

Advanced Manufacturing Technology

先进制造技术

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Outline



- **What's advanced manufacturing technology (AMT)?**
- **Course description**
- **Why bilingual teaching?**



1. What's manufacturing ?

□ The definition

Manufacturing is the production of merchandise for use or sale using labour and machines, tools, chemical and biological processing, or formulation.

The term may refer to a range of human activity, from handicraft to high tech, but is most commonly applied to industrial production, in which raw materials are transformed into finished goods on a large scale.

Such finished goods may be used for manufacturing other, more complex products, such as aircraft, household appliances or automobiles, or sold to wholesalers, who in turn sell them to retailers, who then sell them to end users – the "consumers".



1. What's manufacturing ?

□ Historical development of manufacturing technology

- In ancient ages: hand-crafted production (手工生产)
 - Manufacture = “manu” (手) + “facere” (做)
 - Manufacturing activities were performed in handcraft workshop
 - China played an important role to promote the development of manufacturing technology at this stage



Grinder (磨床)



Terra-Cotta Warriors (兵马俑)



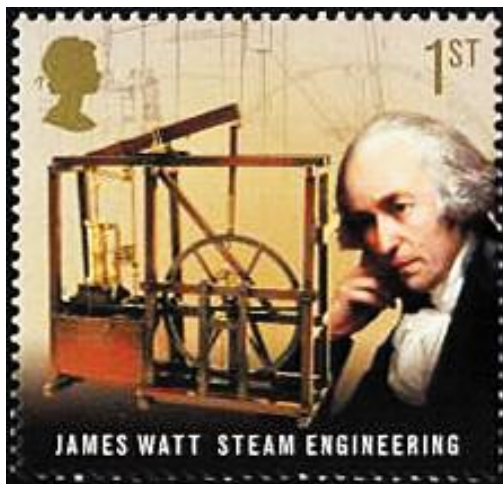
Chang's seismograph (地动仪)



1. What's manufacturing ?

□ Historical development of manufacturing technology

- In late 18th – middle 19th century: mechanized production (机械化生产)
 - In 1765, James Watt invented steam engine (蒸汽机), providing power to various machines and extremely replacing human labors
 - **Start the first industrial revolution**
 - England became the manufacturing center of the world at this stage



Watt's steam engine



Spinning jenny (珍妮纺纱机)



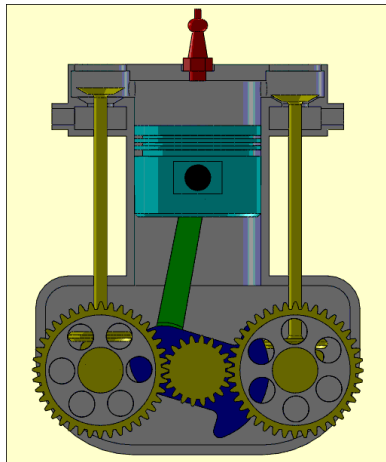
Steam train (蒸汽火车)



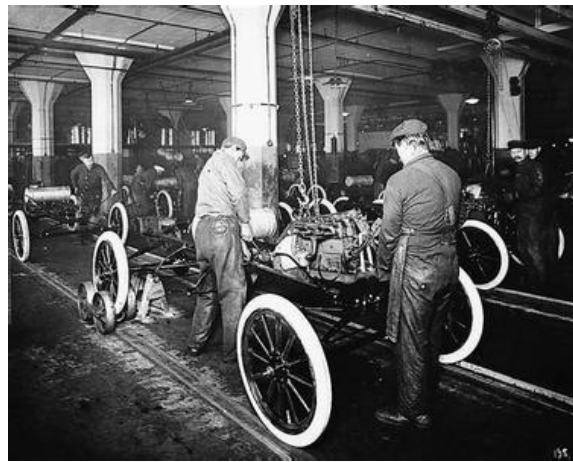
1. What's manufacturing ?

□ Historical development of manufacturing technology

- In late 19th – early 20th century: mass production
 - Invention of internal combustion engine (内燃机)
 - **Start the second industrial revolution**
 - Europe and American became the manufacturing center of the world
 - Mass production: Automobiles, Weapons



Internal combustion engine



Ford's production line



In 1903, Wright brothers invented the plane



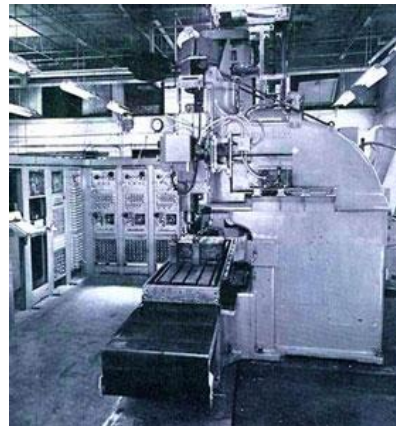
1. What's manufacturing ?

□ Historical development of manufacturing technology

- In 1939-1980: Computer + Automatic production
 - Digital computer: Atanasoff-Berry Computer (ABC) in 1939, not ENIAC in 1946
 - In 1952, the first numerically controlled machine was invented in MIT
 - Computer-aided design (CAD), computer-aided manufacturing (CAM), flexible manufacturing system (FMS), computer integrated manufacturing system (CIMS)
 - America, Europe and Japan



ABC (阿塔纳索夫-贝瑞计算机)



The world first NC



Toshiba events (东芝事件)

1. What's manufacturing ?



□ Historical development of manufacturing technology

- **In 1990-Now: Advanced manufacturing technology (AMT)**
 - **In 1993, the federal coordinating council for science, engineering and technology (FCCSET, 美国联邦科学、工程与技术协调委员会) firstly proposed AMT concept**
 - **The use of innovative technology to improve products or processes**
 - **Classification of AMT**
 - **Modern Design Technologies**
 - **Advanced Processing Technologies**
 - **Automation Technologies**
 - **Advanced Production and Management Technologies**
 - **Rapid development of AMT in America, Europe, Japan, Korea and China**





1. What's manufacturing ?

□ The third industrial revolution

➤ **“The third industrial revolution”**, Apr 21st 2012

➤ **Digital manufacturing**

➤ Easy-to-use robots

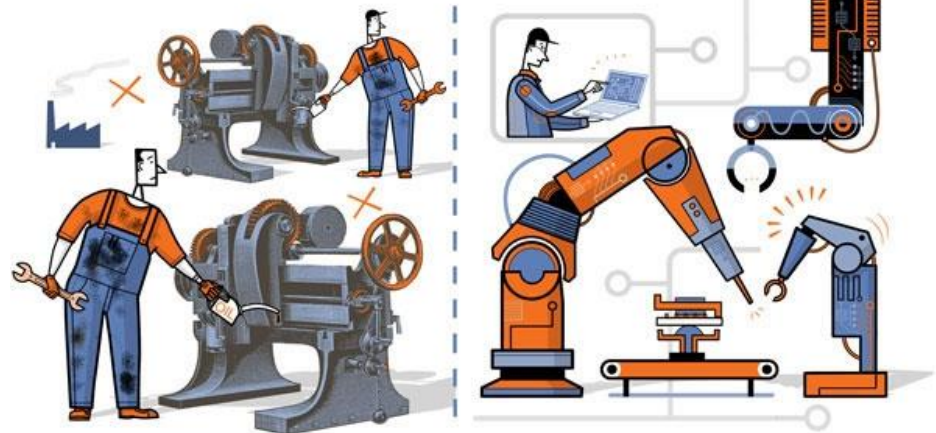
➤ New collaborative manufacturing services

