

Additive Finishing Processes Environmental Impact and Design Strategies

Objectives

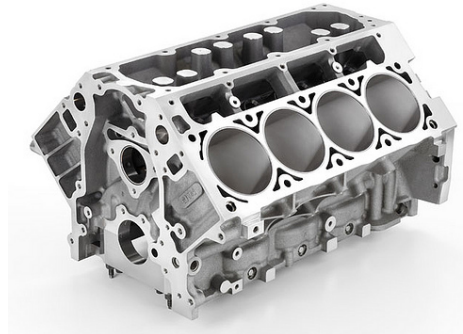
- To drive environmental sustainability and efficiency of products through a review of additive finishing processes
- To help product designers assess the environmental trade-offs between multiple candidate designs
- To determine sub-processes for targeted improvement that are both large resource consumers and used in many finishing processes

Introduction

Why do we use finishing processes?

To add...

- Aesthetics
- Function
- Corrosion resistance
- Precision



[EU, "Surface Treatment of Metals and Plastics, Best Available Techniques", 2006]

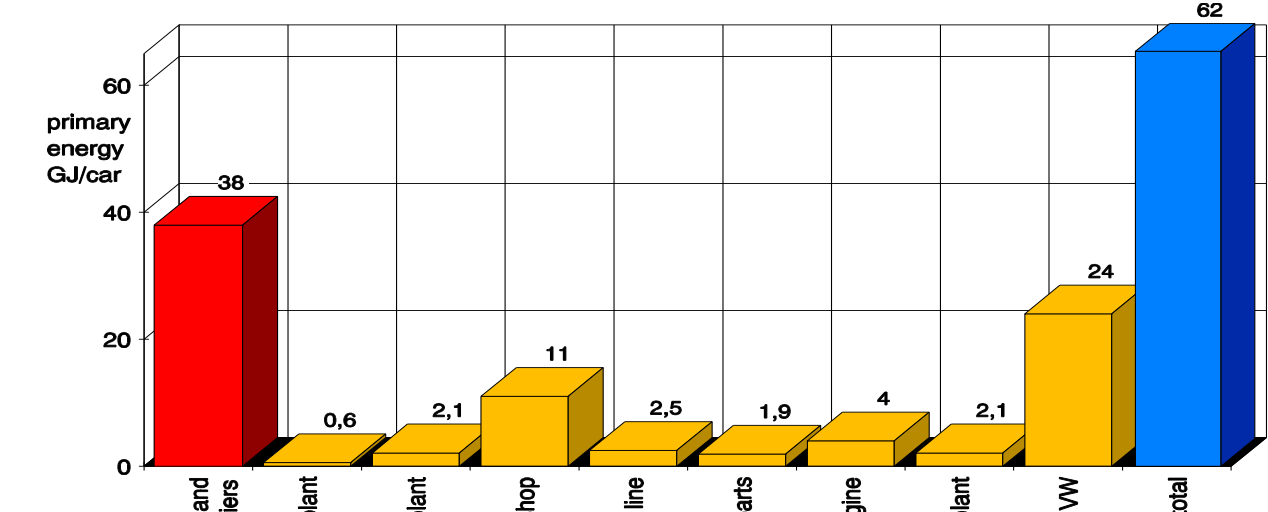
Uses of Processes

	Aesthetic	Function	Corrosion Resistance
Paint	[1][3]		[1][3]
Powdercoating	[2][3]	[3]	[2][3]
Electroplating	[1][3]	[1][3]	
Anodizing	[1][3]	[1]	[3]
Galvanizing			[1][3]
Vapor Deposition	[3]	[1][3]	

[1] Kalpakjian, *Manufacturing Engineering and Technology*, 2006
 [2] Geng, *Manufacturing Engineering Handbook*, 2004
 [3] Thomas, *Manufacturing Processes for Design Professionals*, 2007

Significance

- VW GolfA3 LCA shows that the paint-shop is the largest primary energy consuming process

