

Cost-Effective Alternative Methods for Steel Bridge Paint System Maintenance

A Program Overview and Focus on
Eight Field Painting Technologies

Federal Highway Administration
Contract No. DTFH61-97-C-00026

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Presentation Outline

- Objectives
- Approach
- Cost Model
- Technologies
- Comparisons



Objective

- To Identify Methodologies and Technologies that will Reduce the Cost of Bridge Maintenance Painting for Steel Bridge Owners.
 - Compare Technologies by Cost
 - Distribute Program Results



Need for this Study

- Too Many Choices
- Not Enough Money



Many Choices

Surface Preparations

- At least 12 major different Methods

Coatings

- At least 10 different generic types

Other Criteria

- At least 10 vital variables



= Thousands of Options

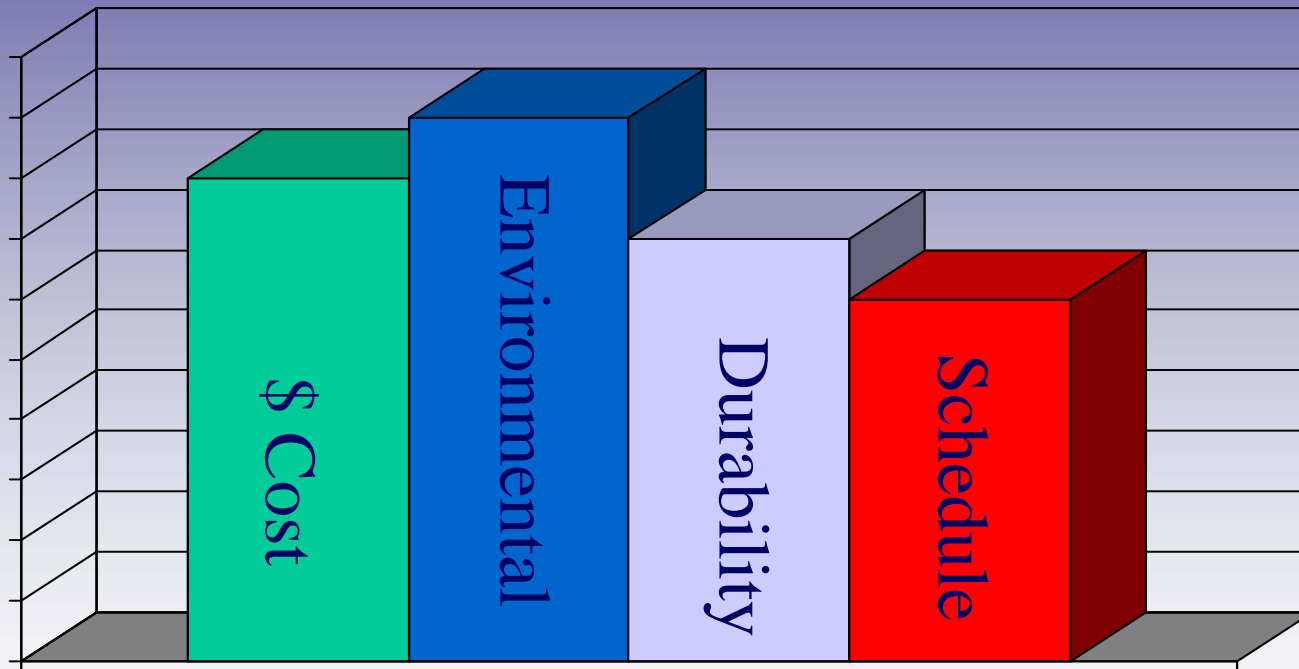


Approach

- Compare “New” Technologies to the Current “State-of-the-Practice”
- Initial Cost is the Main Comparison Criteria
- Cost Model Developed
 - A Comparison Tool
 - Major Project Cost Factors
 - Potential Cost Saving Technologies



Approach (cont.)



Other Project Drivers

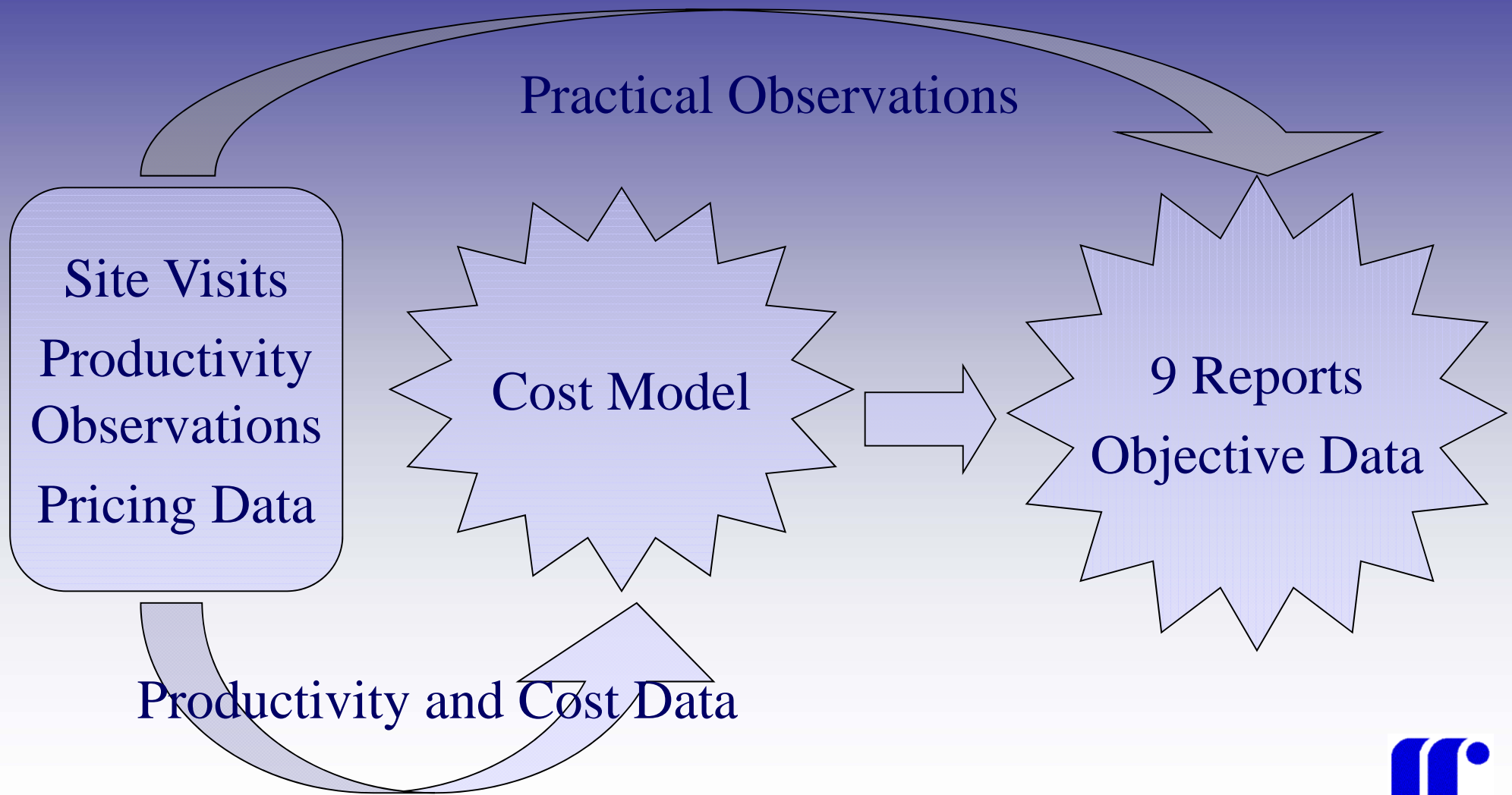


Approach (cont.)

- Field Visits and Interviews
 - Real Project Data
 - Mature Work Practices
- Reports Comparing Technologies to the Current-State-of-Practice



Program Overview



The Cost Model - What is it and How Does it Work?