➤ **Completely new processes**

➤ 3D printing

➤ **New materials**

➤ **Individualized production**

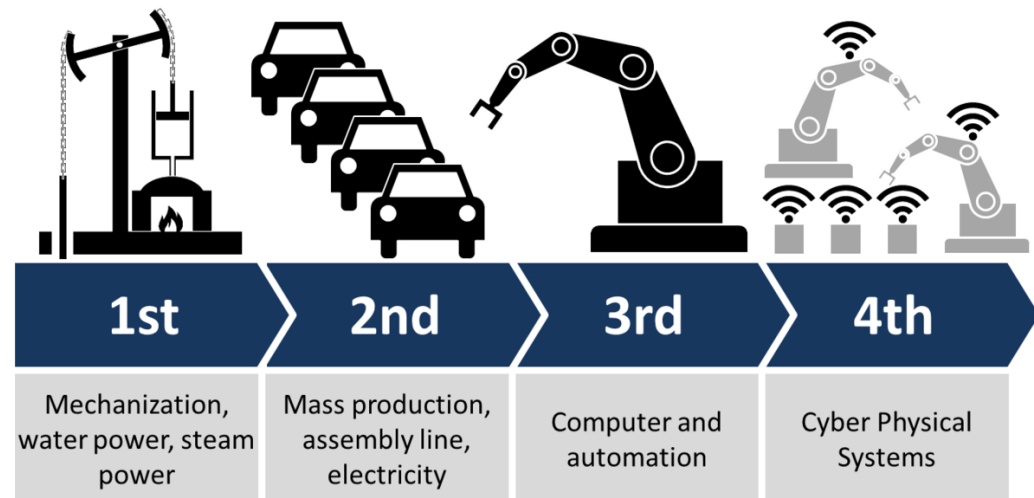




1. What's manufacturing ?

□ Industry 4.0

- The basic principle of Industry 4.0 is that by connecting machines, work pieces and systems, businesses are creating intelligent networks along the entire value chain that can control each other autonomously.
- It is the current trend of automation and data exchange in manufacturing technologies. It includes **cyber-physical systems**, **the Internet of things** and **cloud computing**.





1. What's AMT ?

□ The definition

Advanced manufacturing is the use of **innovative technology** to improve products or processes.

https://en.wikipedia.org/wiki/Advanced_manufacturing

Advanced manufacturing was defined as the insertion of **new technology, improved processes, and management methods** to improve the manufacturing of products.

National Defense University, 2002, as reported in PCAST

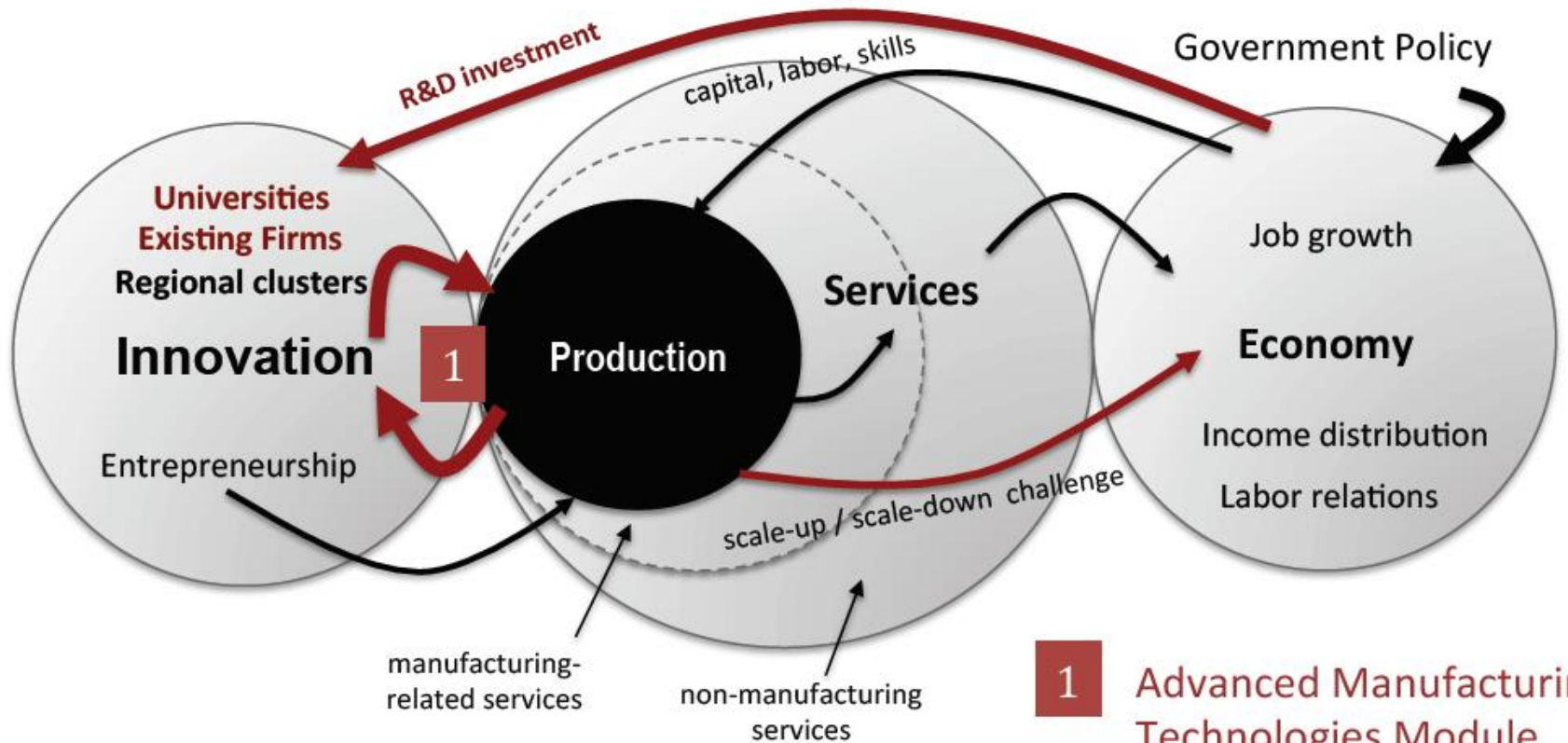
Advanced Manufacturing is the **creation of integrated solutions** that require the production of physical artifacts coupled with value-added services and software, while exploiting custom-designed and recycled materials and using ultra-efficient processes.

MIT, Trends in Advanced Manufacturing Technology Innovation, 2013



1. What's AMT ?

□ Position of AMT in “Production in the Innovation Economy”



1 Advanced Manufacturing Technologies Module

AMT is the changing frontiers of manufacturing technologies

MIT, Trends in Advanced Manufacturing Technology Innovation, 2013



1. What's AMT ?

□ Converging Trends

- **Five large-scale trends that have been instrumental in the shift from traditional labor-intensive processes to advanced-technology-based processes.**

- (1) the ubiquitous role of information technology
- (2) the reliance on modeling and simulation in the manufacturing process
- (3) the acceleration of innovation in global supply-chain management
- (4) the move toward rapid changeability of manufacturing in response to customer needs and external impediments
- (5) the acceptance and support of sustainable manufacturing



1. What's AMT ?

□ Traditional vs. Advanced Manufacturing

➤ Traditional manufacturing?

