Sustainable manufacturing in China

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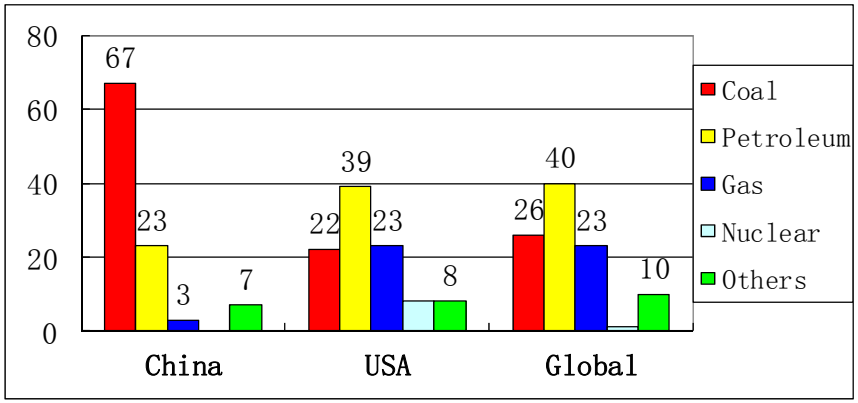
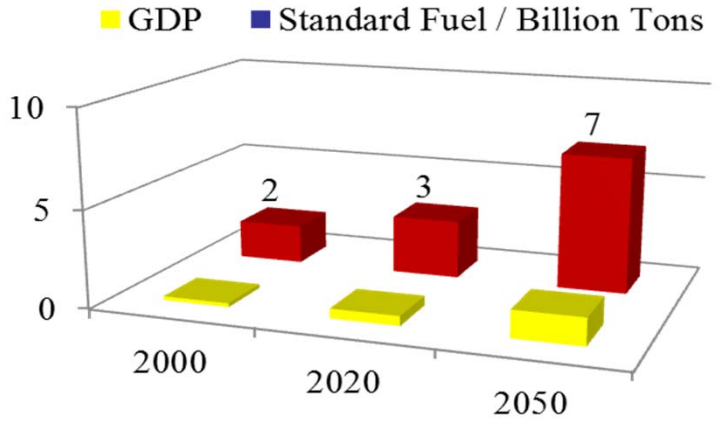
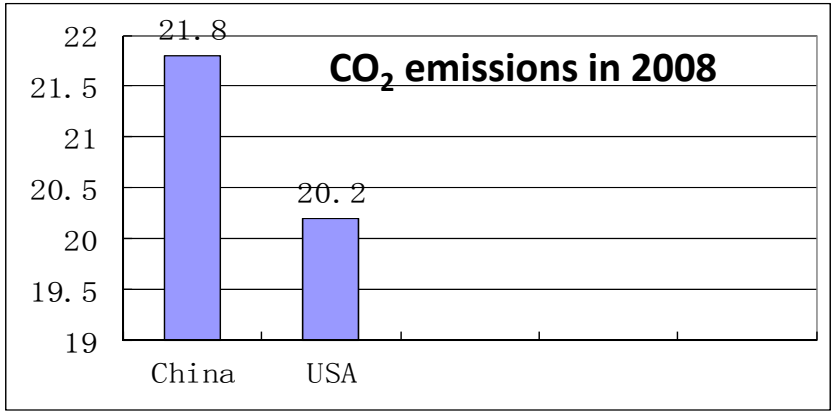
Contents

Challenges

High energy consumption and serious environmental pollution in manufacturing industry







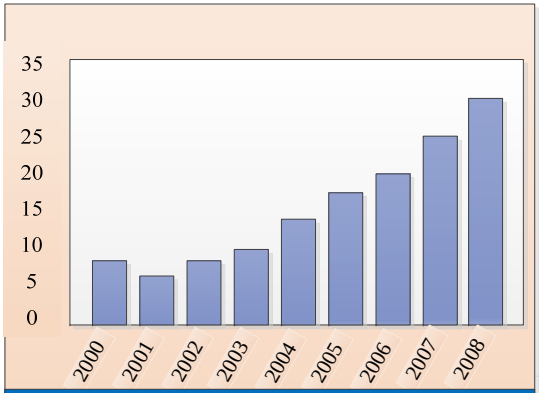
- China is the world's largest consumer of coal
- China is the world's largest CO_2 emitter
- Energy consumption per unit GDP of China is 7 times greater than Japan
- The GDP loss caused by environmental pollution in China is about 10%