- A Comparison Tool
- User Inputs Project Constraints
- User Selects Painting Options
- Model Quickly Evaluates Process Changes
- Summarizes Data Various Ways

Designed to provide activity-based cost estimates
Allows alternative technology comparisons
Validated through field observations
Fully adjustable cost factors (e.g. for regional labor differences)
Default data is based on this study



Cost Model Calculations

- Creates a Time Estimate Based on User Inputs
 - Mobilization-Demob Time / Containment Time / Surface Preparation Time / Painting Time
- Estimates Project Materials
 - Abrasive / Water Usage
 - Paint Required
 - Waste Produced
- Compiles Estimate Based on Unit Cost Factors



- Project Constraints
- Bridge Square Footage
- Percent Area Deteriorated
- Lead in Coating
- Containment / Staging
- Labor Rates / Workday Duration

Project Constraints

Cost Effective Alternate Methods for Steel Bridge Paint System Maintenance			
FHWA Contract No. DTFH61-97-C-00026			
Cost Model Input Page			
Use this page to input various painting options. View model results on the "Output" page. Compare various options with the "Comparison Page"			
Item	Input	Description	
Bridge Square Footage	25,000	The paintable square footage (SF) of the bridge. Suggested minimum is 5,000. A "typical" 2-lane bridge over	
percent deteriorated	10.0%	The percent area of the paintable area that is corroded through the coating. Typical deterioration for an overcoat project is less than 10%. Deterioration greater than 10% is seen on some paint removal projects. Deterioration over 25% may slow cleaning	
Forman	1	The number of crew foremen working this project. Typically one.	
Blaster/Painter	4	The total number of blasters and painters working this project. Typically four to six.	
Helper	2	The total number of helpers or apprentice workers for this project. Typically one to three.	
Average Labor Rate	\$ 30.00	The weighted average hourly labor rate for the total of all Foremen, Painters, and Helpers. This varies by region and has an approximate median number.	
Hours/Day	10.0	The number of hours the crew works each day. Varies by hours crew is provided access to the jobsite. Average	
Lead in coating	Yes	Select if the existing coating contains lead. This relates mostly to disposal and I&H&S costs.	
Washing	Yes	Select if a pre-wash of the bridge is required prior to additional surface preparation. This is a low pressure and disposal.	
Dehumidification	No	Select if the contained area will be dehumidified.	
Pretox	No	Select if lead is in the coating and a pre-applied lead stabilizer will be used.	
Blastox	Yes	Select if lead is in the coating and an abrasive additive will be used.	
Rapid Deployment	No	Select if a rapid deployment set-up and schedule are to be used.	
Stripe Coat	Yes	Select if a stripe coat is applied (default is yes)	
Full Removal Surface Preparation Select a single surface preparation method from the choices below. Each option has an associated production rate.			
	1	Preparation Method	Production Rate
		0. Spot-Sweep Preparation	
		1. Once Through Abrasive	100
		2. ElectroStrip	40
		3. Recyclable Steel Grit	200
		4. Water Jetting	100
		5. Grit Injected Water Jetting	100
		6. Turbo Wetblast System	91

Item	Input
Bridge Square Footage	25,000
percent deteriorated	10.0%

Average Labor Rate	\$ 30.00
Hours/Day	10.0
Lead in coating	Yes



Project Operating Parameters

Cost Effective Alternate Methods for Steel Bridge Paint System Maintenance			
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Cost Model Input Page			
Full Removal Surface Preparation Select a single surface preparation method from the choices below. Each option is based on a production rate of 10 SF per man-hour.			
1	Preparation Method	Production Rate	Description
	0. Spot-Sweep Preparation		Benchmark removal rate for this study. Typical range may be from 50 to 100 SF per man-hour.
	1. Once Through Abrasive	100	Direct current removal method. Estimated production rate of 100 SF per man-hour. Products like "Metgra" are used. Typical range may be 100 to 200 SF per man-hour.
	2. ElectroStrip	40	Ultra-High pressure water jetting. Typical range of 3 site visits. Typical production rate of 40 SF per man-hour.
	3. Recyclable Steel Grit	200	Variable pressure water jetting. Typical range of 200 to 300 SF per man-hour.
	4. Water Jetting	100	Variable pressure water jetting. Typical range of 100 to 200 SF per man-hour.
	5. Grit Injected Water Jetting	100	Variable pressure water jetting. Typical range of 100 to 200 SF per man-hour.
	6. Torbo Wetblast System	91	Production rate of 91 SF per man-hour.
Spot-Sweep Surface Preparation Select a single surface preparation method from the choices below. Each option is based on a production rate of 10 SF per man-hour.			
0	Preparation Method	Production Rate	Description
	0. Full Removal Preparation		Benchmark spot preparation method for this study. Typical production rate is 10 SF/MH for cleaning of "spots" only. These numbers vary greatly depending upon the condition of the bridge.
	1. Hand Tool Cleaning	10	Calculation based on 10 SF per man-hour.
	2. Water Jetting	172.73	2.6371*Deterioration+10
	3. Brush Blast (expendable grit)	189.40	Calculation based on 10 SF per man-hour.
	4. Grit Injected Water Jetting	189.40	Calculation based on 10 SF per man-hour.
	5. Recyclable Steel Grit	200	Rate to sweep all surface.
	6. Water Injected Blasting (Torbo)	150	Rate to sweep all surface.
	7. Vacuum Blasting	80	Rate to clean at individual locations.
Staging/Containment Options Select a single staging and containment option from the choices below. Each option is based on a production rate of 10 SF per man-hour.			
1	Staging/Containment Option	Hours per location	Description
	1. Lift Trucks	0.75	Lift trucks are a common staging method. Enter the hours required for the study = .75 hrs.)
	2. Safe-Span Platform	200	Enter SF built by the entire crew per hour (this study = 200 SF/hr.)
	3. Suspended Rigid Platform	320	Enter SF built by the entire crew per hour. (This study = 320 SF/hr.)
	4. ARK Mobile Platform System	0.5	Hours required to set-up and remove an ARK platform per shift (This study = .5 hrs.)
Coating System Options Select a single Coating System from the choices below.			
1	Coating System Type	Description	
	1. Three Coat System	Primer over bare metal plus two full coats	
	2. Two Coat System	Primer over bare metal plus one full coat	

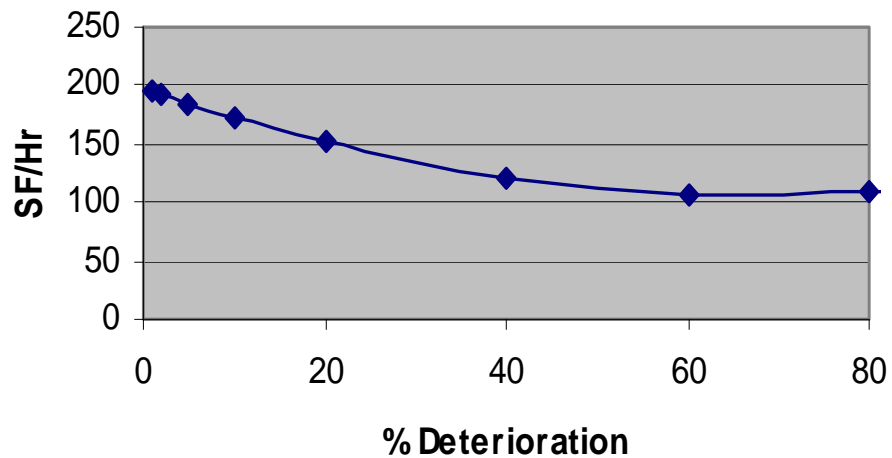
Preparation Method	Production Rate (SF per Man-hour)
0. Spot-Sweep Preparation	
1. Once Through Abrasive	100
2. ElectroStrip	40
3. Recyclable Steel Grit	200

Staging/Containment Option	Hours per location
1. Lift Trucks	0.75
2. Safe-Span Platform	200
3. Suspended Rigid Platform	320

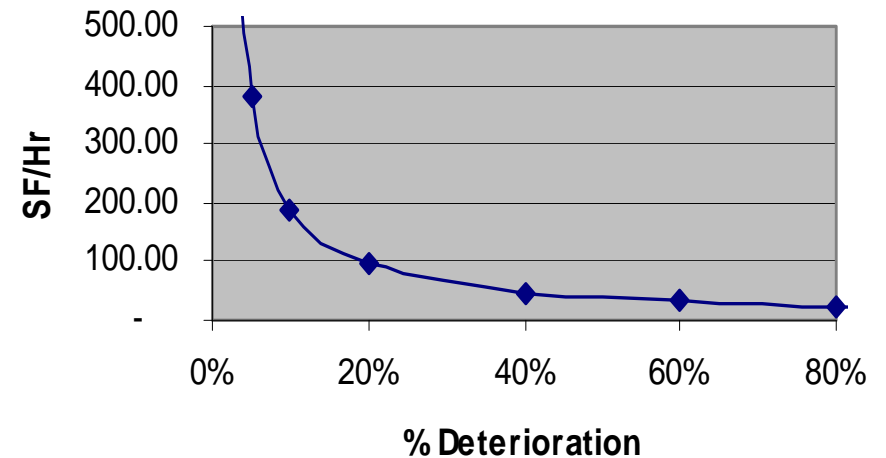


Spot Preparation Production Rates

Spot H2O jet production



Spot Blast and Grit Injection production



Cost Variables

- Over 140 Variable Inputs
- Contains Default Information
 - Surface Preparation Equipment Costs
 - Staging / Containment Equipment Costs
 - Material Costs, Usage Rates
 - Disposal Costs
 - Lead Health and Safety Costs
 - Operating Cost Factors



All Equipment is amortized over periods selected

Initial Cost, Service Life, and Discount Rate

Calculates Total Cost, Cost per Year, and Cost per 9-month period

Equipment Costs

Background Variables page - Use this page to vary the calculation parameters for the cost model