Traditional Manufacturing is defined as the act of converting raw materials into finished products by using **manual or mechanized** transformational techniques.

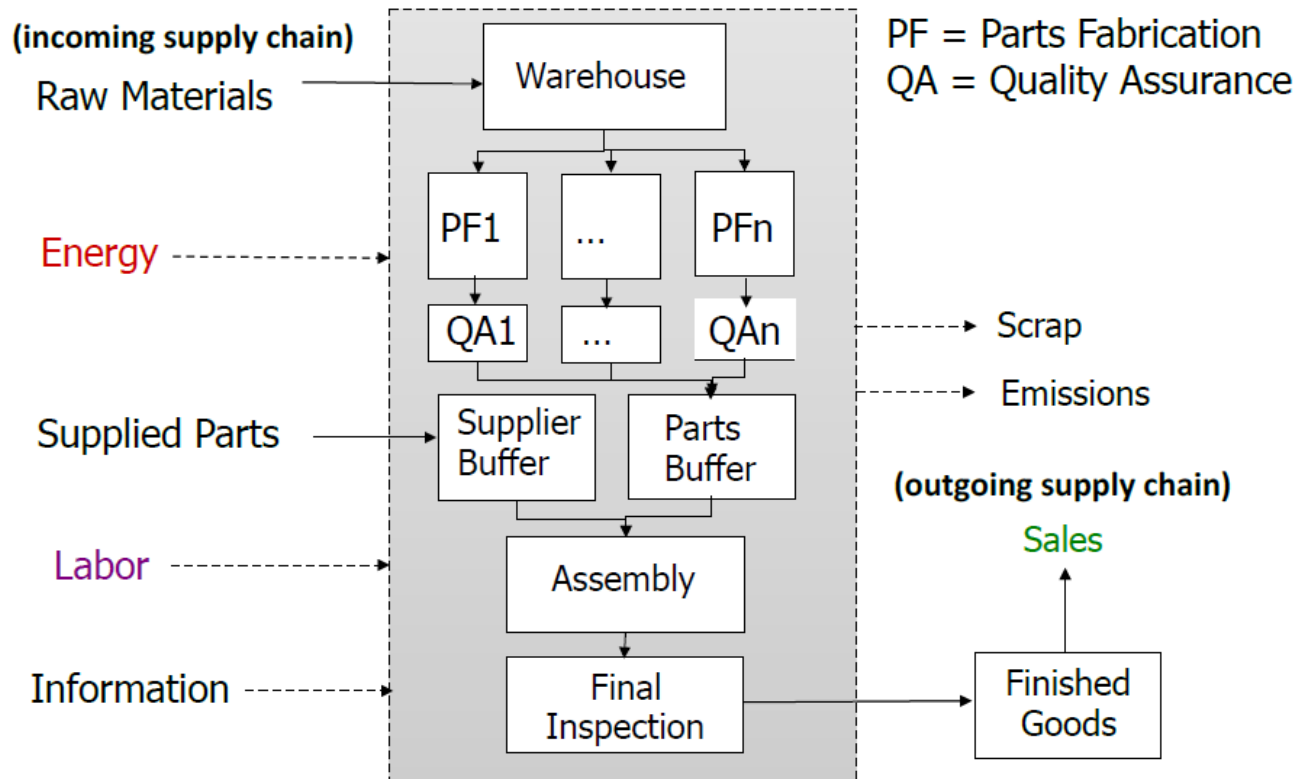
Thareja, Priyavrat,(2005), Manufacturing Paradigms In 2010, Proceedings of National Conference on Emerging trends in Manufacturing Systems, JMIT, Radaur, March 15–16, 2005.



1. What's AMT ?

□ Traditional vs. Advanced Manufacturing

- **Traditional manufacturing:** step-wise transformation of raw materials into finished goods



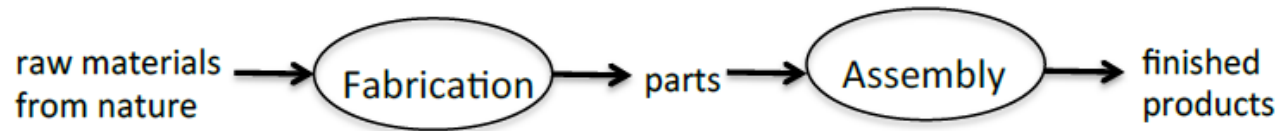


1. What's AMT ?

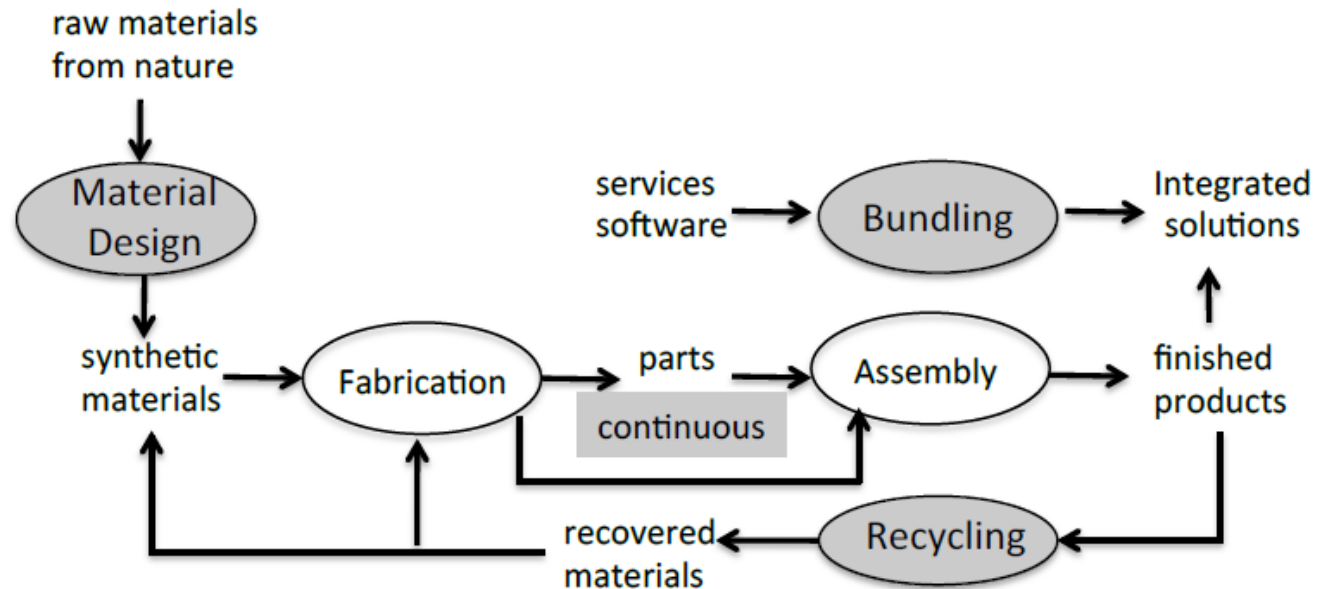
□ Traditional vs. Advanced Manufacturing

- **Advanced manufacturing technology: much broader and less linear**

Traditional
Manufacturing
(20th century)



Advanced
Manufacturing
(21th century)