Challenges

Increasingly serious green regulations and standards

Technique barriers to trade (TBT)

- EU low voltage directive and electro magnetic compatibility (EMC) directive
- EU RoHS directive, WEEE directive, and REACH regulations
- Germany CFGB directive
- American air conditioner efficiency standards
- Japanese environmental protection regulations and standards
- Australian air conditioner efficiency standards



Home appliance industry from 2000 to 2008

Carbon Tariffs approaching the Chinese manufacturing

About 7.4 billion Chinese commodities are rejected for export because of TBT

Challenges

Excessive material consumption and energy consumption in manufacturing process

Industry	Domestic	Abroad
Foundry industry	0.55 to 0.7 tons standard coal per ton of cast iron	0.3 to 0.4 tons standard coal per ton of cast iron
Forging industry	1.4 tons Standard coal per ton of forging	0.515 tons Standard coal per ton of forging in Japan
Heat treatment industry	660 kWh per ton workpiece	Less than 450 kWh per ton workpiece in Japan, U.S.A, E.U and other countries.

Milestones of state policy for green manufacturing

2006. 2 《国家中长期科学和技术发展规划纲要（2006-2020年）》：

Developing green manufacturing technology to reduce resource consumption and environmental pollution

2009.1 《中华人民共和国循环经济促进法》：

Legally supporting the parts remanufacturing of motor vehicle, construction machinery and machine tools, etc.

2011.3 《国民经济和社会发展十二五规划纲要》：

Energy saving and environmental friendly industry was listed as one of national strategically emerging lines

2013 《**2013**年工业节能与绿色发展专项行动实施方案》：

Special program plan of industrial energy-saving and green development

Contents

2.1 R&D Stages of Sustainable Manufacturing

1997-2006

Sponsored by NSFC and “863” High Tech Program of the MOST, Universities and institutes started the fundamental researches, and published related papers, reports and books,

2006-2010

The MOST sponsored a major project of “Key technologies and equipment for green manufacturing ”with 136 million RMB; NSFC setup sustainable design and manufacturing program.

