

Metals and Metal Manufacturing

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Major Sources of Metal Manufacturing Emissions

- **Primary/Secondary Metal Production**
- **Machining**
 - cutting fluids
 - chips and other solid waste
- **Casting**
 - mold decomposition products
 - spent sand and other solid waste
- **Surface Protection**
 - cleaning/surface preparation fluids and compounds
 - plating discharges
 - paint fumes

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Aluminum

- **Huge Potential in Automotive Industry**
- **Current U.S. Goals**
 - eliminate carbon dioxide emissions by 2020
 - decrease energy use to 11KWH/kg by 2020
 - reduce perfluorocarbon emissions by 40%
- **Recycling**
 - uses 5% of the energy to produce virgin ingot
 - limited by trace element build-up

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Steel

- **Mini-Mills**
 - use electric arc furnaces (EAF)
 - melt scrap
 - highly efficient
- **Problems in Steel Production**
 - element build-up in scrap
 - coatings on steels
 - lead and zinc removal

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Direct Reduction Iron(DRI)

- **Reduce iron ore with methane**
 - carbon dioxide cut by 25 to 35% over basic oxygen furnace using pig iron charge
 - using scrap as a charge CO₂ reduction is 90%
 - DRI works well in electric arc furnaces
- **Concerns**
 - heat time is reduced when carbon is added
 - hybrid furnace (EAF + BOP) is trend of future

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Net Shape Manufacturing

- **Net Shape Casting and Forging identified as a major way to reduce emissions**
 - eliminate machining
 - combine components
- **Precision Engineering**
 - “control dimensions to one part in ten or one hundred thousand” *not* tiny parts
- **Thermo/Mechanical Processing**

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Casting

- **High Potential for Net Shape**
 - sand molds are poorly understood
 - resin decomposition beginning to be understood
 - Casting Emission Reduction Program (CERP) facility
- **Semi-solid casting and advanced die casting processes for non-ferrous alloys**
 - net shape
 - high integrity castings
 - potential extension to cast iron/steel

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Machining

- **Research Priority: Dry Machining**
 - minimize or eliminate the use of cutting fluids
 - some success, but consensus is that some fluid will be necessary
 - chips build up on machine ways
- **Other Approaches**
 - punch or stamp holes instead of machining them

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Joining/Disassembly

- **Implications of joining methods**
 - welded joints can't be disassembled (re-use of components?)
 - melt processing (welding) destroys structure
 - mechanical joining involves machining, and increases part count
- **Development of tools for disassembly**

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Coating/Surface Preparation

- **Few good ways**
 - organic solvents must be treated
 - water-based systems require water treatment
 - pre-coated steel can be scratched (but might be okay for clear-coat)
- **Major problem for manufacturing**
 - opportunity for innovation

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Alloy Development

- **High strength low alloy steels**
 - micro-grain
 - ultra clean
 - corrosion-resistant steels for marine applications
- **“Advanced Materials”**
 - composites are hard to recycle
 - tailored and graded alloys impossible to recycle
- **Alloy Characterization is very expensive**

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Take-back Laws

- **What alloys will be used in ten years?**
 - If this year’s alloys show up then, what to do with them? Will there be a market for them?
 - Will alloy and material development stop?
- **How much life remains in the components?**
 - Life prediction modeling
 - NDE methods for used components
- **Disassembly, Clean and Rebuild Technology**

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Corporate Divestitures

- **OEM's are divesting their metalworking divisions**
 - Delphi, Visteon
 - “Vendors can concentrate on their ‘special knowledge’”
- **These are small/medium-sized companies (SME's)**
 - Small environmental staffs
 - Concentrate on compliance, not avoidance
 - Under strong cost pressures from OEM's
- **Opportunity/need for research support**

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Summary/Needs

- **Primary Research Needs**
 - **Methods to remove trace elements from alloys during recycling**
 - **Methods to recover and recycle composite materials**
 - **Development of true net shape casting and forging methods**
 - **Research projects to support Tier I, II and III suppliers (SME's)**

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More Summary/Needs

- **Life Extension Technology**
 - Life Prediction Modeling techniques
 - NDE for remaining life
- **Better Furnaces/Thermal Processing**
 - Melting
 - Heat Treating
 - Remanufacturing

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