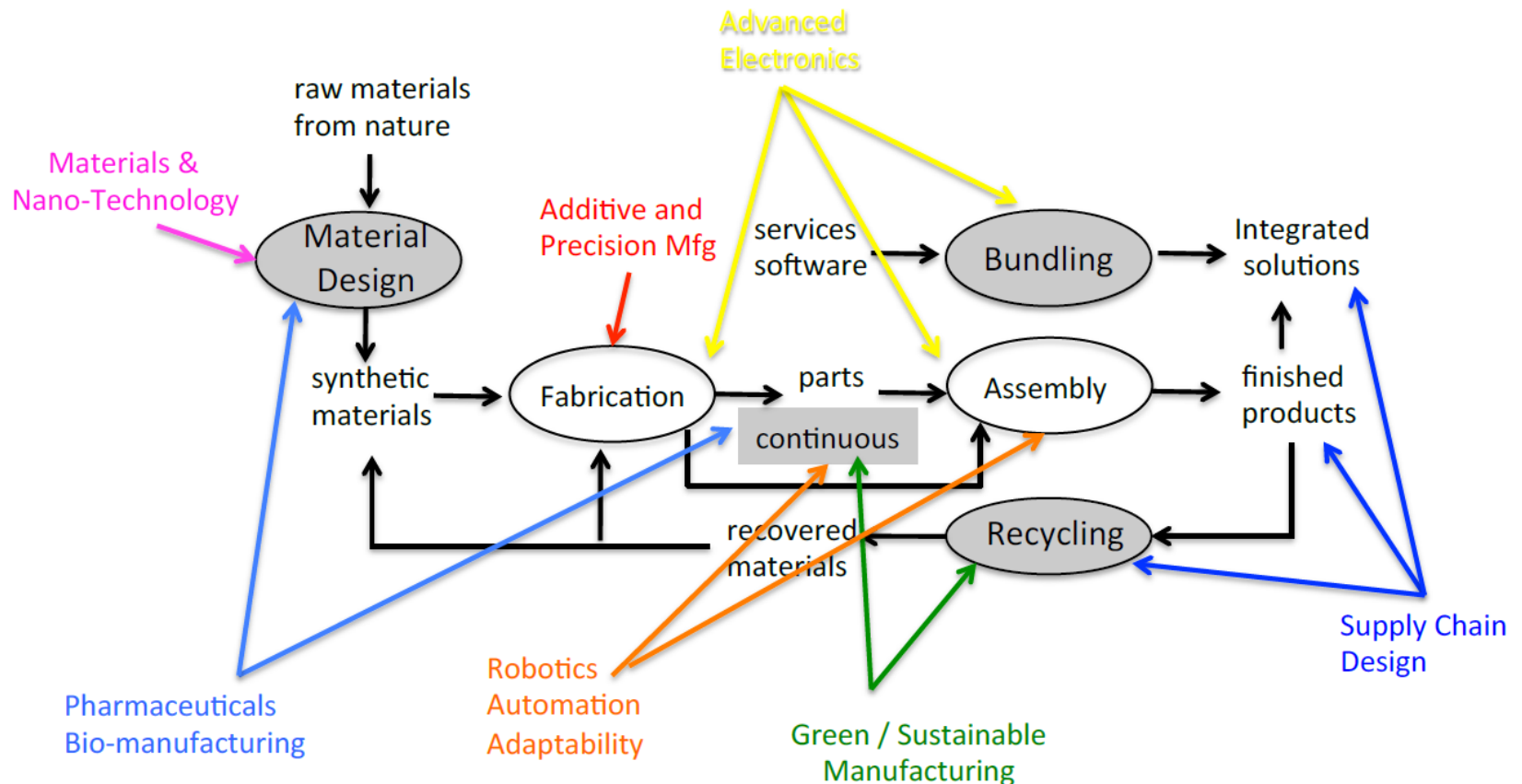




1. What's AMT ?

Traditional vs. Advanced Manufacturing

- **Advanced manufacturing technology: much broader and less linear**



Impact of manufacturing technology research on advanced manufacturing



1. What's AMT ?

□ Traditional vs. Advanced Manufacturing

- **Advanced manufacturing technology: much broader and less linear**

Nano-engineering of Materials and Surfaces

Synthesis of multi-functional materials at the nano-scale from the ground up

Additive Precision Manufacturing

Building up components by adding layers of material in complex 3D shapes

Robotics, Automation and Adaptability

Using robotics to substitute for or complement human labor in new ways

Next Generation Electronics

Next generation circuits using non-Si materials, using mask-less processes and flexible substrates

Bio-manufacturing / Pharmaceuticals

Continuous manufacturing of small molecules, turning cells/ organisms into programmable factories

Distributed Supply Chains / Design

Enabling flexible and resilient decentralized supply chains, new approaches to web-enabled mfg

Green Sustainable Manufacturing

New manufacturing processes that use minimal energy, recycle materials and minimize waste and emissions



1. What's AMT ?

□ Traditional vs. Advanced Manufacturing



Traditional bikes

vs.



Mobikes

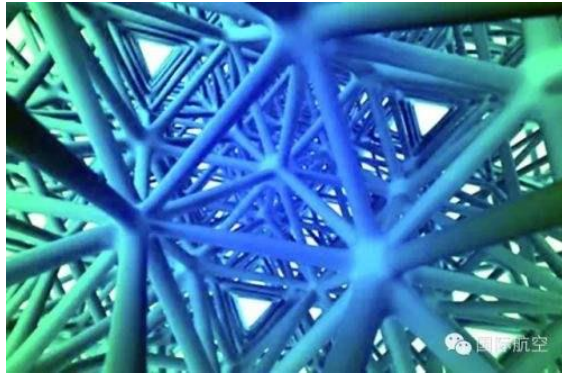
What are the technological factors in Mobikes in comparison with traditional bikes?



1. What's AMT ?

□ Typical achievement of AMT

- **Meta-materials, Structural materials and composites**



Ultralight structural materials



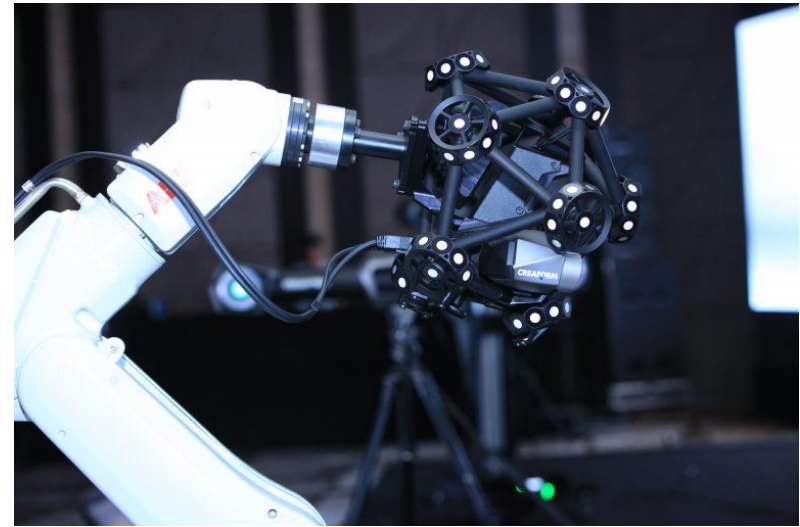
Heat shield composite structure for NASA's Orion spacecraft, over 4500° F re-entry temperatures, 16.5 feet in diameter