Surface Preparation Equipment Costs	Initial Cost	Service Life (yrs)	Discount Rate	Total Cost	Cost per year	Cost per month (9 month year)	Notes
Recyclable Steel Grit Rig - 4 outlet	\$ 240,000	5.0	7%	\$ (336,612.42)	\$ (67,322.48)	\$ (7,480.28)	
UHP (10 GPM) - 2 outlet	\$ 200,000	5.0	7%	\$ (280,510.35)	\$ (56,102.07)	\$ (6,233.56)	
WJ Crawler/w vac.	\$ 200,000	5.0	7%	\$ (280,510.35)	\$ (56,102.07)	\$ (6,233.56)	
UHP (6 GPM) - 2 outlet	\$ 135,000	5.0	7%	\$ (189,344.48)	\$ (37,868.90)	\$ (4,207.66)	
Compressor - for 3 crewmen	\$ 75,000	5.0	7%	\$ (105,191.38)	\$ (21,038.28)	\$ (2,337.59)	
Grit Blast Gun - 4 outlet	\$ 70,000	5.0	7%	\$ (98,178.62)	\$ (19,635.72)	\$ (2,181.75)	

Surface Preparation Equipment Costs	Initial Cost	Service Life	Total Cost	Cost per year	Cost per month (9 month year)
Recyclable Steel Grit Rig - 4 outlet	\$ 240,000		\$ (336,612.42)	\$ (67,322.48)	\$ (7,480.28)
UHP (10 GPM) - 2 outlet	\$ 200,000	5.0 7%	\$ (280,510.35)	\$ (56,102.07)	\$ (6,233.56)

Convention Sprayer	\$ 1,750	5.0	7%	\$ (2,434.65)	\$ (486.91)	\$ (54.11)
Generator (2.25 kW) - for 6 crewmen	\$ 1,000	5.0	7%	\$ (1,402.55)	\$ (280.51)	\$ (31.17)
Moister Separator	\$ 725					
Blast Hoods B-88's	\$ 628					
Misc. Hand Tools	\$ 3,850					
Vacuum Blast Rig - 4 outlet	\$ 96,250					
Vacuum Truck	\$ 65,000					
Decon Trailer - for leadwork	\$ 24,000					
Truck MPT/Towing for 4 crewmen	\$ 25,000					

Staging/Containment Equipment Costs	Initial Cost	Service Life (yrs)	Discount Rate
Ark System (2 crewmen per section)	\$ 14,500	5.0	7%
Ark Overpass Master	\$ 74,900	5.0	7%
Lift Truck for 4 crewmen	\$ 70,000	5.0	7%
Dust Collector	\$ 75,000	5.0	7%

Staging/Containment Equipment Costs	Initial Cost	Life (yrs)	Rate	Total Cost	Cost per year	(9 month year)	Notes
ARK System (2 crewmen per section)	\$ 14,500	5.0	7%	\$ (20,337.00)	\$ (4,067.40)	\$ (451.93)	
Ark Overpass Master	\$ 74,900	5.0	7%	\$ (105,051.12)	\$ (21,010.22)	\$ (2,334.47)	
Lift Truck for 4 crewmen	\$ 70,000	5.0	7%	\$ (98,178.62)	\$ (19,635.72)	\$ (2,181.75)	
Dust Collector	\$ 75,000	5.0	7%	\$ (105,191.38)	\$ (21,038.28)	\$ (2,337.59)	
D/H Unit	\$ 25,200	5.0	7%	\$ (35,344.30)	\$ (7,068.86)	\$ (785.43)	
Rigid platform staging (plywood)	\$ 1.00	\$/SF for the platform materials, set up with unit increments of 5,000 SF. This disposal cost of Safespan is calculated based on the safe span rental schedule located within					
SafeSpan System							



Material Costs

Material Costs							
	cost/unit	unit					
Steel Grit	\$ 300	Ton					
Slag Grit	\$ 60	Ton					
Grit with Blastox	\$ 148	Ton					
Pretox	\$ 19.95	Gallon					
Water	\$ 0.027	Gallon					
Paint	\$ 30.00	Gallon					
Fuel	\$ 1.30	Gallon					
Other Misc. Items	\$ 200	Day (misc. sundries each day)					
Material Use/Application Rates							
Pretox Application Rate	3,000	SF/Hr					
Pretox usage rate	80	SF/gal	The ideal spreading rate at the specified WFT				
PreTox dry density	8.28	lb./gal	density of dried Pretox used in waste tonnage calculation.				
LPWC Production Rate	600	SF/Hr					
Stripe Coat Production Rate	2,600	Edges in SF shown / Hr					
RSG usage rate	0.50	lb./SF	This is the average RSG consumption rate for the project NOT the amount needed to clean each SF. If new RSG is specified for a project this should be higher, if new RSG is not specified .5 lb./SF is an accurate number.				
Once Through Slag usage rate	10.00	lb./SF	Average needed to clean each SF				
UHP water usage rate	3	GPM	1.80 gal/SF full remc	1.04	gal/SF spot work		
LPWC usage rate	0.15	gal/SF					
Water with Grit injection - Water use	0.123	gal/SF					
Water with Grit injection - Grit use	1.00	lb./SF					
Grit blast with Water injection - Grit use	3.00	lb./SF					
Grit blast with Water injection - Water use	0.12	gal/SF					
Vacuum Blast grit use rate	1.00	lb./SF	This is the grit consumption rate for the project NOT the amount needed to clean each SF. If new grit is specified increase this amount, otherwise 1 lb./SF is a reasonable average consumption.				
Paint usage rate	400	SF/gal	The ideal spreading rate at the specified WFT				
Fuel usage rate	12	gal/day	For all equipment at the jobsite				

	cost/unit	unit
Steel Grit	\$ 300	Ton
Slag Grit	\$ 60	Ton
Grit with Blastox	\$ 148	Ton
Pretox	\$ 19.95	Gallon
Water	\$ 0.027	Gallon
Paint	\$ 30.00	Gallon
Fuel	\$ 1.30	Gallon



Environmental Health and Safety Costs

Pre-Existing Conditions			
Existing Paint DFT	15.00	mils	Thickness of the existing paint to be removed. Default value is 15 mils.
Existing Paint Specific Gravity	2.50	ratio	Specific gravity of the existing coating to be removed. Typical values range from 1.8 to 2.8. Default is 2.5
Disposal Cost Factors			
Barrel for solid waste disposal	\$ 30.00	each	
Hazardous material disposal	\$ 180.00	ton	
Non-hazardous material disposal	\$ 60.00	ton	
Wash water disposal	\$ 0.10	gallon	
Lead Health and Safety Costs			
Lead Health and Safety Plan	\$ 500.00	dollars	Variable input depending upon size and complexity of Project
Site Pre-Assessment	\$ 500.00	dollars	Variable input depending upon size and complexity of Project
High Vol. Air Monitoring	\$ 50.00	dollars	Price per day for HV monitoring. If lead is present = applies to full duration, If no lead = applies to S Prep t
Field Tech./Emissions Observer	\$ 75.00	dollars	Price per day for field tech. If lead is present = applies to full duration, If no lead = applies to Surface Prep t
Lab Testing of Samples	\$ 100.00	dollars	Price per day for sample testing. If lead is present = applies to full duration, If no lead = applies to Surface
Post Site Assessment	\$ 500.00	dollars	Variable input depending upon size and complexity of Project

Disposal Cost Factors		
Barrel for solid waste disposal	\$ 30.00	each
Hazardous material disposal	\$ 180.00	ton
Non-hazardous material disposal	\$ 60.00	ton
Wash water disposal	\$ 0.10	gallon



Cost Effective Alternate Methods for Steel Bridge Paint System Maintenance

FHWA Contract No. DTFH61-97-C-00026

Cost Model Spreadsheet - Results Page

For a Bridge Project with:

25,000 Paintable Square Feet
 10.0% Percent Area Deteriorated
 7 Persons in the Work Crew

The Costs to:

Full removal with once through abrasive
 Contain using Lift Trucks
 Conventional spray apply a three coat system

are given below.

Select below to send results to the "Comparison Page"

	Item Cost	Item Percentage	Cost / SF
Labor Cost	\$ 72,450.00	35.25%	\$ 2.90
Waste Disposal	\$ 33,521.25	16.31%	\$ 1.34
Materials	\$ 29,185.05	14.20%	\$ 1.17
Production Equipment	\$ 18,583.75	9.04%	\$ 0.74
Lead Health and Safety	\$ 6,675.00	3.25%	\$ 0.27
Staging and Containment	\$ 8,208.58	3.99%	\$ 0.33
Project Insurance	\$ 10,117.42	4.92%	\$ 0.40
Profit	\$ 26,811.16	13.04%	\$ 1.07
Total Cost	\$ 205,552.20	100%	\$ 8.22

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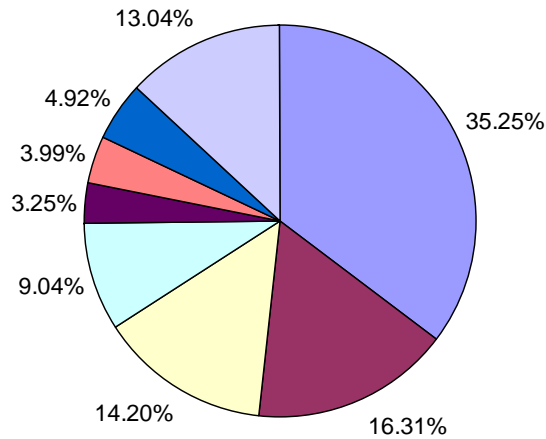
Copy as "Option 2"

Copy as "Option 3"