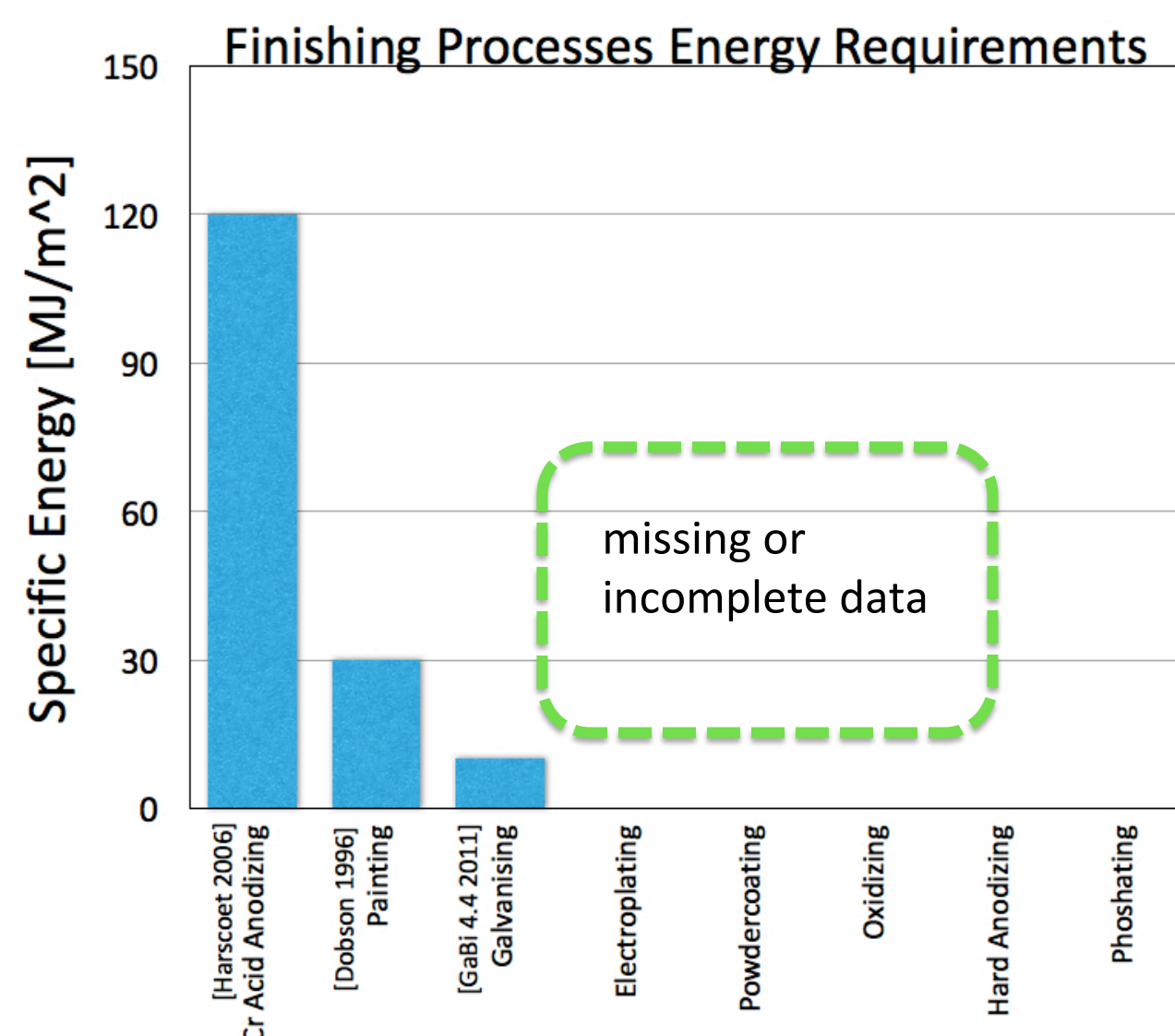


[Harold Florin, PE Europe/IKP-University of Stuttgart, 2010]

- [Kim, 2010] claims painting produces 50% of impact of forklift manufacturing (compared with cutting/welding, assembly, testing, repair, and shipment) using Eco-indicator 99 scoring system

Review – Additive Finishing

Finishing processes have been characterized for environmental impacts. Though, these studies do not characterize all finishing processes and there is still potential to examine other environmental impacts.