1. What's AMT ?

□ Typical achievement of AMT

- **In-process inspection, making adaptive machining a reality**



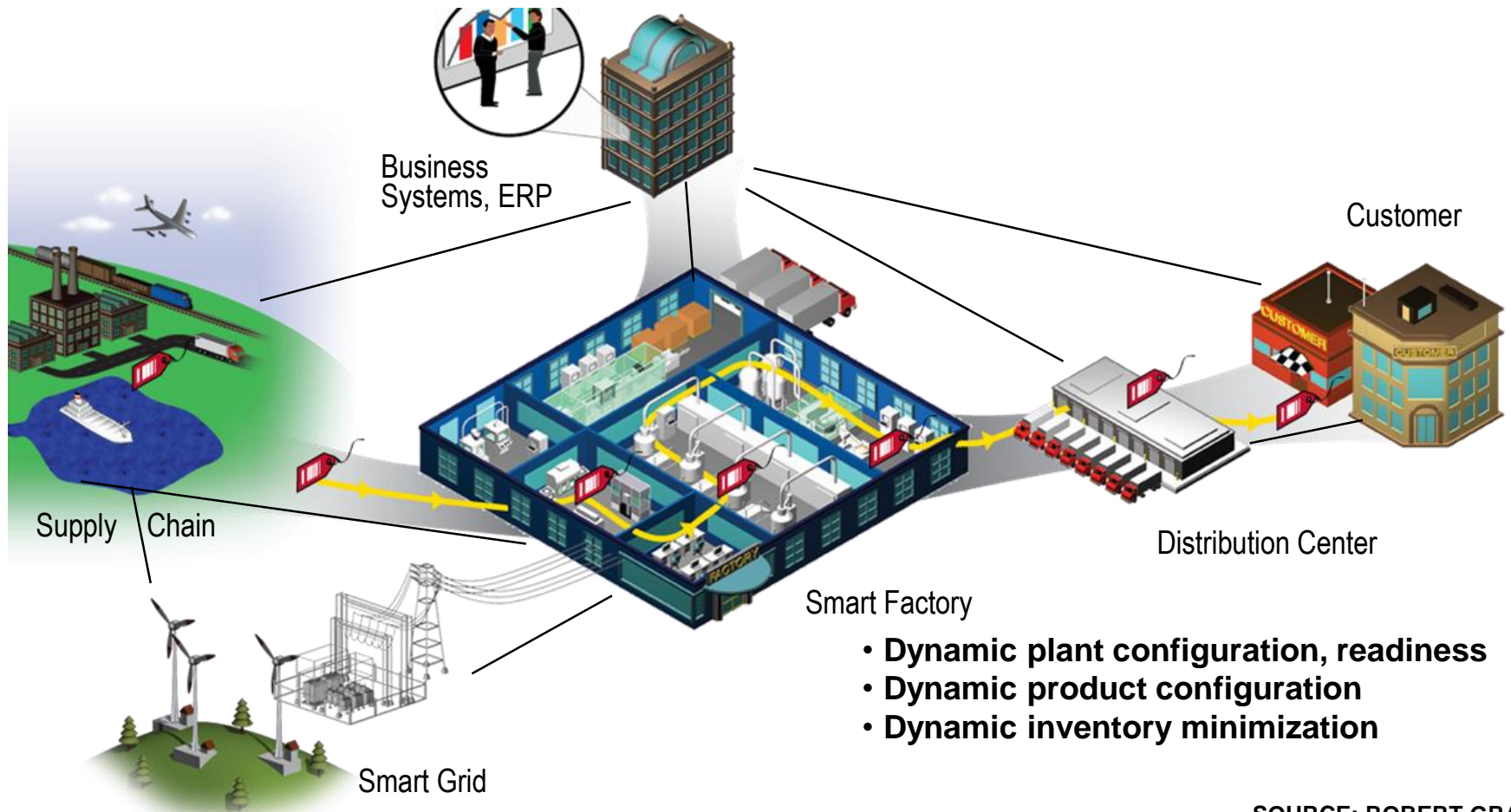
Using robots to move scanners for in-process inspection



1. What's AMT ?

□ Typical achievement of AMT

➤ Industry 4.0-Smart Manufacturing

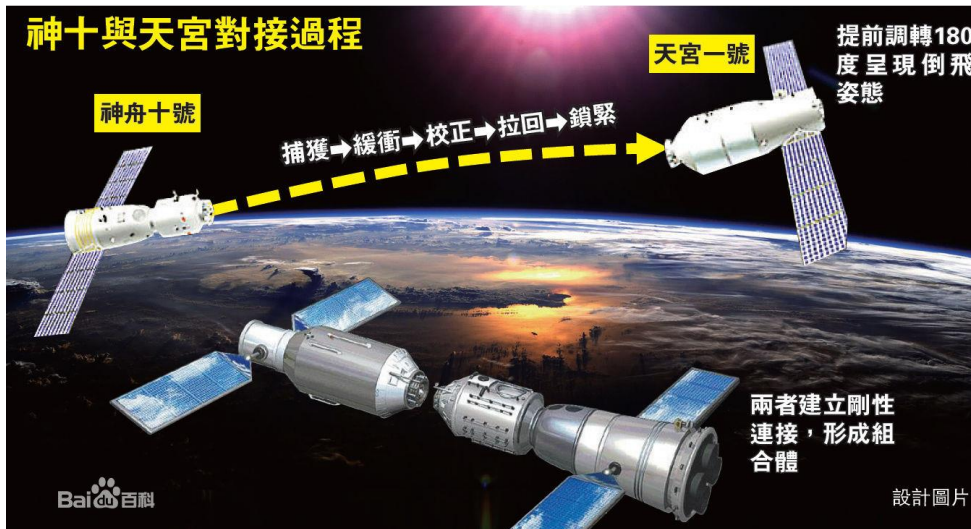




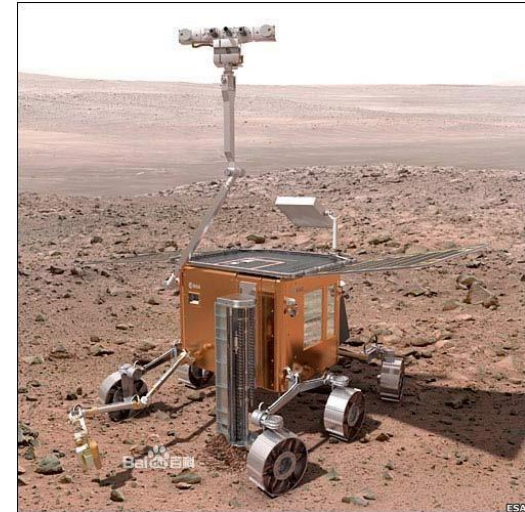
1. What's AMT ?