Output Spreadsheet

- Cost Categories
- Percent and Unit Cost Calculations

Project Cost Analysis



	Item Cost	Item Percentage	Cost / SF
Labor Cost	\$ 72,450.00	35.25%	\$ 2.90
Waste Disposal	\$ 33,521.25	16.31%	\$ 1.34
Materials	\$ 29,185.05	14.20%	\$ 1.17



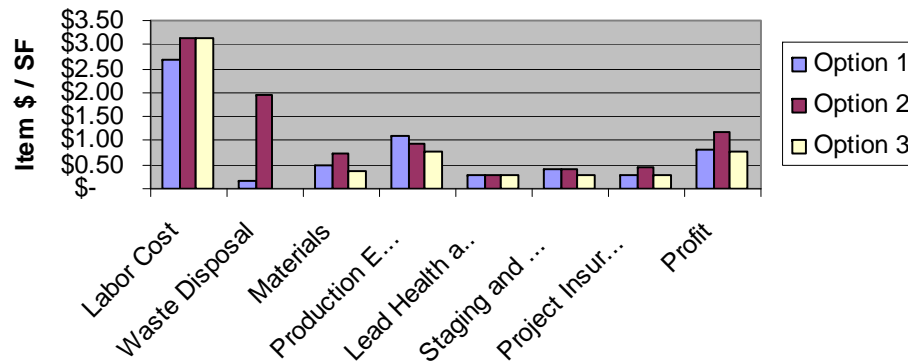
Painting Comparisons

Cost Effective Alternate Methods for Steel Bridge Paint System Maintenance

FHWA Contract No. DTFH61-97-C-00026

	Option 1	Option 2	Option 3
Labor Cost	\$ 2.68	\$ 3.15	\$ 3.15
Waste Disposal	\$ 0.15	\$ 1.95	\$ 0.01
Materials	\$ 0.49	\$ 0.74	\$ 0.37
Production Equipment	\$ 1.11	\$ 0.94	\$ 0.75
Lead Health and Safety	\$ 0.27	\$ 0.30	\$ 0.30
Staging and Containment	\$ 0.40	\$ 0.40	\$ 0.28
Project Insurance	\$ 0.30	\$ 0.45	\$ 0.29
Profit	\$ 0.81	\$ 1.19	\$ 0.77
Total Cost	\$ 6.20	\$ 9.13	\$ 5.93

Painting Option Comparison



- Unit Cost Comparisons
 - RSG
 - Once - Through Grit
 - SP-3 (Spot Power Tools)
 - Bridge with 20,000 SF, 10% Deterioration, 7-Person Crew
- Hand Tools \$5.93
- Slag Grit \$9.13
- RSG \$6.20



The “Alternative Methods”

- Technologies and our Field Visits
 - Cost of Specific Items
 - Performance of Specific Methods
- Investigated 8 Field Technologies at over 25 Job Sites
 - Produced a Separate Report for Each Technology



Reports

- ElectroStrip
- Abrasive Injected Water Blasting
- Rapid DeploymentSM
- Recyclable Steel Grit
- TorboTM System
- Lead Stabilizers (Abrasive Additive and Pre-applied Coating)
- Water Jetting
- Metallizing
- Adhesive Foil

All are Available through the Advisory Council
Web Site, Corrpro, or the FHWA



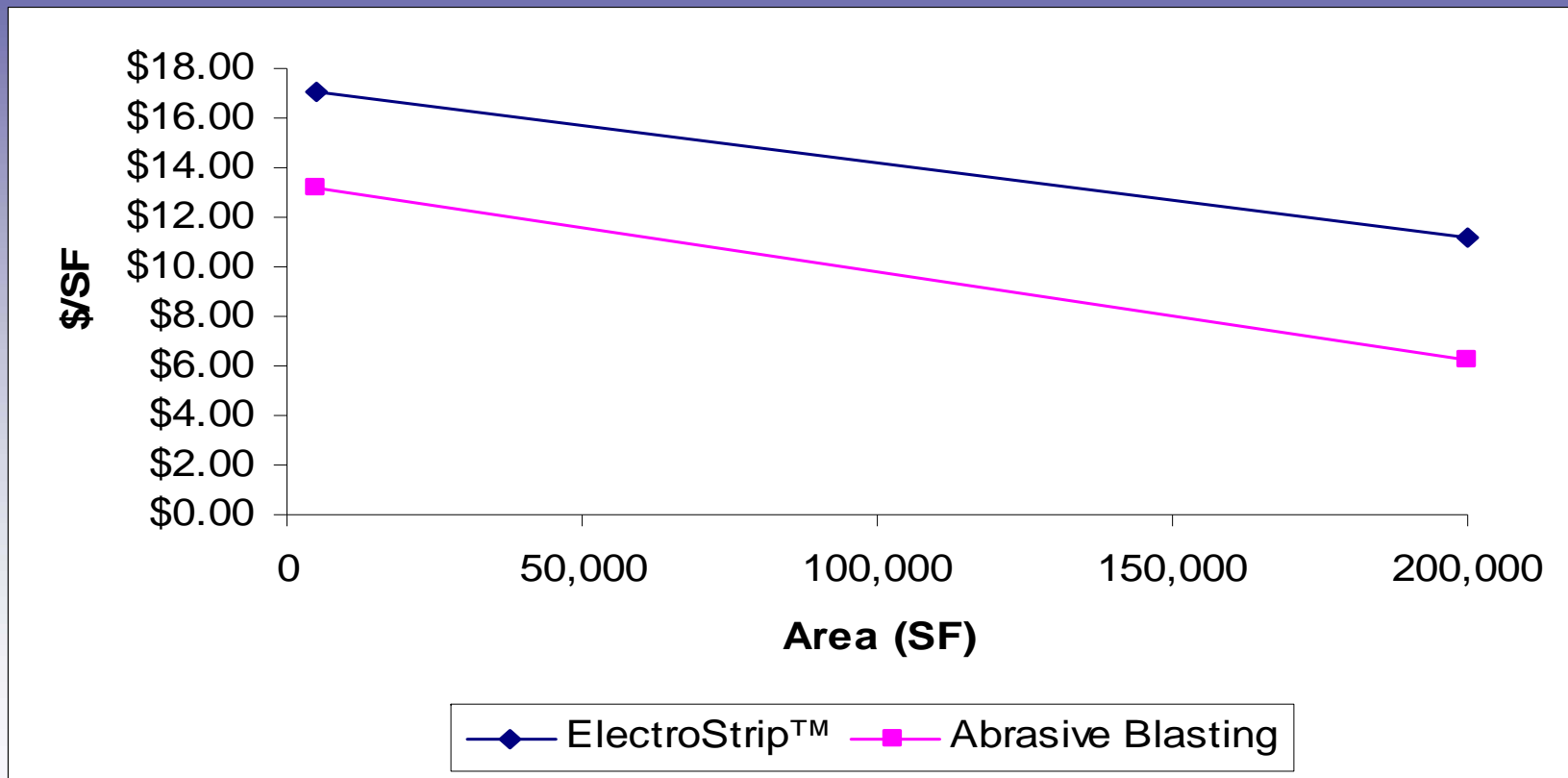


ElectroStrip™

- Applicable to “Small” Areas
- No Dust
- Needs High-Ampere DC Electric Source
- Relatively Slow Production (40-60 Ft²/Hr.)
- Supplement with Hand Tool Cleaning