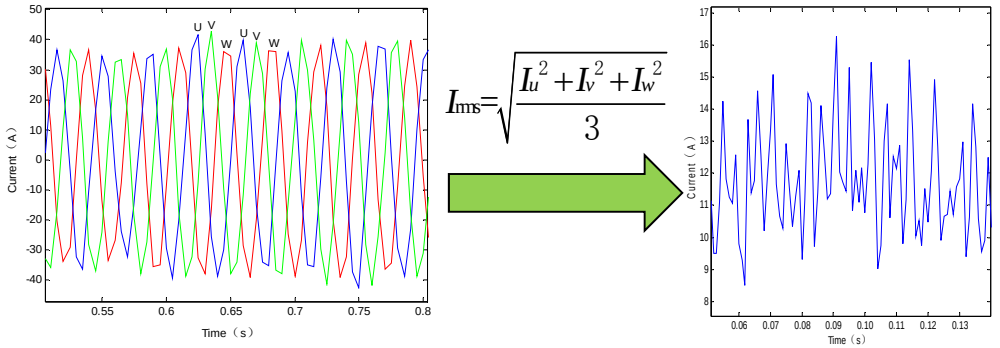
2010-2015

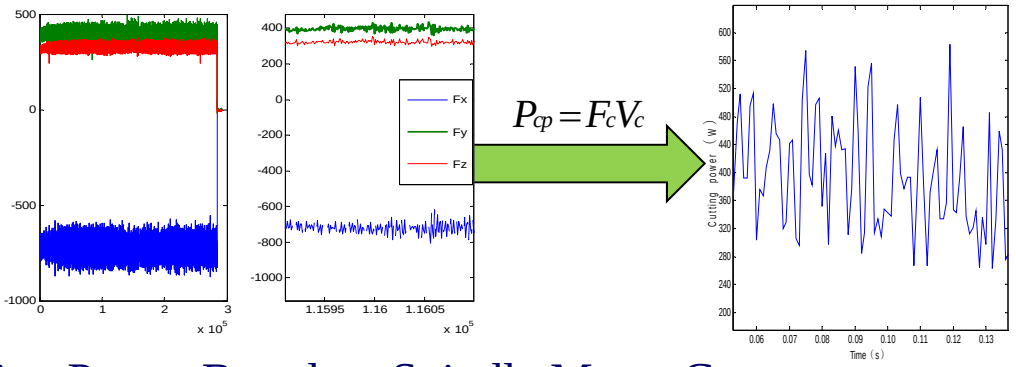
Green manufacturing was planned as one of the three major national science and technology major project in advanced manufacturing field. The budget was up to 900 million RMB. NSFC sponsored two key projects with 3 million for each, and other dozens of general projects.

2.2 Fundamental Research

Key project supported by NSFC:

- **2011: The basic theories and key technologies of operational optimization for manufacturing system with high efficiency and low carbon**



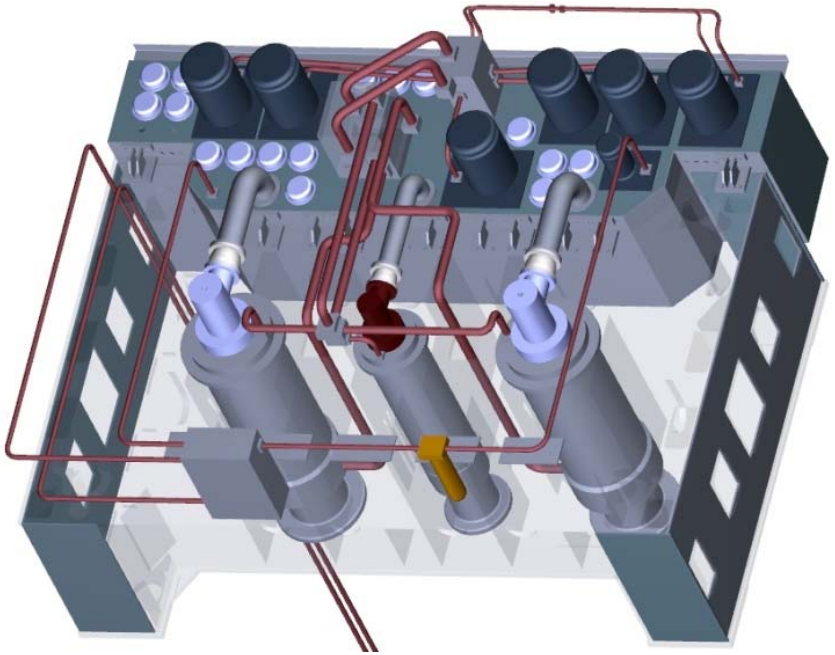


The Real-time Monitoring Cutting Power Based on Spindle Motor Current

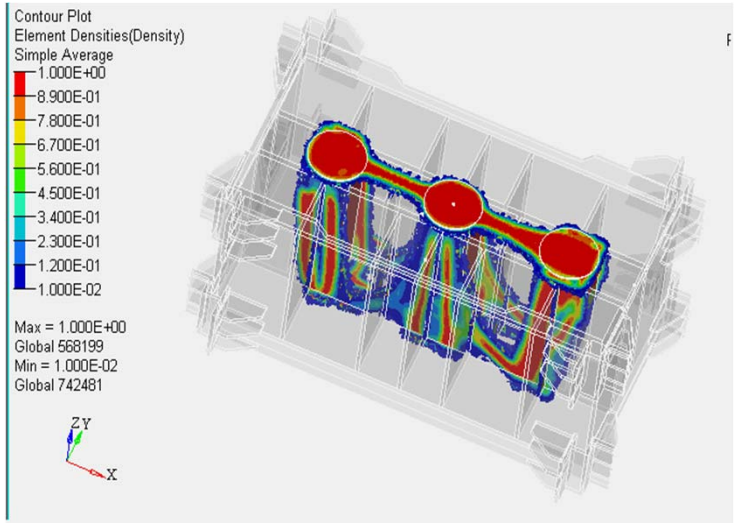
2.2 Fundamental Research

Key project supported by NSFC:

- **2012: The basic theory and key technology of low carbon manufacturing for High-end metal forming machines**



A 2000-ton hydraulic press system

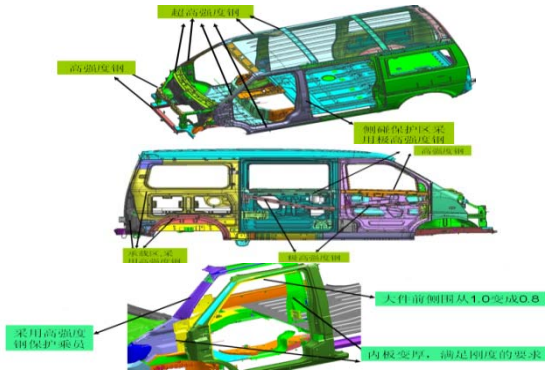


The ultimate goal is to change traditional design ideas of strength, stiffness and power for metal forming machine!

2.3 Development of key technologies

- **Lightweight design**

  - Focus on studying the impact of lightweight design on the strength, stiffness and passive safety of automobiles, the performance evaluation and selection of high-strength materials and structure of parts optimization;
  - Study lightweight design techniques of energy saving and noise reducing methods for engineering machine;
  - Study the method and technology systems for lightweight designs under the constraints of tools.



Green and lightweight design of automotives

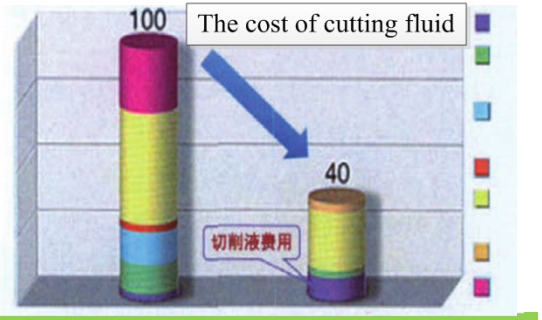
lightweight design of tools

2.3 Development of key technologies

- **Clean and harmless processes**
  - Develop new energy conversation and emission reducing processes for wet cutting, molding, casting, forging, heat treatment, welding and laser processes in manufacturing industry.
  - Develop the technological limit of micro nanostructure design, thin film material preparation and roll-to-roll Nano imprint, and to develop inkless printing processes and equipment.
  - Study the principles and processes of green physical cleaning like carbon dioxide ice cleaning, ultrasonic cleaning, laser cleaning, as well as efficient non emission intelligent automatic cleaning equipment.