□ Typical achievement of AMT

□ In aerospace field



Shenzhou spacecraft automatically docking with Tiangong-1 trial space laboratory module



European Mars Express

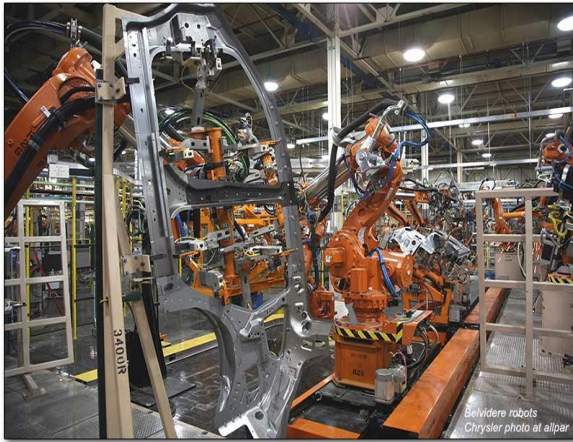


American Mars Curiosity



1. What's AMT ?

□ Typical achievement of AMT



Robotic manufacturing line



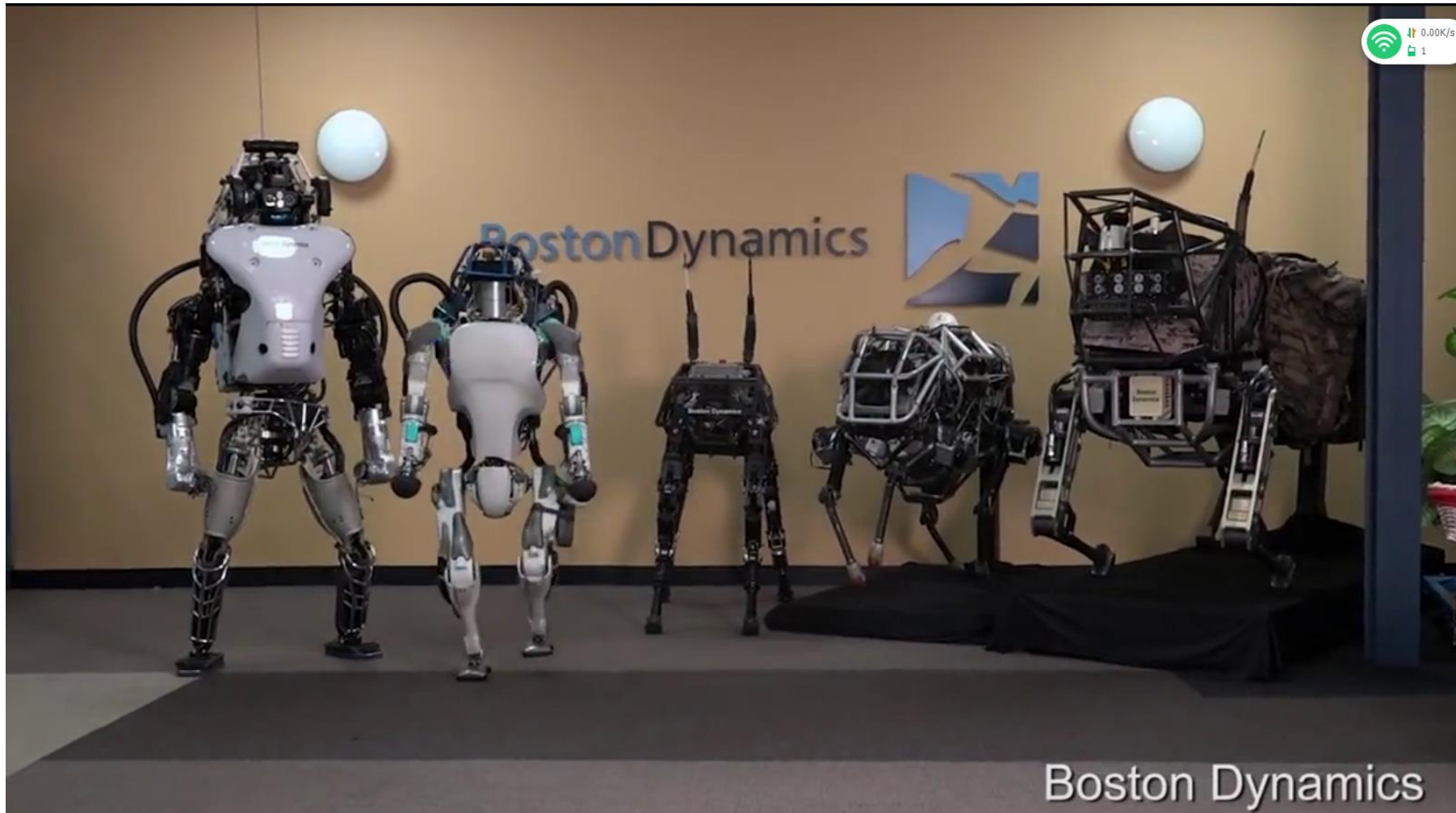
Boeing 777: paperless design





1. What's AMT ?

□ Typical achievement of AMT

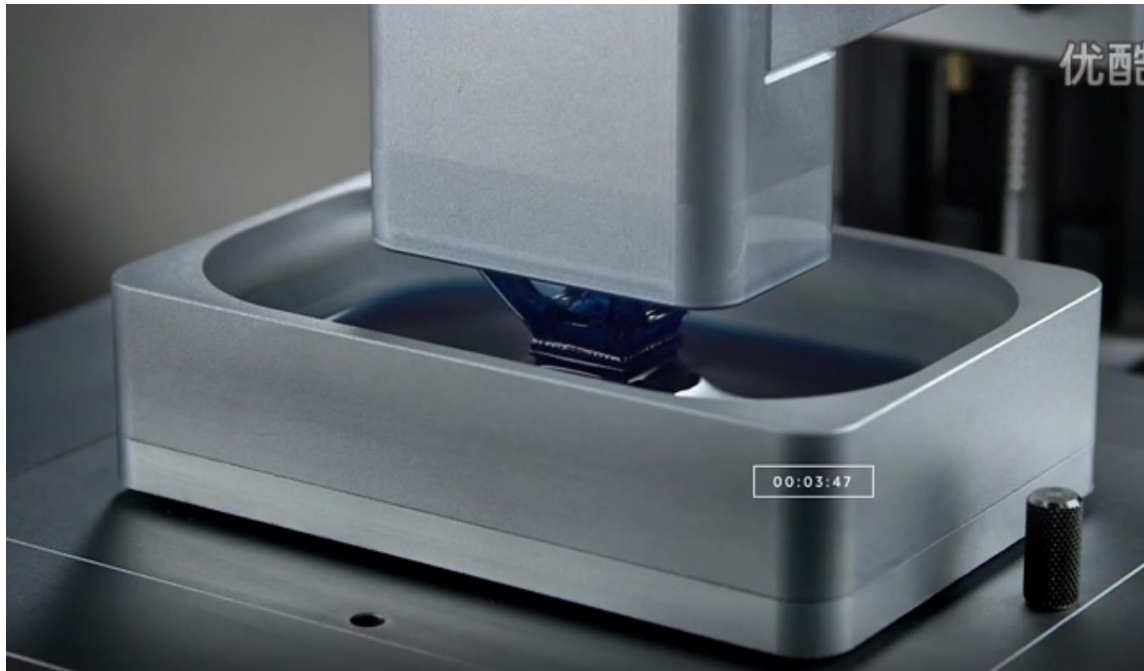


1. What's AMT ?



□ Typical achievement of AMT

- **3D printing**
 - Building a part in a layer-by-layer manner
 - Will produce the third industrial revolution



FEBRUARY 12TH - 18TH 2011

Worldwide cover

Why it's China's turn to worry about manufacturing



1. What's AMT ?



□ Typical achievement of AMT

➤ 3D printing



The 3D-printed nozzles are five times more durable than the previous model.



