Assessing Resource Consumption Flows Through Manufacturing Process Chains

Stefanie Robinson © 2013 LMAS contact email: SLR@me.berkeley.edu

Funding Source: Caterpillar Inc. & Industrial Affiliates of LMAS

Industry Drivers

- Cost reduction
- Operational efficiency
- Corporate responsibility
- Stakeholder expectations
- Market competitiveness
- Standards and regulations
  - Energy: GHG emission limitations
  - Water: water discharge limitations
  - Waste: spill and remediation requirement

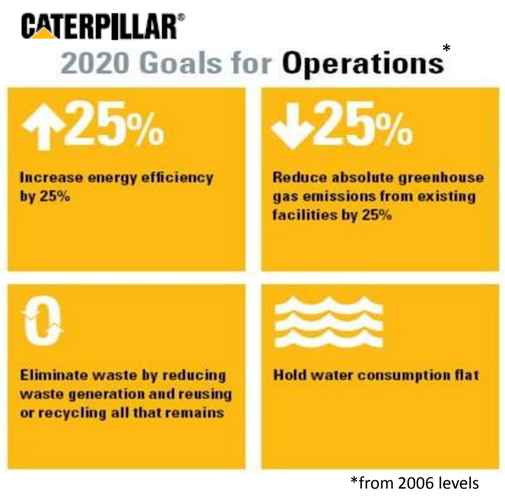
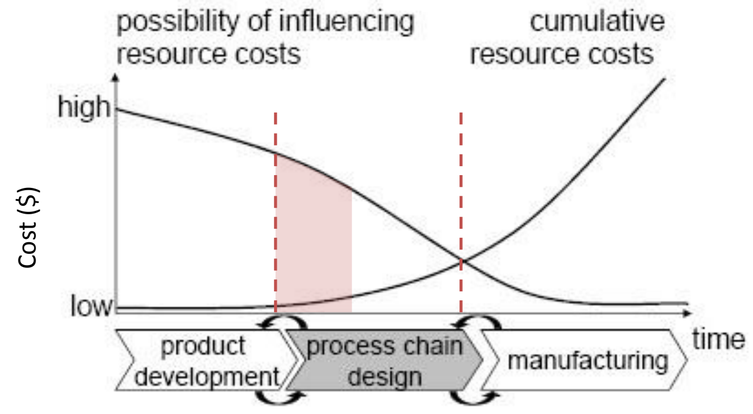


Image source: Sustainability Report, http://www.caterpillar.com/sustainability/sustainability-report

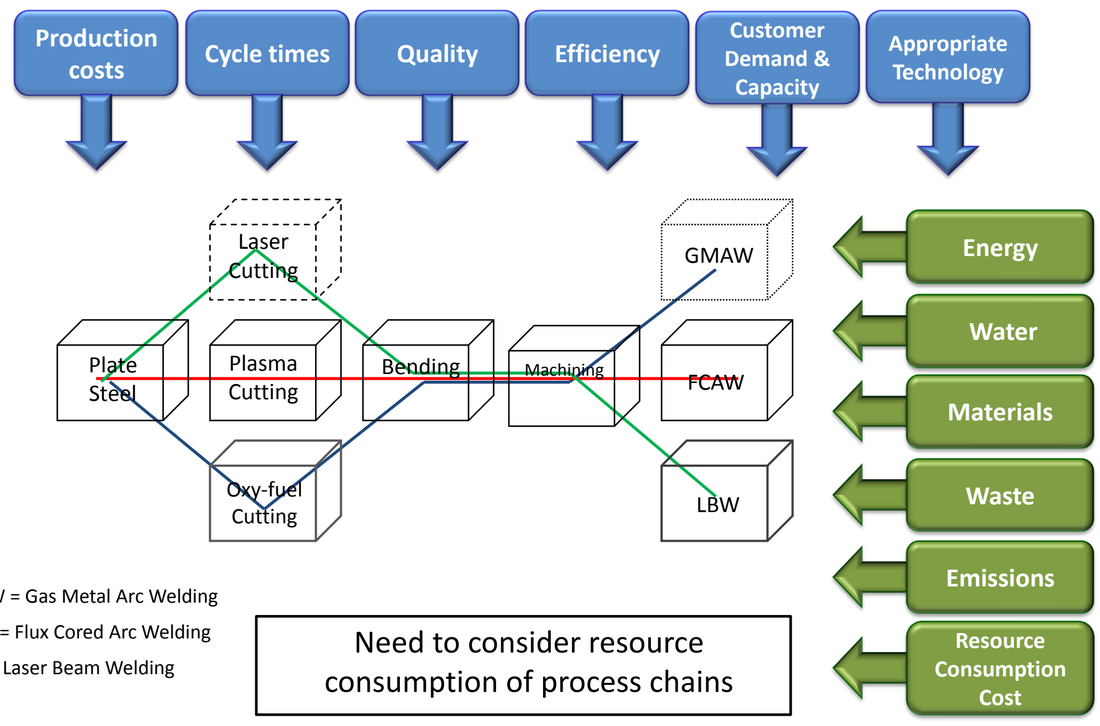
Potential for Improvement

A considerable part of the energy and resource demand in manufacturing is determined during the production planning process