Cost Comparison for ElectroStrip™ vs. Abrasive Blasting



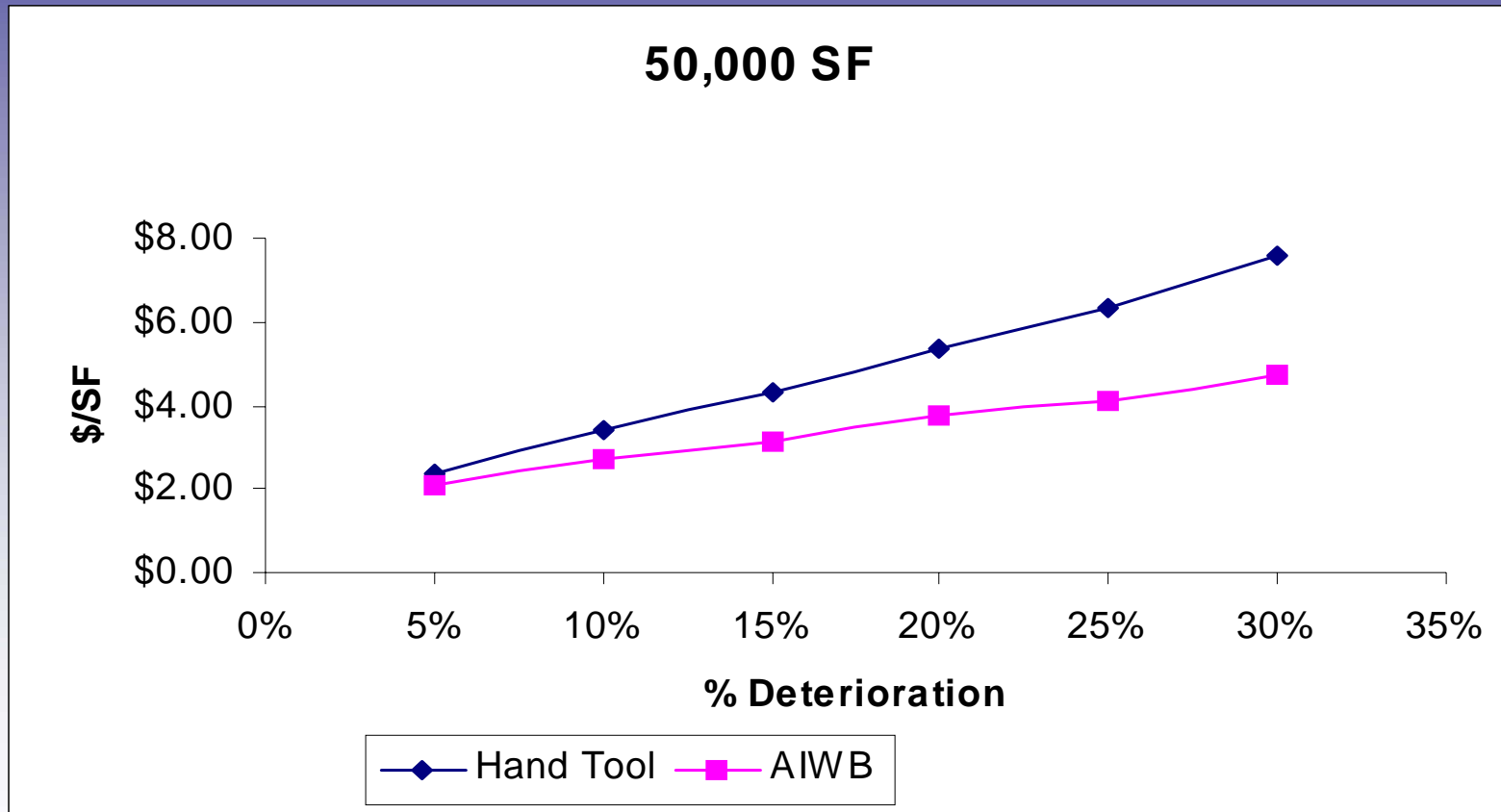


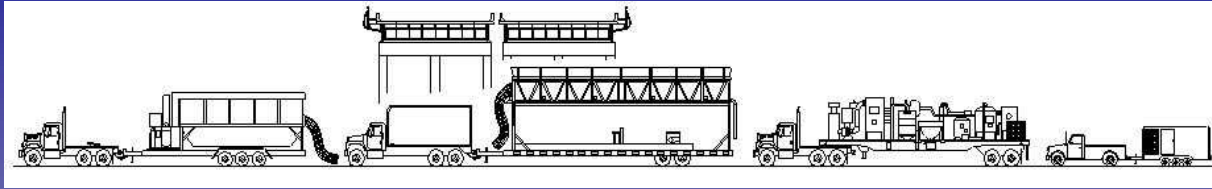
Abrasive Injected Water Blasting (AIWB)

- 4 kpsi Grit Injected Waterjetting in VA
- Productivity Dependent Upon Deterioration
- Comparison vs. Hand-tool Spot Preparation
- No Dust
- Must Contain Water



AIWB vs. Hand Tools



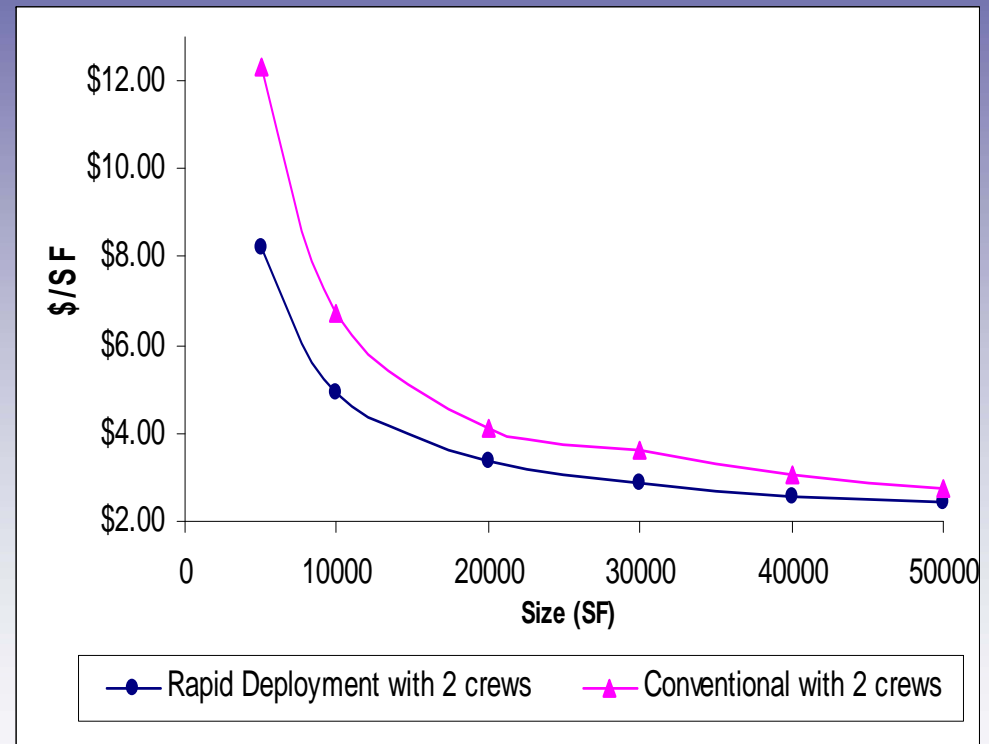
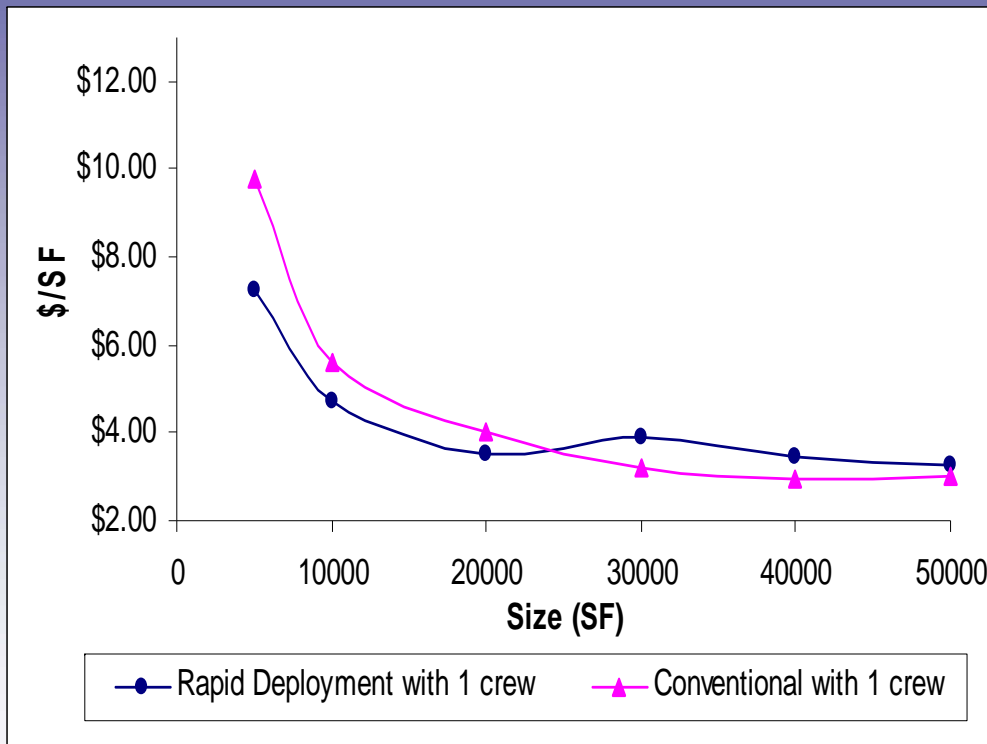


Rapid Deployment

- Work is Performed in Manageable Sections that are COMPLETED Each Night
- Use Quick Cure Coatings
 - 2 coats + Stripe Coat
- Reduced Inconvenience to Travelling Public
- Substantial Coordination Required



