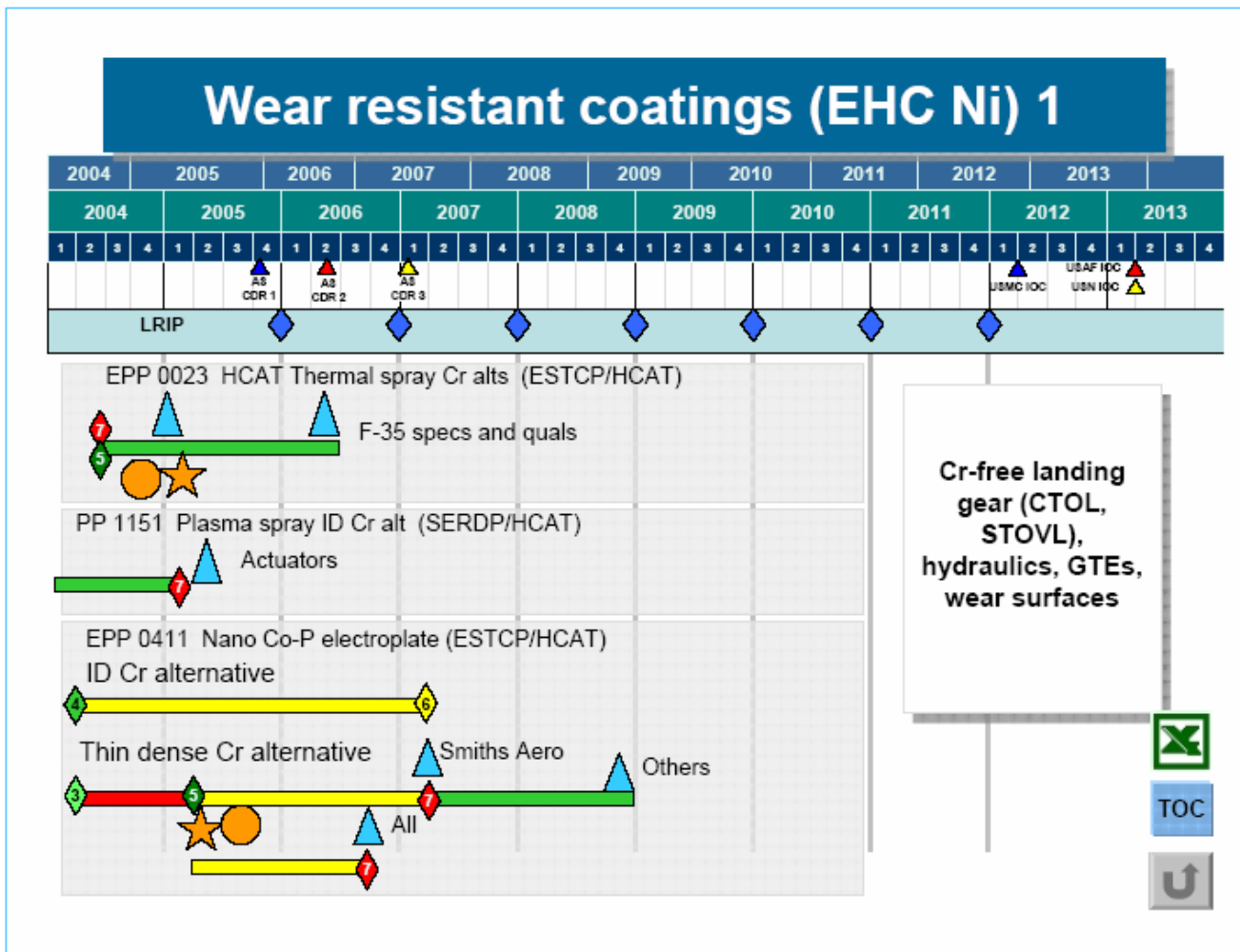
Roadmapping

Structure of Roadmap



Ranking Matrix and the Roadmap are downloaded and modified
All the rest is held on web site

Structure



- ❑ Shows timelines, decision points, technology insertion
- ❑ Interactive links to project details
- ❑ Interactive with funding and other decisions

Dual purpose

- ❑ For program office and management
 - **Top level view – gory details hidden**
 - Track projects, overview budgets
 - See gaps and make sure projects on track to fill them
 - Decide what to fund and keep track of funded and important projects

- ❑ For technical teams
 - **All the gory details**
 - Keep track of projects and what is coming down the pike from all related DoD and commercial programs
 - Keep track of gaps and find ways to fill them

Conclusions

- ❑ Clean technology decisions are far from trivial
- ❑ There are various new tools available to help make decisions on technology solutions, costs, risks