Glove made by LS, courtesy of FOC



Melonia Shoe made by laser sintering, courtesy of Naim Josefi and Souzan Youssouf

1. What's AMT ?

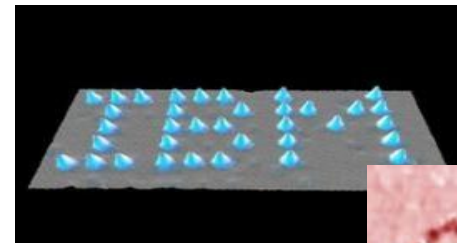
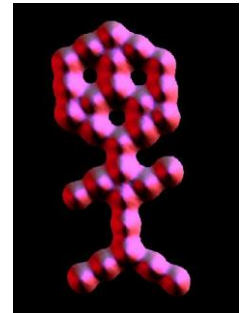
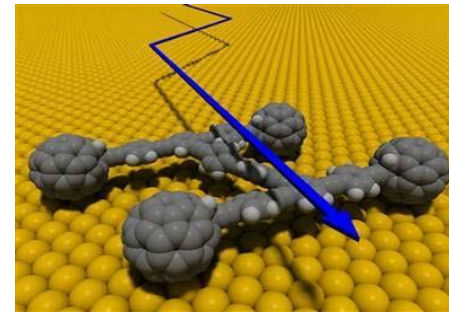
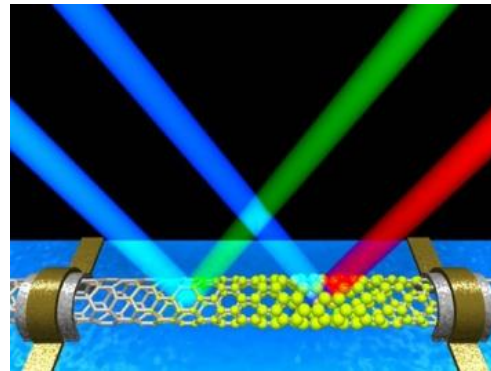
□ Future development of AMT in 21th century

➤ Micro- or nano-manufacturing

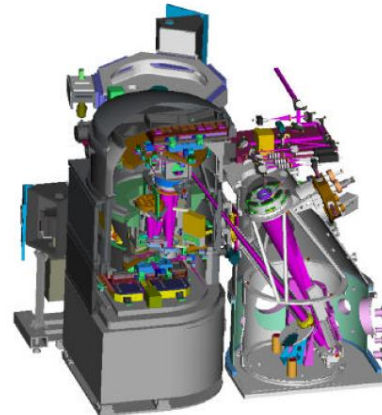
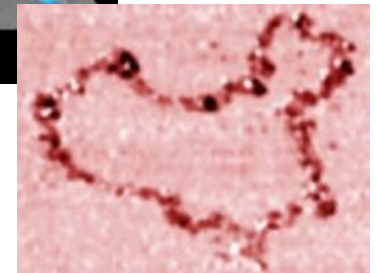
- In the 21th century, nano technologies will dramatically change the macroscale world



Surgical microrobotics



Self-assembly
of molecules
and atoms



Novel nano-manufacturing
techniques in MIT: 9nm

1. What's AMT ?

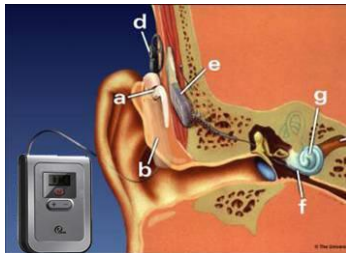
Future development of AMT in 21st century

➤ Biofabrication

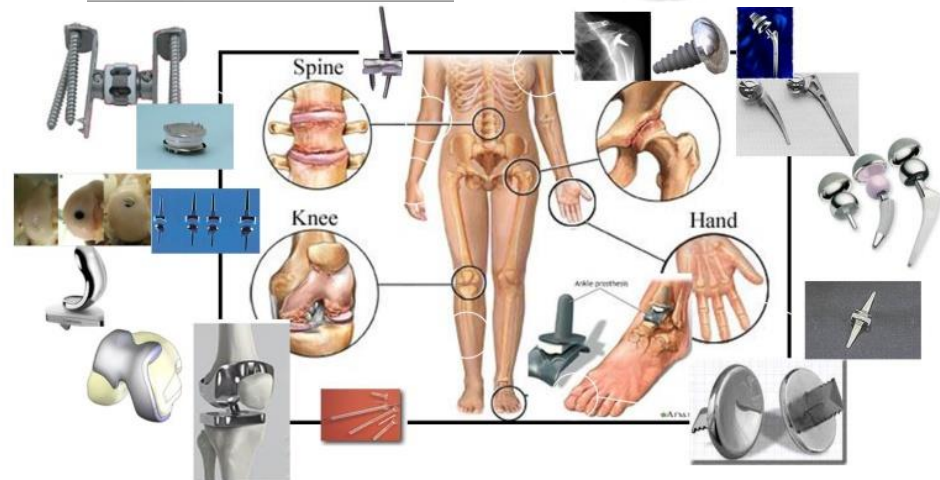
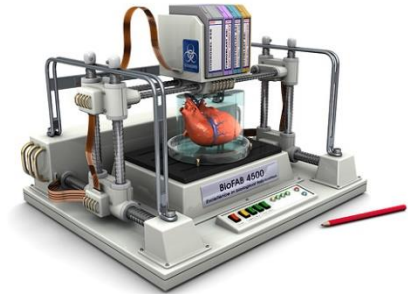
- AMT is extending its applications from traditional industry and agriculture fields to people's healthcare field



¥90,000



¥200,000



Treat patients as repair a car

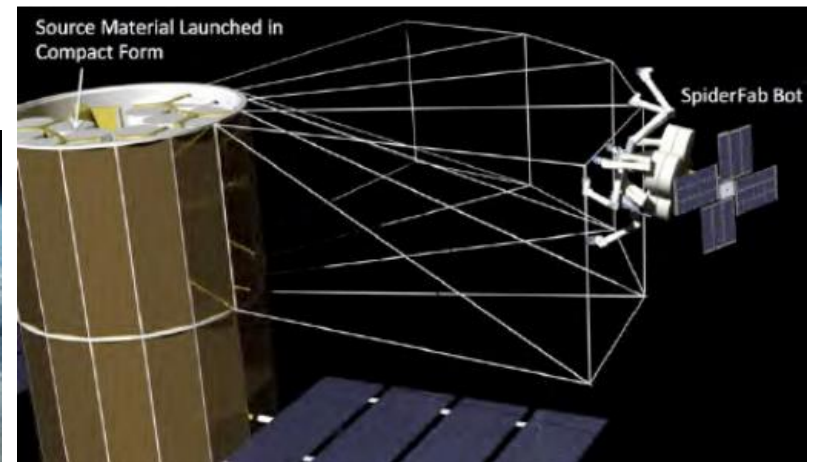
1. What's AMT ?

□ Future development of AMT in 21th century

➤ Potential applications of 3D printing



3D printed lunar outpost, ESA



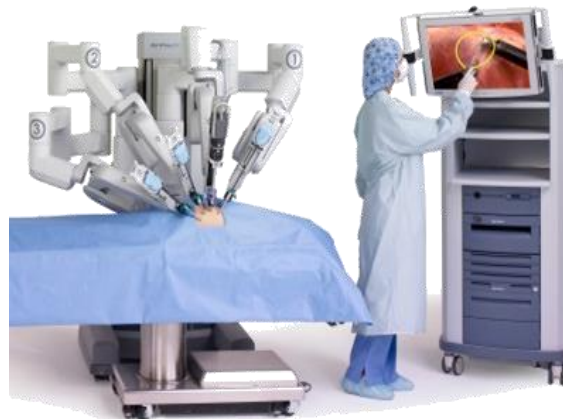
SpiderFab realized in-situ fabrication in Space, NASA



2. Course description

■ Objective

- Introduction to the latest development of advanced manufacturing technologies
- Ability training for searching and reading AMT-related documents in professional English



What's this?