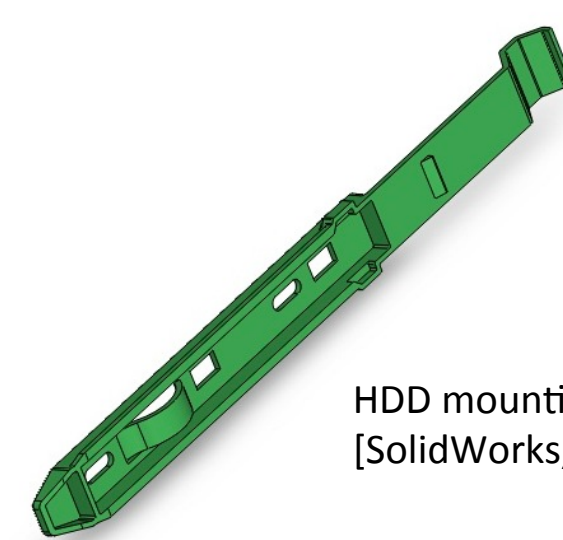


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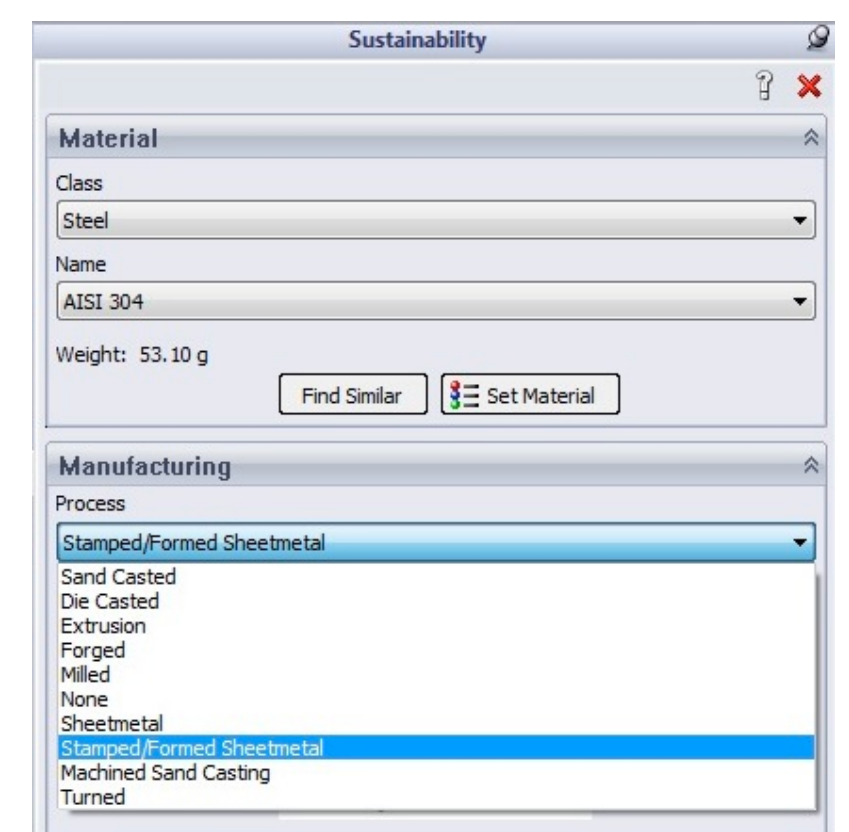
Application – Design Tool

CAD systems are beginning to incorporate toolboxes to estimate sustainability during design. Currently, most do not include surface finish in their environmental model. [Mosovsky 2001]

An review of different finishing processes can guide product design.



HDD mounting bracket [SolidWorks, 2010]