MQL technique

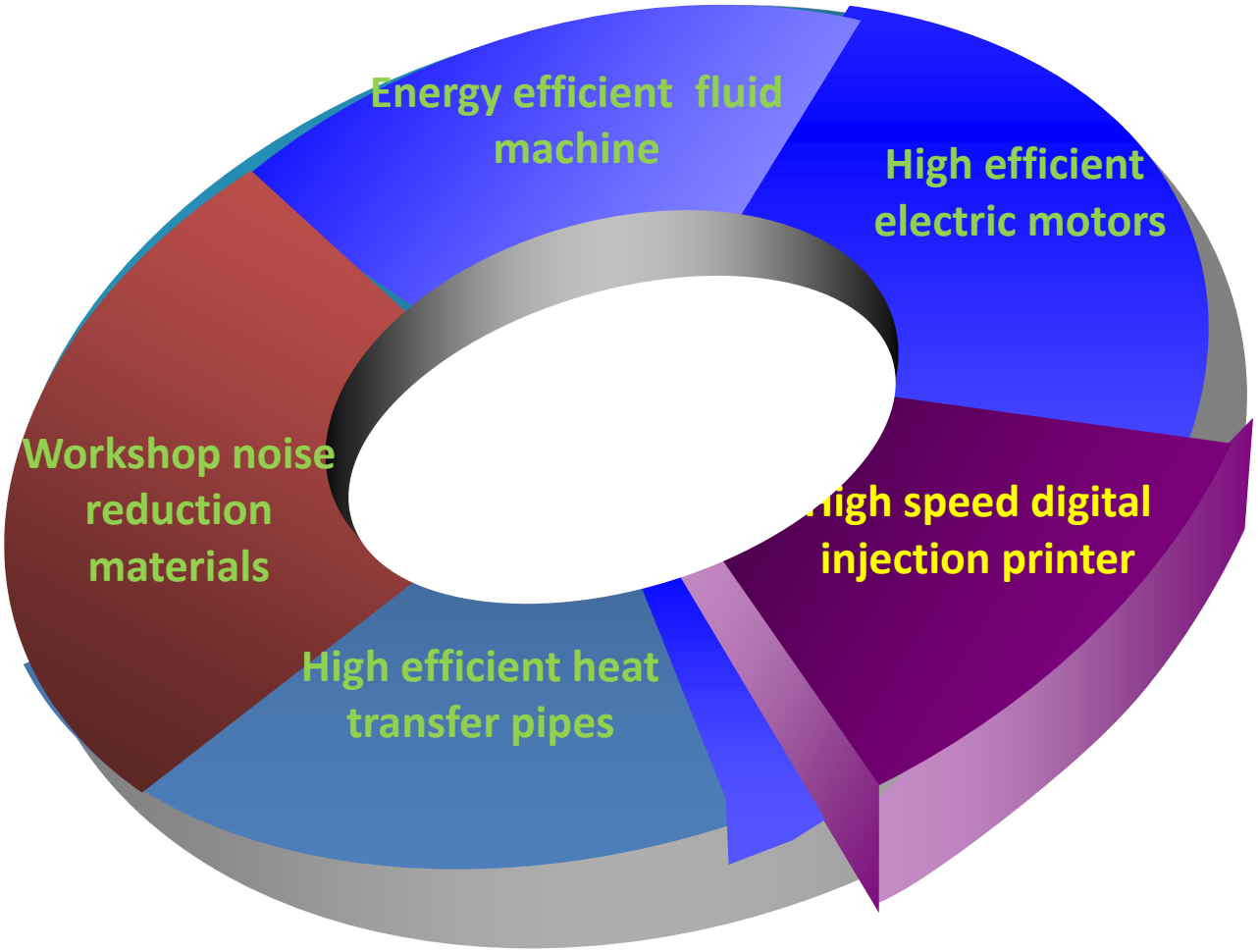
Cold jet machine



Compare wet cut to MQL technique

2.3 Development of key technologies

- **Energy saving mechatronic products**



2.3 Development of key technologies

- **Recycling and Remanufacturing**

1) Disassembly and recycling of used cars

2) remanufacturing of auto parts

3) Remanufacturing of machine tools

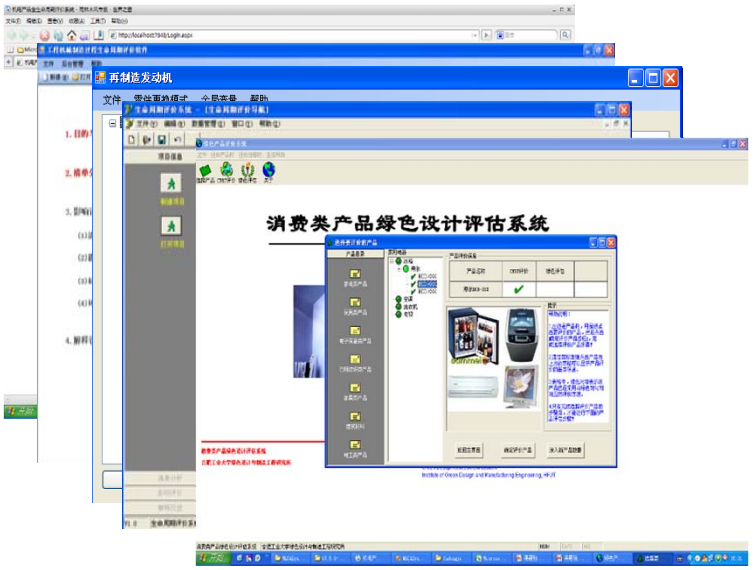
4) Remanufacturing of Construction machinery