Cost Comparison for Rapid Deployment vs. Conventional Operations



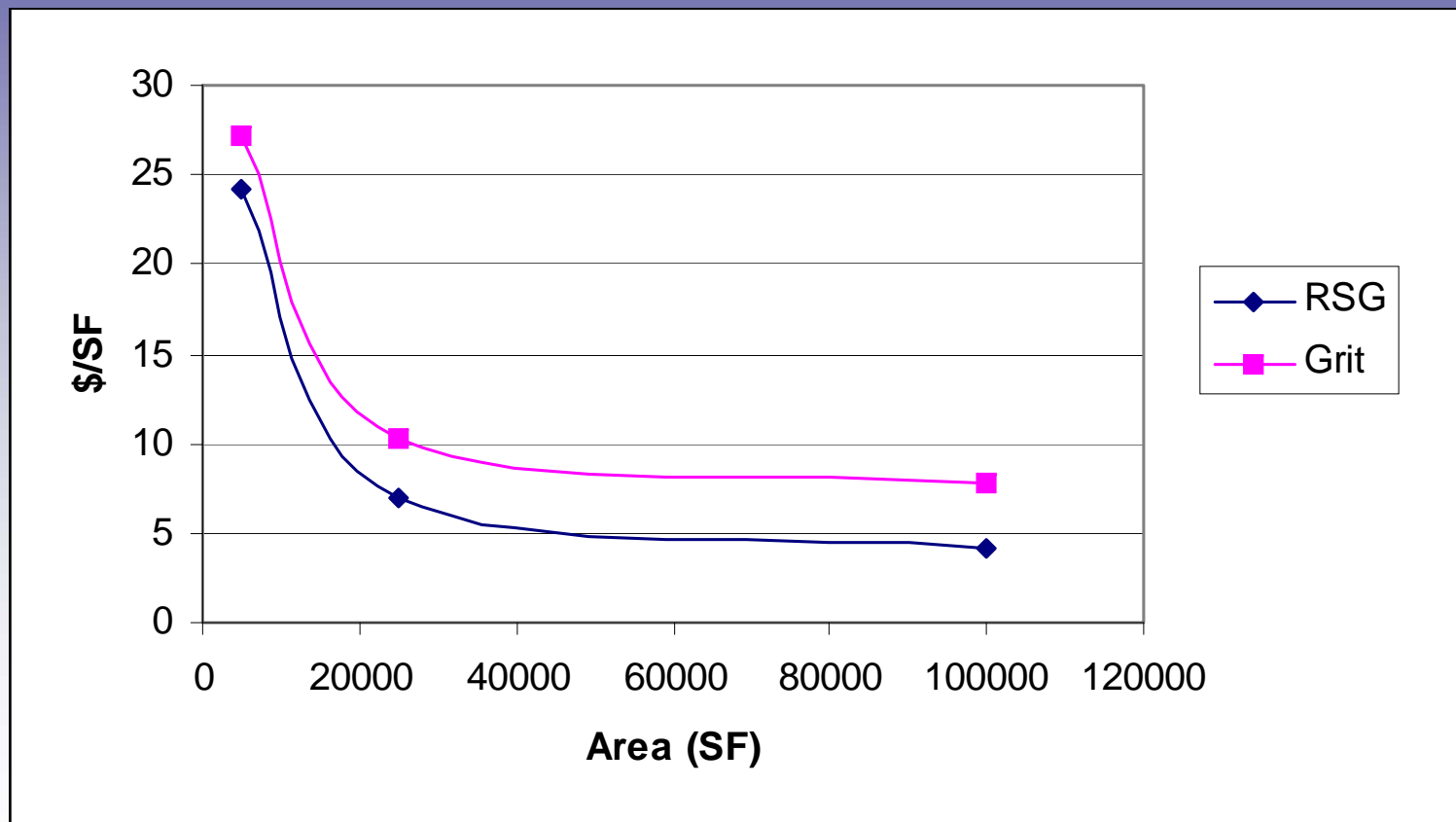


Recyclable Steel Grit

- Less Dust Than Disposable Abrasives
- Larger Equipment Costs
- Less Waste Generated
- Higher Pressure = Better Production



Cost Comparison of Recyclable Steel Grit vs. Expendable Abrasives



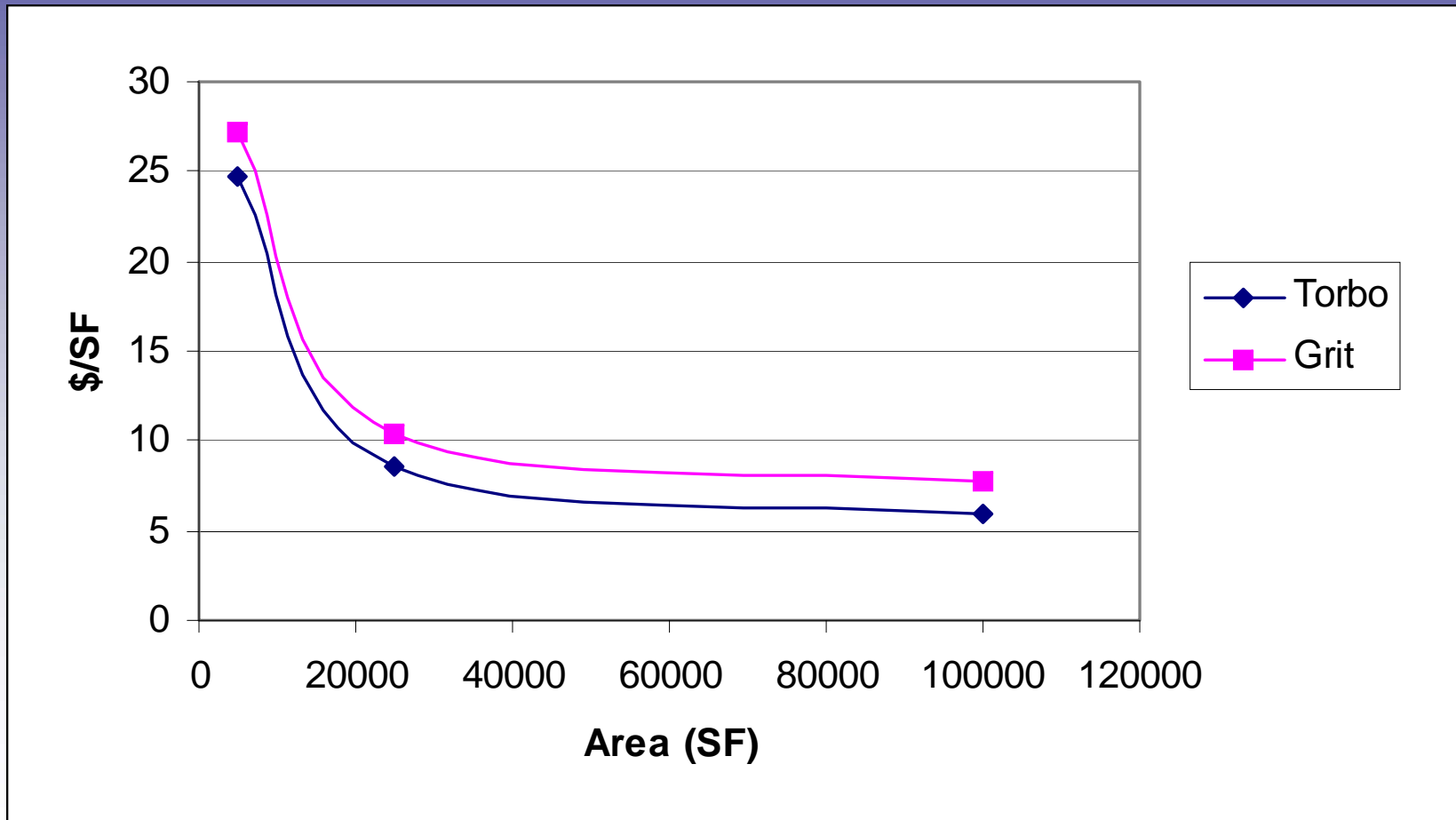


Torbo™ System

- Low Dusting
- Operator Control of “Mixture”
- Must Rinse Surfaces After Preparation
- Collection of Slurry



Cost Comparison for Torbo vs. Dry Grit



Lead Stabilizers (Abrasive Additive and Pre-applied Coating)

- Lower Disposal Costs
- Possible Extra Application
- Greater Material Costs
- Slight Savings Overall

	Cost	% Savings
regular disposal	\$ 10.34	0%
pre-applied	\$ 10.12	2%
blended abrasive	\$ 10.13	2%