Greatest influence and savings potential is located in the early phases of the production planning process *(Schrems 2011)*

Process Chain Selection



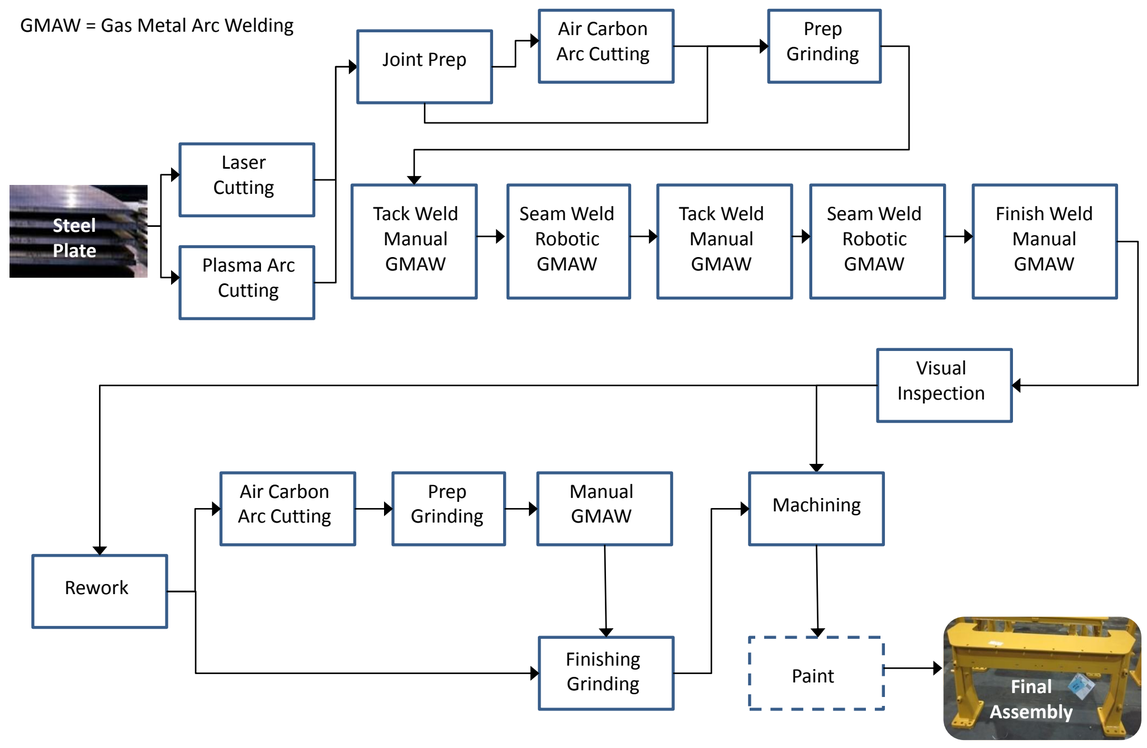
GMAW = Gas Metal Arc Welding

FCAW = Flux Cored Arc Welding

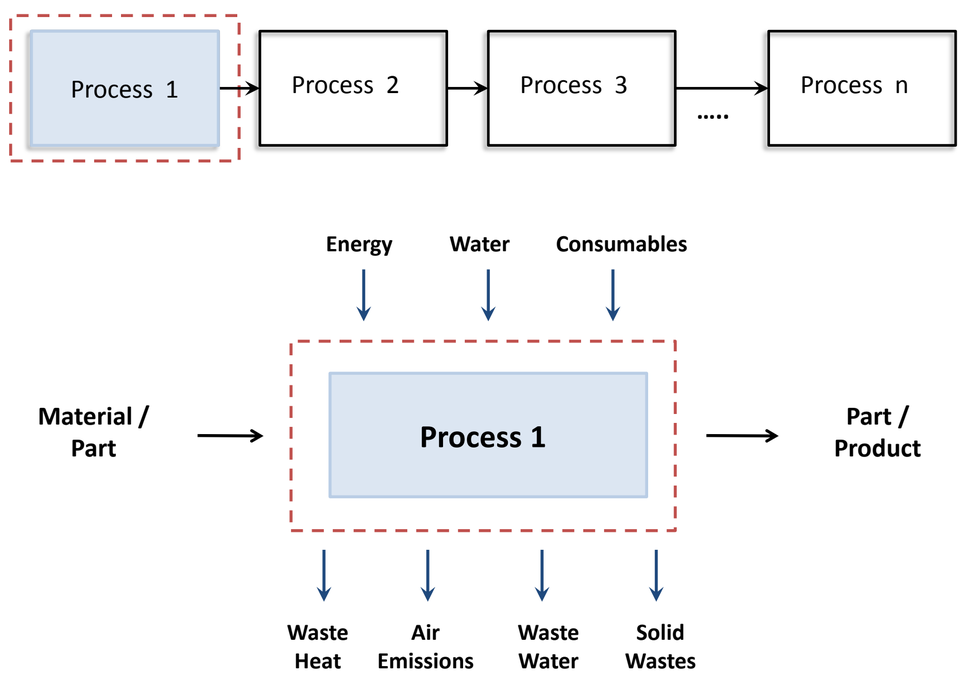
LBW = Laser Beam Welding

Need to consider resource consumption of process chains

Process Chain Configurations

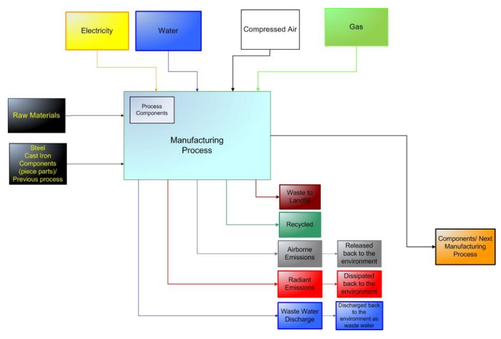


Process Chain Analysis

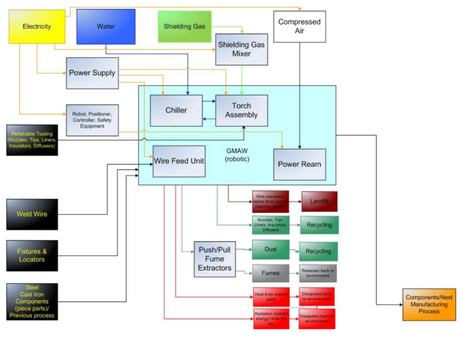


Process Mapping Methodology

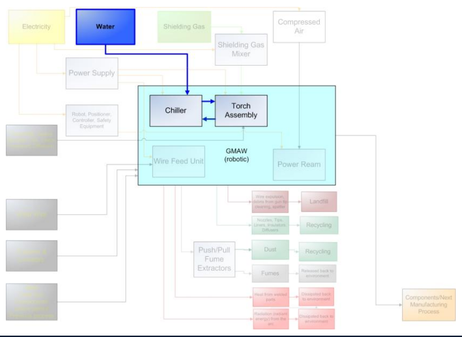
Generic Process Map



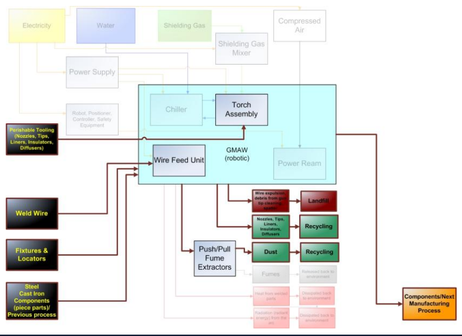
Gas Metal Arc Welding Process Map



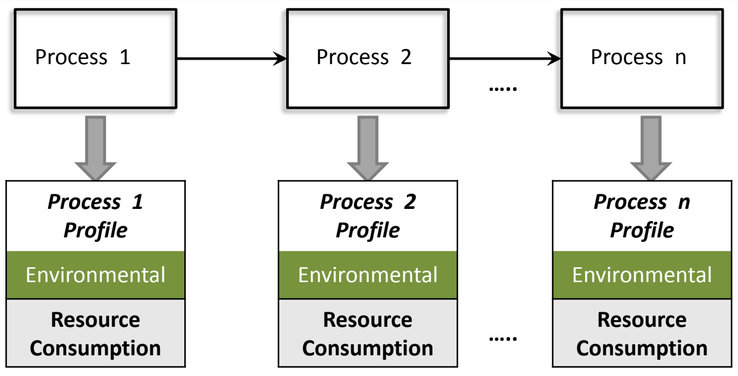
Gas Metal Arc Welding Water Flows



Gas Metal Arc Welding Material Flows



Environmental & Economic Impacts



Environmental	Environmental	Economic
Resource Consumption	**Impacts**	

- Energy use (kWh)
- Water use (gal)
- Tooling & Consumables (kg, ft^3, # of, m)
- Waste generated (kg)
- Air Emissions (g)
	- Global warming potential (CO_{2eq})
	- Other
		- Energy cost ($)
		- Water cost ($)
		- Consumables ($)
		- Disposal fees ($)
		  - Landfill
		  - Recycling

Summary & Future Work

Summary

- Track (all flows) EVERYTHING!!!
- Ability to characterize the resource consumption and environmental impacts of fabrication process chains
- Can be integrated into other models/tools to help provide decision making support for selecting fabrication process chains based on resource consumption and environmental and economic impacts

Future Work

- Further refinement of the model -- data!
- Integrating interdependencies -- upstream/downstream effects
- Automated vs. manual labor
- Expanding model to include additional processes

Berkeley
UNIVERSITY OF CALIFORNIA