5) Disassembly and recycling of household appliance

2.4 Standardization

Established national technology standard committee for green manufacturing(SAC/TC 337)

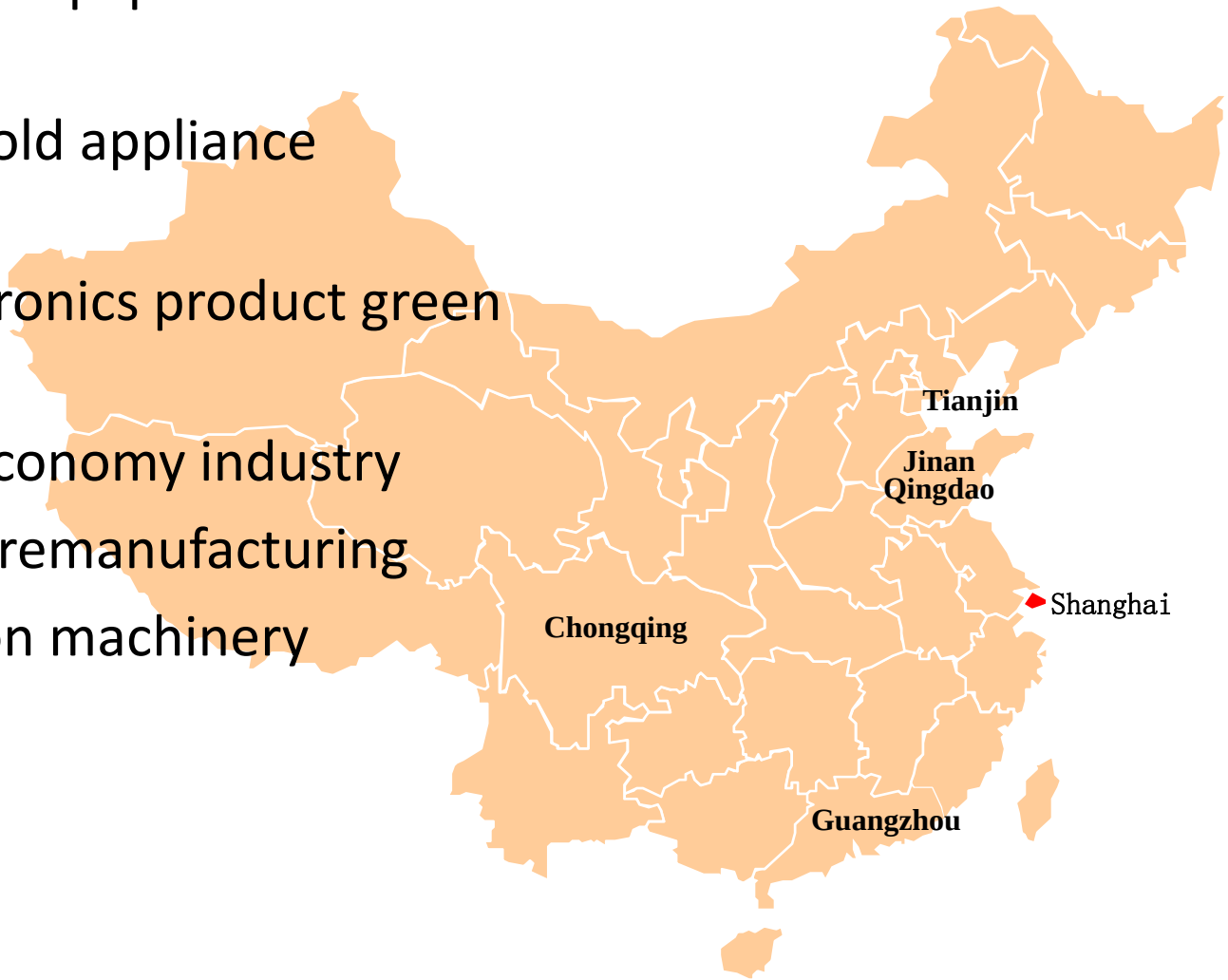
- developed the systematic structure of technology standard for green manufacturing, and drafted 83 standards;
- Proposed Chinese product LCA index and methods；
- Developed related database, knowledgebase and software packages