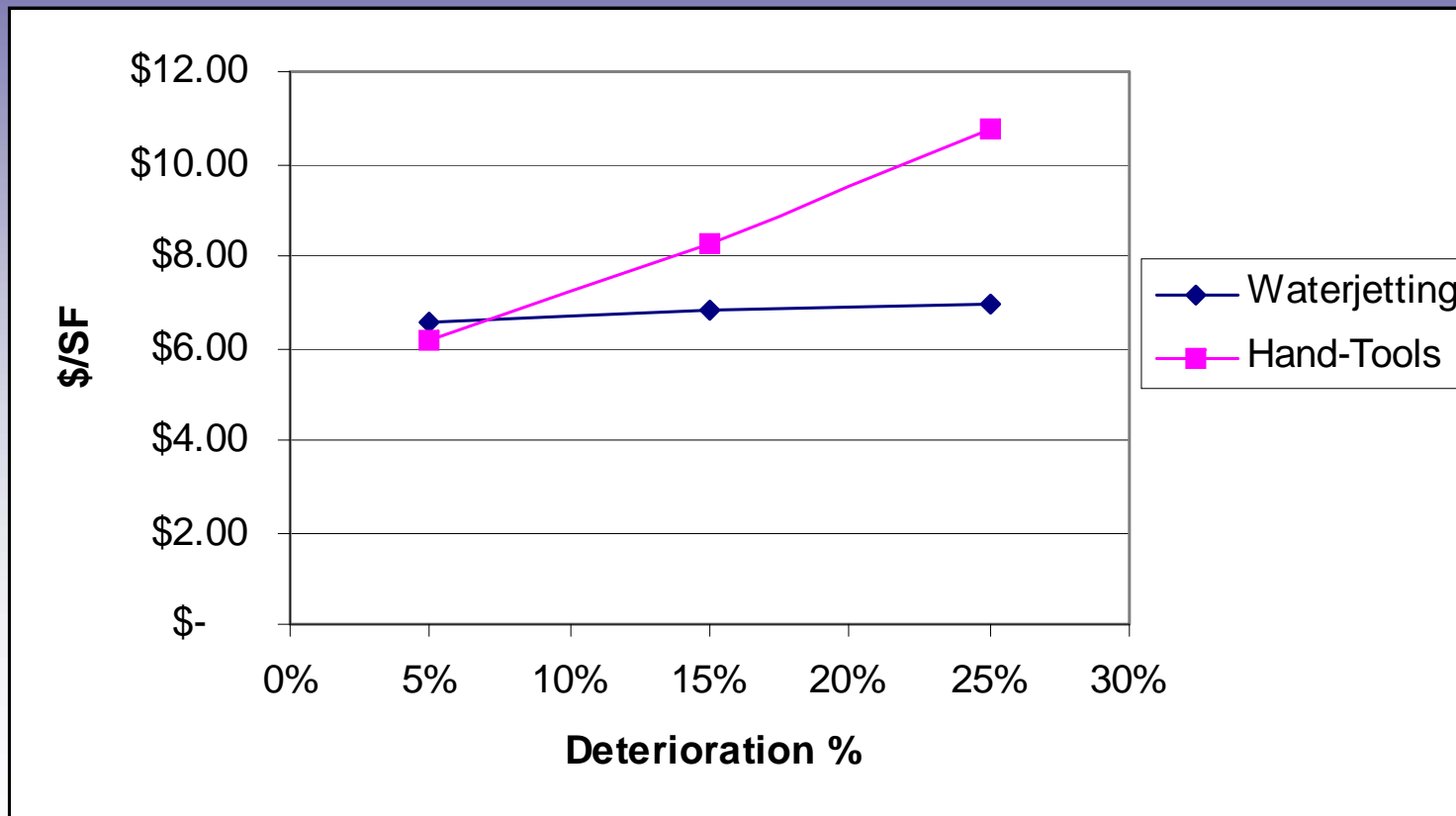


Waterjetting

- Higher Equipment Costs
- Cleans Contaminants from the Surface
- Currently used for Spot Prepare and Paint
- Does NOT Generate Profile
- Water Disposal Required
- Low Dust / High Mist



Cost Comp. of Waterjetting vs. Hand/Power Tool Cleaning



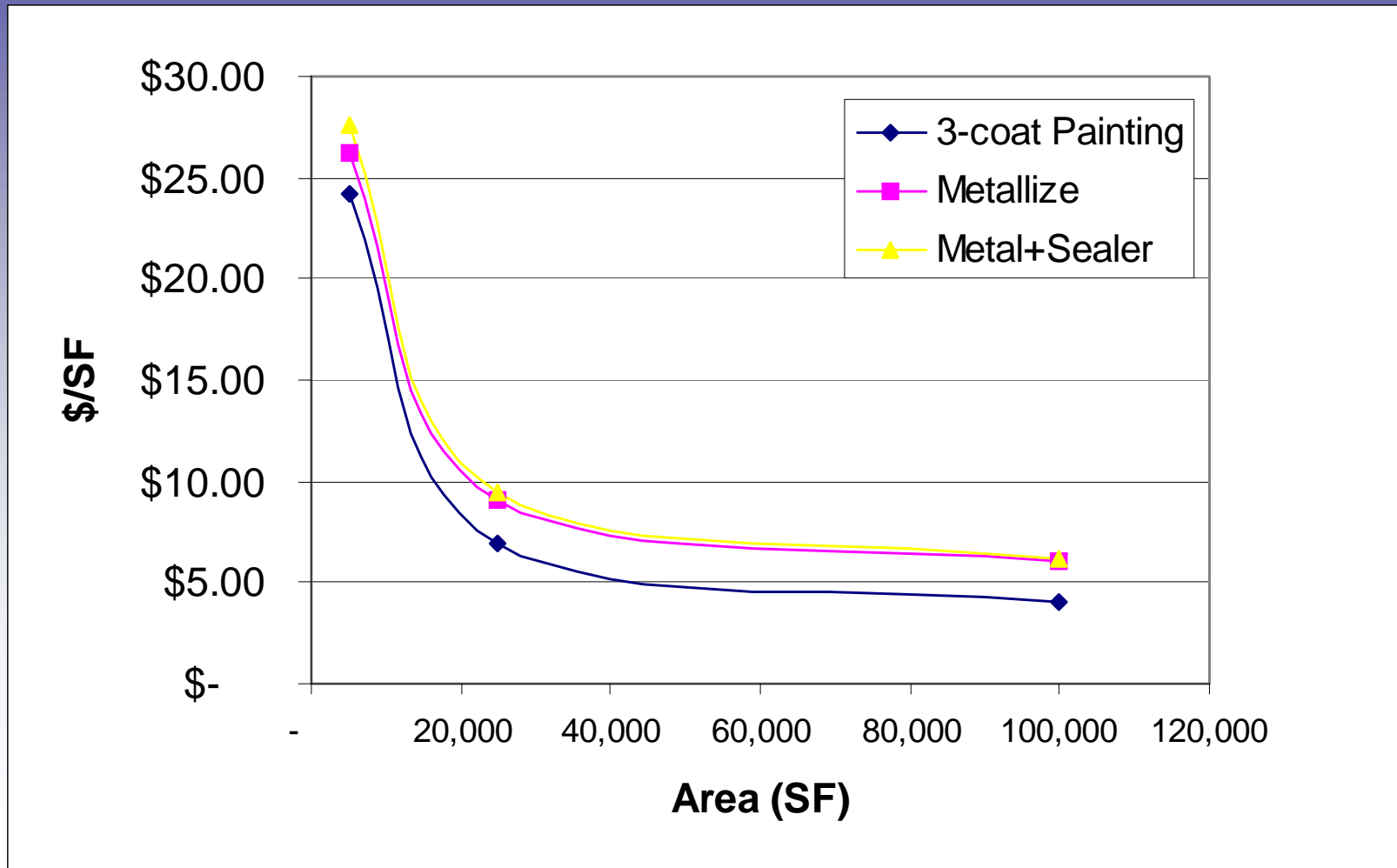


Metallizing

- Higher Equipment Costs
- Higher Material Costs
- Slower Production
- Single Application
- Superior Coating Durability



Cost Comparison of 3-Coat Painting to Metallizing



Modular Containment/Staging



- Lift trucks in VA/NJ



Modular Containment/Staging

- SafeSpan

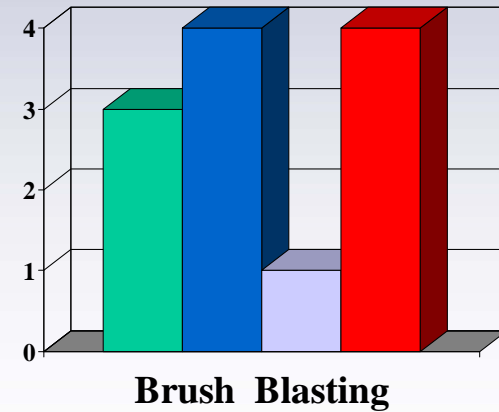
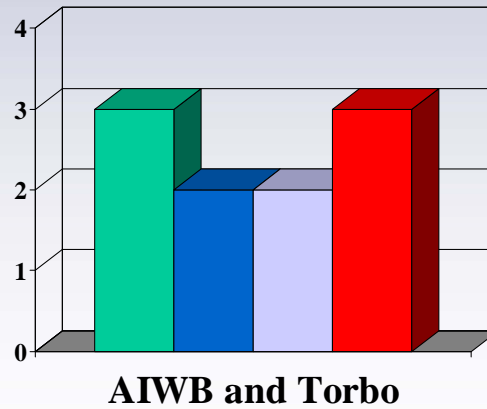
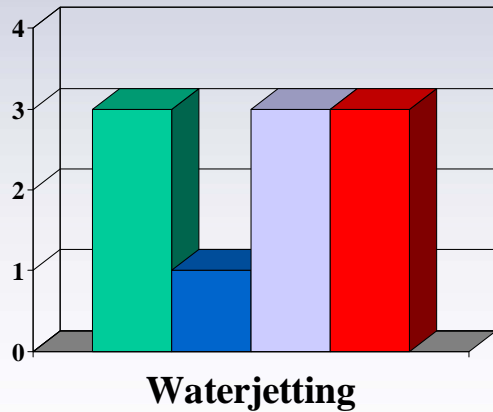
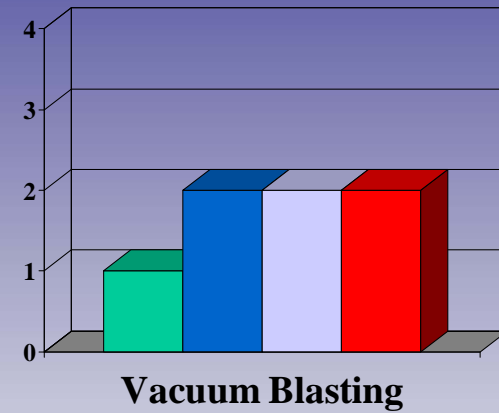
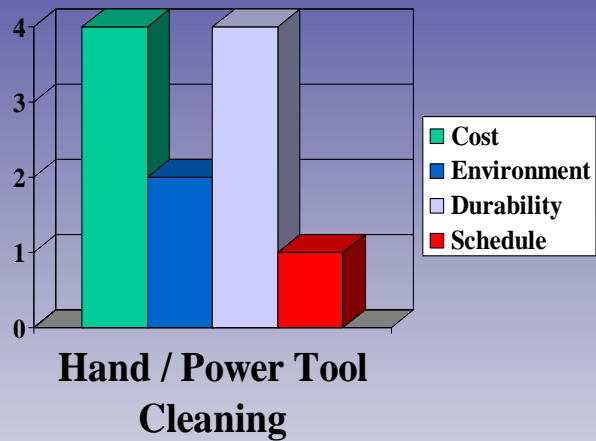