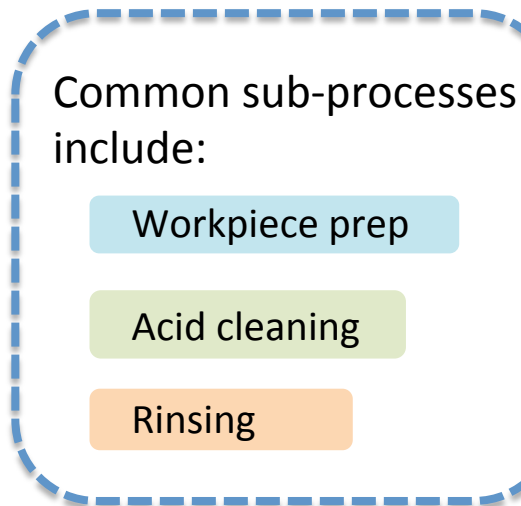
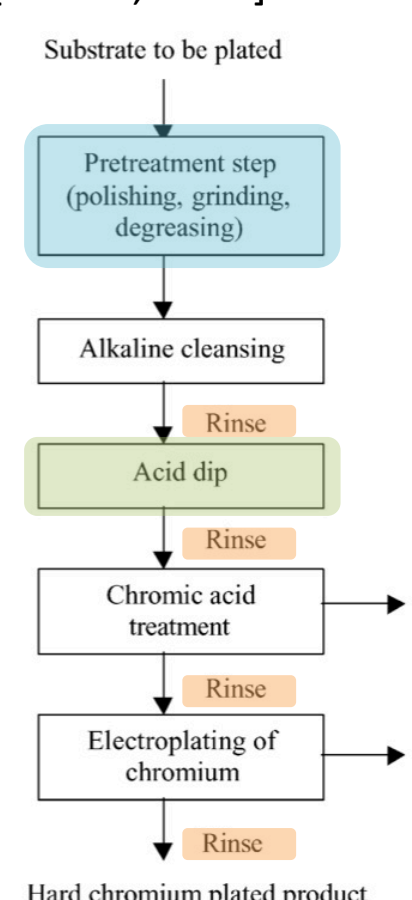


Example:
For a typical electronics component, how does a designer understand the environmental impact of a finishing process they selecting?

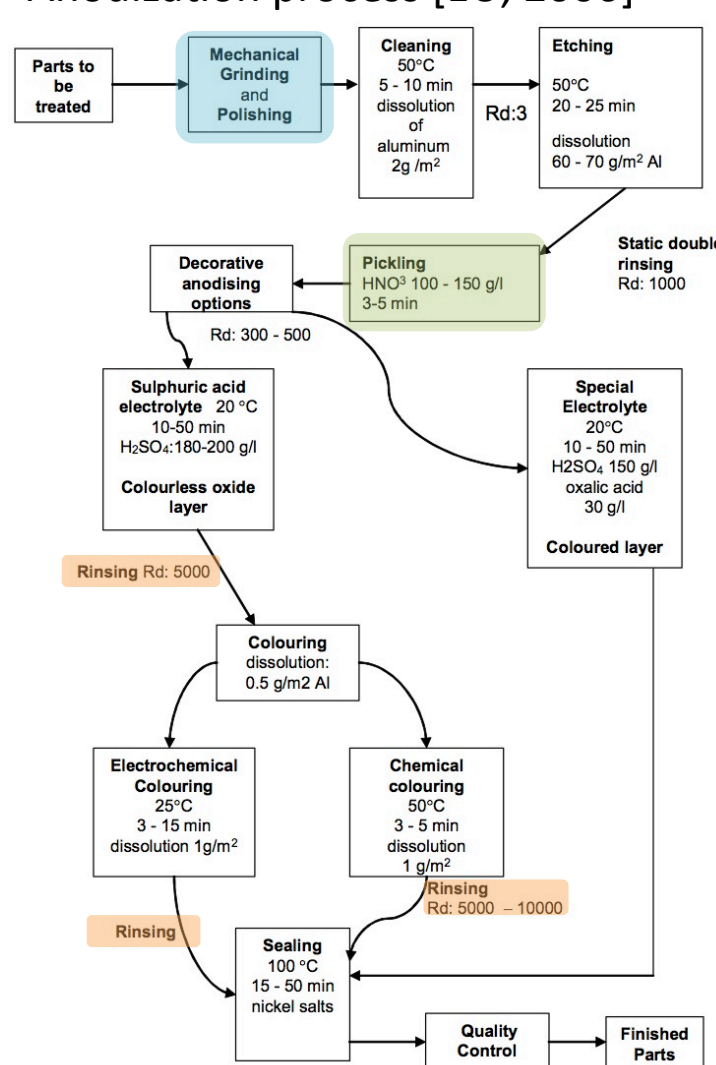
Process Improvements

Many finishing processes share similar sub-processes, such as part preparation, acid cleaning, and rinsing. High-impact sub-processes are most suitable for improvement.

Chromium Electroplating process [KOECT, 1980]



Anodization process [EU, 2006]



Future Work

- Develop environmental impact profiles for major additive finishing processes
- Investigate workpiece pretreatment, acid cleaning, and rinsing sub-processes contributions toward the environmental impact of additive finishing processes
- Form recommendations for improvement of these sub-processes