中国汽车材料数据系统（CAMDS）

2.5 Industrialization Base

- Chongqing: Green equipment manufacturing
- Qingdao: Household appliance recycling
- Guangzhou: Electronics product green manufacturing
- Tianjin: Circular economy industry
- Shanghai: Engine remanufacturing
- Jinan: Construction machinery remanufacturing



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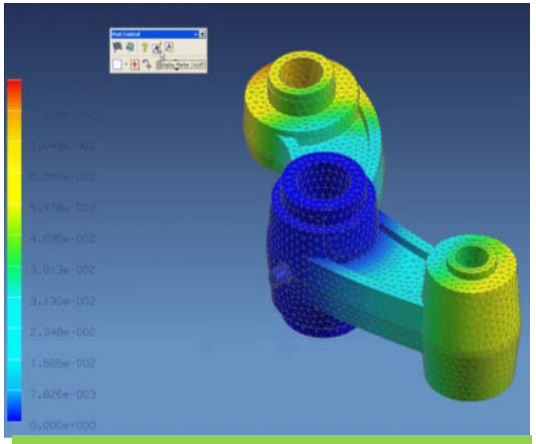
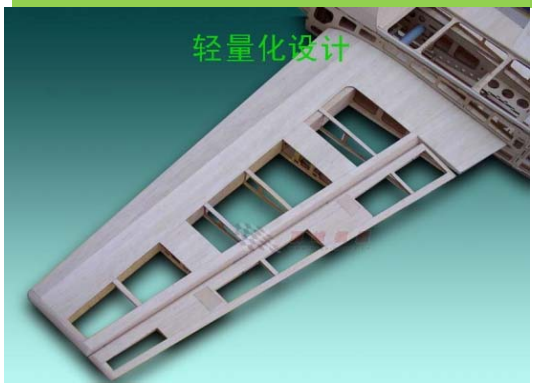
Future Work

1) Green design and life cycle assessment

- To satisfy the requirements of energy conservation and emissions reduction, new theories and methods should be developed to create lightweight, energy efficient and resource-saving designs.
- To satisfy the requirements of environmental-friendly and sustainable development, we should focus on producing recyclable and disassemble-able parts. Further more, we should focus on considering environmental impacts and remanufacturing of the products.
- It is necessary to set up basic database of green design and develop green design software and tools which can support life cycle assessment.