2. Course description

□ Textbook

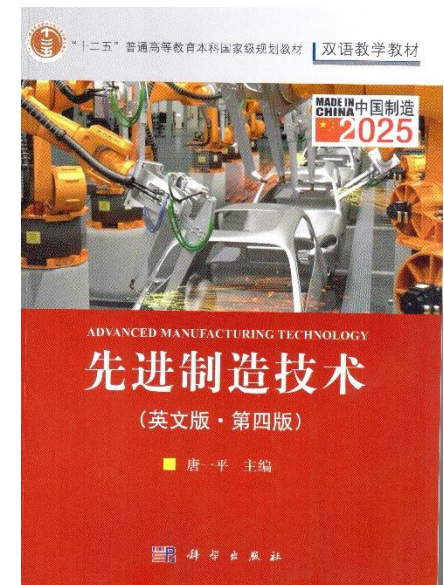
- Yiping Tang, Advanced Manufacturing Technology (Forth Edition), Science press, 2016

□ Reference

- P.K. Wright, 21th century manufacturing, Tsinghua University press, 2002

□ Internet resources

- Latest manufacturing concept and technology
- How to acquire these information
 - Google scholar
 - Web of Science.....





2. Course description

□ Contents

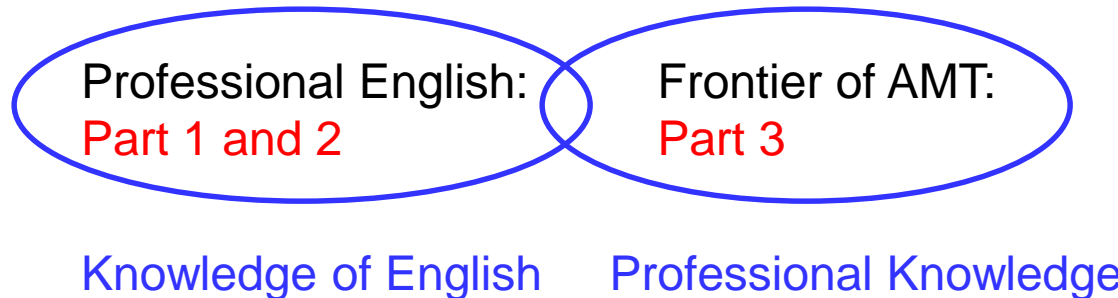
- **Part 0 Introduction**
- **Part 1 Computers in Manufacturing**
 - 1.1 Computer-aided Production and Control System
(计算机辅助生产与控制系统)
 - 1.2 Cloud manufacturing (云制造)
- **Part 2 Automated Manufacturing**
 - 2.1 CAD/CAM (计算机辅助设计与制造)
 - 2.2 Numerical Control (数控技术)
 - 2.4 Flexible Manufacturing (柔性制造)
 - 2.5 Computer Integrated Manufacturing (计算机集成制造)
 - 2.6 High speed cutting (高速切削)



2. Course description

□ Contents

- **Part 3 Manufacturing Technology Facing the 21st Century**
 - 3.1 Agile Manufacturing (敏捷制造)
 - 3.2 Additive Manufacturing (增材制造)
 - 3.4 Environmentally Conscious Design and Manufacturing (基于环境意识的设计与制造)
 - 3.5 Nanotechnology and Micromachine (纳米技术与微机械)
 - 3.6 Biofabrication (生物制造)





2. Course description

□ Teaching arrangement

➤ **Bilingual Teaching**

- Textbook, PPT, homework, examination in English
- Oral presentation in Chinese

➤ **Examination**

- Score: final examination (70%) + homework(30%)
- Homework (30%) on the topic of the thesis (毕业论文)
 - **Translation (papers), Writing (abstract), Oral presentation (PPT)**
- Open-book examination
- 助教：晏梦雪 博士生，13572581576

3. Why bilingual teaching?



□ Importance of professional English

- **Far beyond a language course**
- **Communication tools in AMT**
 - Globalized manufacturing
 - International conference
 - Latest manufacturing technologies
 - Interview for job hunting
- **What we lack for AMT applications**
 - English study for almost 15 years
 - Pass through CET 4 or CET 6



Belt and road forum for international cooperation



China's high-speed rail revolution



3. Why bilingual teaching?

□ Some typical examples *from Prof. Tang*

➤ **General English vs. professional English**

- 制造: Manufacture, fabricate, make, create, produce, engineer, build
- Manufacture: 大规模制造, 通用词汇; Fabricate: 小规模制造; make: 口语化用词, 多指模具制作; Create: 创造; Produce: 生产 (一切产品); Engineer: 人工加工改造 (engineered materials); Build: 堆积制造

➤ **Some jokes in professional English**

- 一次性用品: One time sex things (Throw-away products)
- 夫妻肺片: Husband and wife's lung pieces (Pork lungs in Chili Sauce)
- 贵阳: Expensive sun (Guiyang)
- 丝杠: Silk pole (Lead screw)
- 离心泵: Leave heart pump (Centrifugal pump)



3. Why bilingual teaching?

□ Some typical examples

➤ Abstract of undergraduate thesis in XJTU

静电纺丝是一种可以直接制造成形连续的聚合物纳米纤维的技术，基本原理是高压静电场下导电聚物流体会产生高速喷射射流。利用静电纺丝方法制得的纳米纤维材料具有比表面积大、孔径尺寸小且复杂等特点，使得它在高效过滤材料，生物医用材料、高精密仪器、防护材料以及纳米复合材料等领域有着广阔的应用前景。但是现在的研究主要集中于寻找更多的可纺丝材料和复合纤维成形的研究等，对成形的纳米纤维的定向性研究较少。

Google
translation!

Electrospinning is a direct manufacture of forming a continuous polymer nanofiber technology, the basic principle is that the conductive polymer under high voltage electrostatic field generated appreciate high-speed jet stream jet. Obtained using the method of electrospinning nanofibers material has a large surface area, pore size is small and complex characteristics, which make it efficient filter materials, biomedical materials, high precision instruments, protective materials, and nano-composite materials and other fields have a wide application prospects. But now research has focused on looking for more materials and composite fibers can be spun forming research and so on, forming nanofibers few studies orientation.



3. Why bilingual teaching?

□ Some typical examples

To meet these desires, methods have been developed from producing simple devices such as weapons for obtaining food to today's modern manufacturing systems, which use computers to produce such items as televisions and space vehicles.

Process control involves the control of variables in a manufacturing process, where one or any combination of materials and equipment produces or modifies a product to make it more useful and hence more valuable.

Although living cells (活细胞) are often employed in industrial biomanufacturing processes, the manufacturing of drugs (药品) and molecules (分子) using living cells is generally considered to be within the classical biomanufacturing domain which usually does not create complex living products than the original biological raw materials.

长句子、逻辑结构复杂!

Homework



- Translation (papers), Writing (abstract), Oral presentation (PPT)
- The first homework
 - Translation of one technical article on the topic of your thesis
 - 第11周提交第一次作业

PPT download from the website:

交大教师个人主页 → 田小永 → 教学工作 → **Additive manufacturing technology**



The END

Thanks for your attention