Technology Comparisons

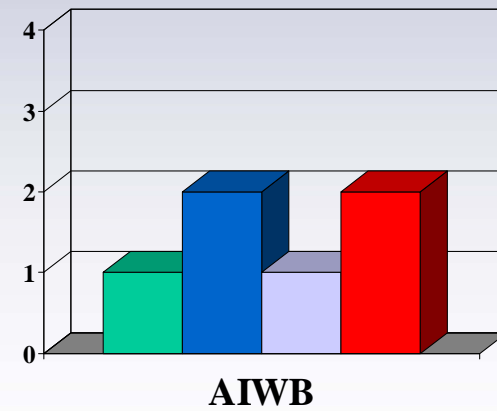
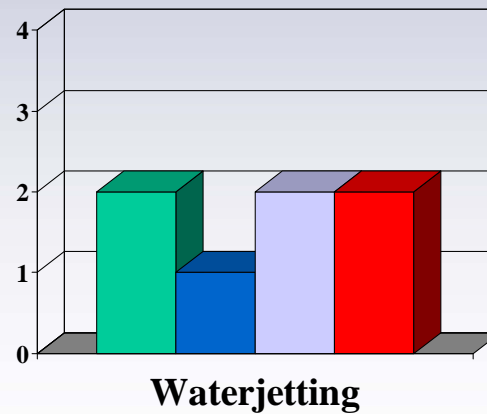
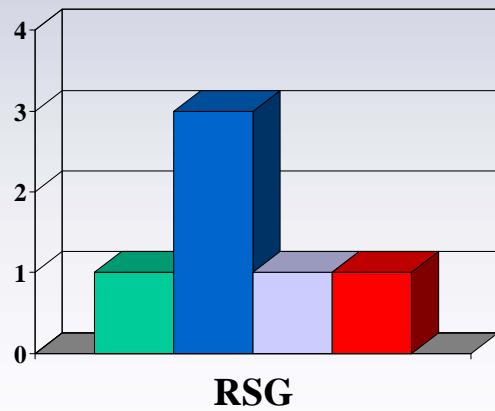
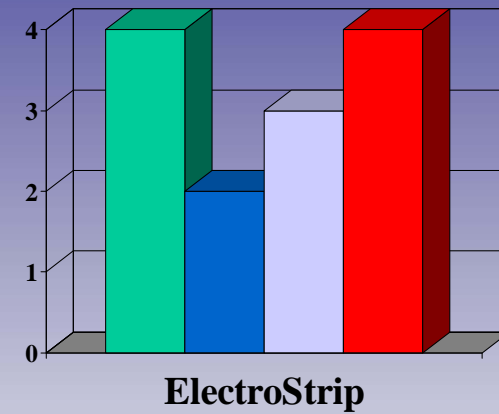
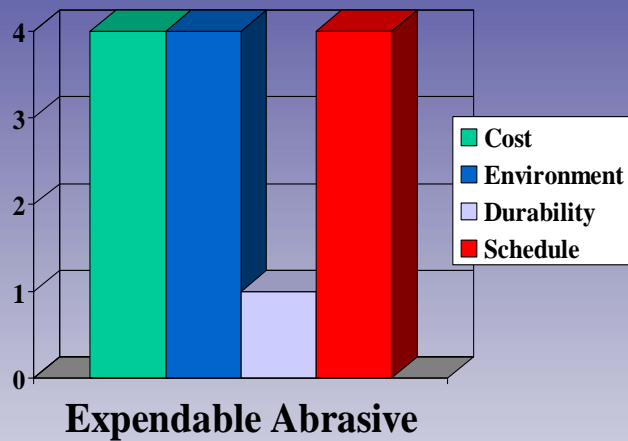
- Quantitative by Cost
- Qualitative by Other Factors



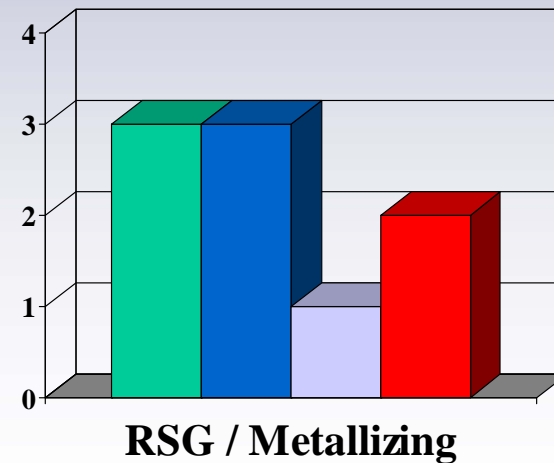
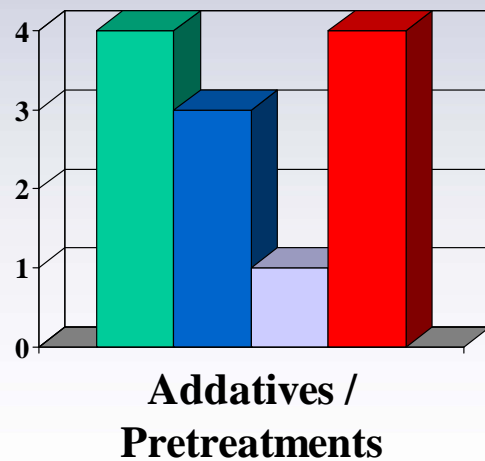
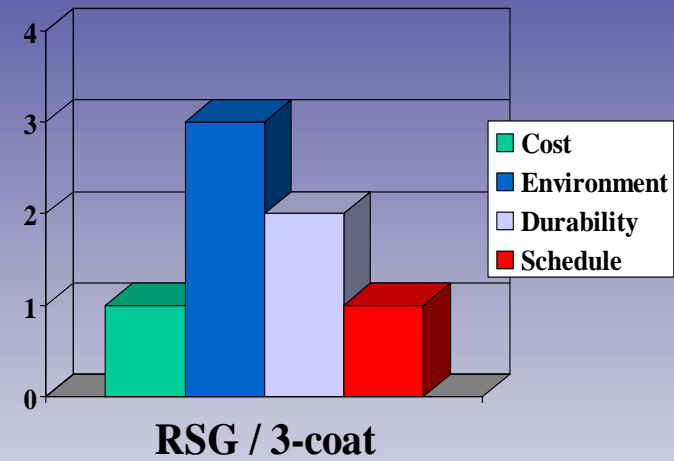
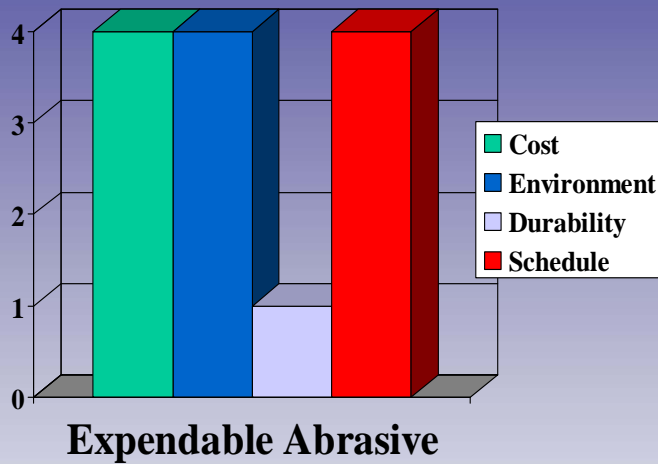
Spot Preparation Methods



Full Removal Methods



Other Technologies



Things to Consider

- Review Objectives
- Understand Constraints
- Technical Durability Estimates
- Cost Estimates
- “Management Approval”



Maintenance Objectives and Constraints

- Aesthetics
- Durability
- Structural Integrity
- Environmental Objectives
- Fit the “Master Plan?”
 - Corridor Development
 - Basic Maintenance
 - Bridge Upgrades
- Cost / Economics
- Learning Curves



Technical Considerations

- Durability
 - Surface Preparation Directly Related to Coating Performance
 - Painting
 - Material Types
 - Number of Coats
 - Thickness
 - Other Materials



Putting It All Together

- Constraints Filter the Choices to a Manageable Number of Options
- Cost Estimate for Each Option
- Durability Estimate for Each Option

- What Color?