FEM application in the lightweight design

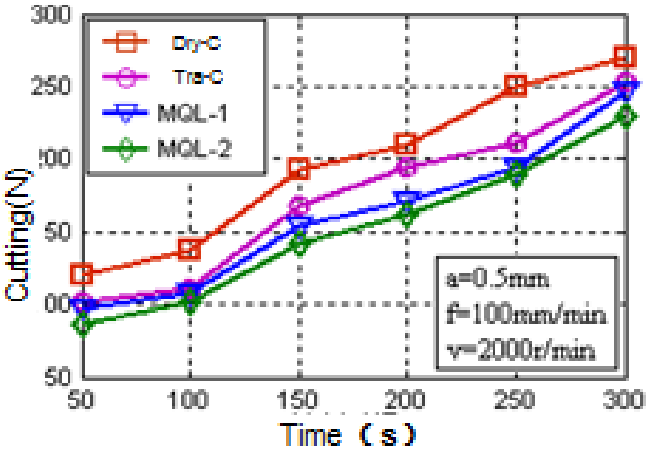


Lightweight design of the wing

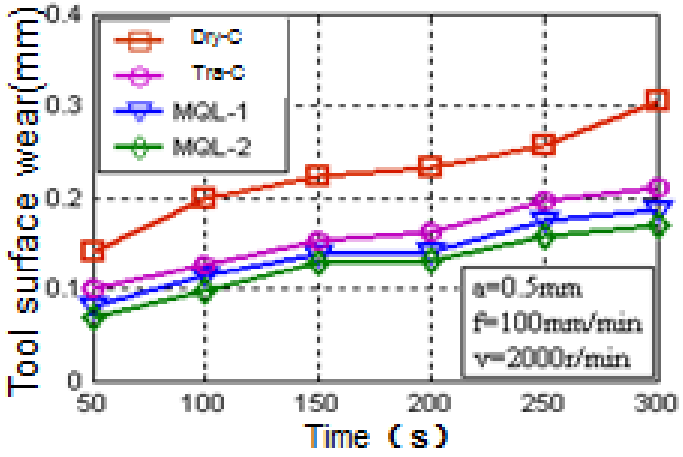
Future Work

2) Innovative sustainable process technology

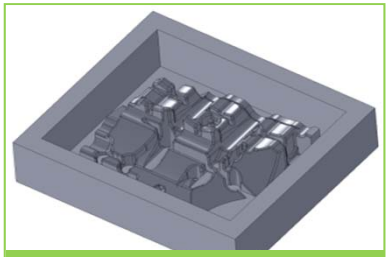
- Green process planning, dry cutting technology, hot processing simulation, rapid prototyping technology, near net-shape technology, laser processing should be considered.



Milling force under different lubrication method VS Time



Tool surface wear VS Time



CAD model

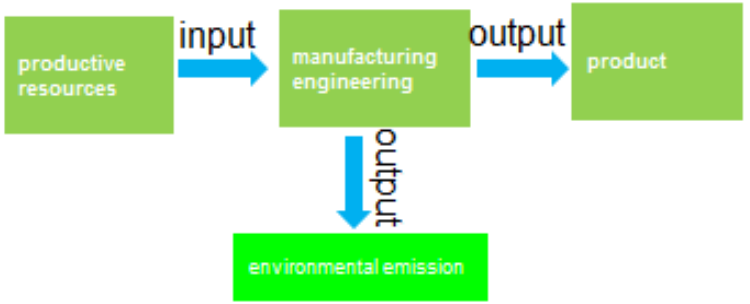
Rough machining

Finish machining

Future Work

3) Carbon efficiency optimization technology

- Carbon efficiency analysis model and manufacturing process assessment
- Energy consumption prediction, measurement, monitoring and assessment
- Optimization of resources and energy during the manufacturing process
- Network simulation
- Energy consumption assessment of electromechanical system
- System which can assess the energy conservation and monitor the emission reduction.



Future Work

4) Key technologies for recycling and remanufacturing

- Techniques for recycling and disassembling of products, recycling, remanufacturing, waste product management techniques including recycling methodologies such as reverse logistics facility layout planning, automatic sorting and tracking , inventory control of waste materials should all be adopted.
- Basic theory and key technologies of product remanufacturing including life prediction, surface strengthening, rapid forming, coating and nano anti-friction self-healing, emergency rapid maintenance, performance upgrading of obsolete product should be used.

worm-gears after remanufacturing

Future Work

5) Green manufacturing technology standards and information platform

- Research in accordance with the standards of green manufacturing technology，and development of green manufacturing technology standard systems conforming with international standards is required to introduce standardized service activities.
- Considering the whole life cycle of the product including designing, manufacturing, usage period of product, recycling and remanufacturing, life cycle assessment system, green manufacturing process planning system, green supply chain supporting system and green manufacturing industry chain information service platform should be developed.

Thanks !