華中科技大學

Intelligent Manufacturing in China

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Outline

- A boost of IM in China
- Some Progresses of IM in Chinese Industry
- Problems & Questions
- Conclusion

A boost of IM in China

Li Keqiang, Premier of the State Council:

We will implement the ‘Manufacturing in China 2025’ strategy; seek innovation-driven development; apply smart technologies; strengthen foundation; pursue green development and make efforts to upgrade China from a manufacturer of quantity to one of quality."

A boost of IM in China

China's manufacturing could step into the world's second phalanx before 2025, **becoming a member of manufacturers of quality.**

（First stage）

2025

China would enter the top rank of the world's second phalanx of manufacturing before 2035, **being worthy name of manufacturers of quality.**

（Second stage）

2035

China may take an occupation in the world's first phalanx of manufacturing by 2045, **playing the role in leading the development of the worldwide manufacturing.**

（Third stage）

2045

A boost of IM in China

four big shifts and one major guideline

Innovation	Quality	Green	Structure
Shift 1: From production elements-driven to innovation-driven	**Shift 2:** From low cost competition to quality competition	**Shift3 :** From resource consumption and pollution to green manufacturing	**Shift4 :** From productive manufacturing to service-oriented manufacturing

Solution guideline: fully integrating information technology with manufacturing.

Intelligent manufacturing

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Intelligent Machine tools

I5 by Shengyang Machine Tools

- **“I5” intelligent machine tools participated in the International Fair in Hanover, Germany in March 2015.**
- **German counterparts: “I5” intelligent machine tool control system completely coincides with the concept of “Industry 4.0”.**
- **Some functions: Intelligent compensation, monitoring and diagnosis, control, Remote control by iPhone or computer, as well as management**

Intelligent Machine tools

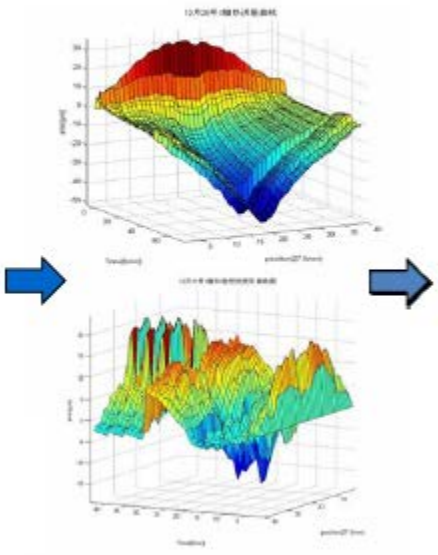
- **I5, by Shenyang Machine Tools**

Intelligent Numerical Control

Huazhong 8（iNC）Intelligent Comps.

Intelligent compensation

API-6D laser interferometer



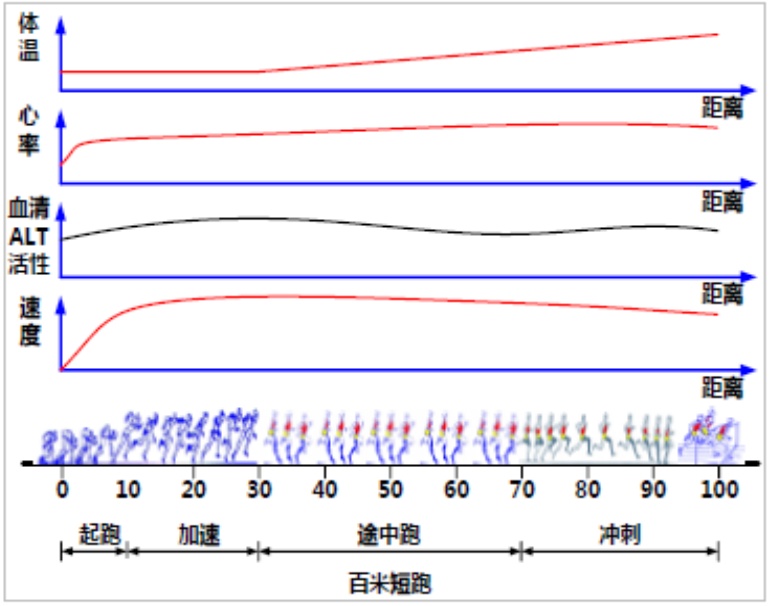
Volume error measuring ▸ **Data modeling** ▸ **multiple axis compensation**

Intelligent Numerical Control

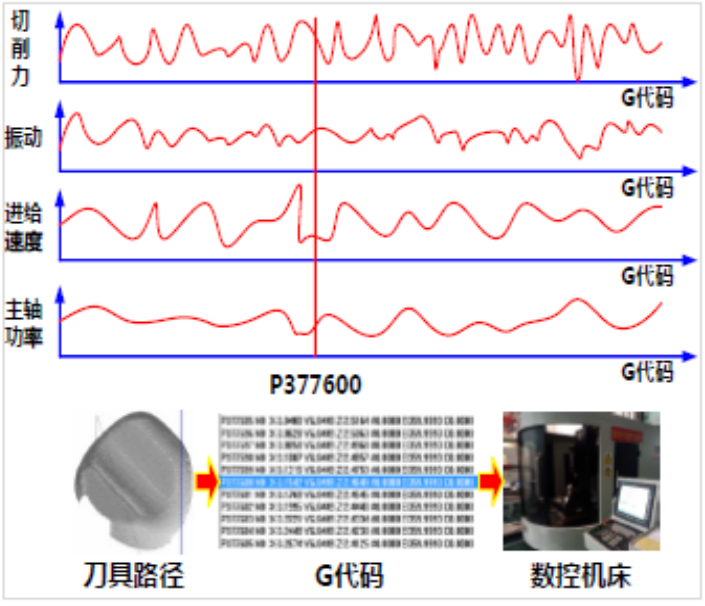
Huazhong 8（iNC）（electrocardiogram）

数控加工大数据与加工质量效率密切相关

- 数控加工大数据与加工指令密切相关，与零件加工质量、精度和加工效率之间存在内蕴的映射关系。
- 大数据采集频率：1S —— 1mS —— 0.05mS



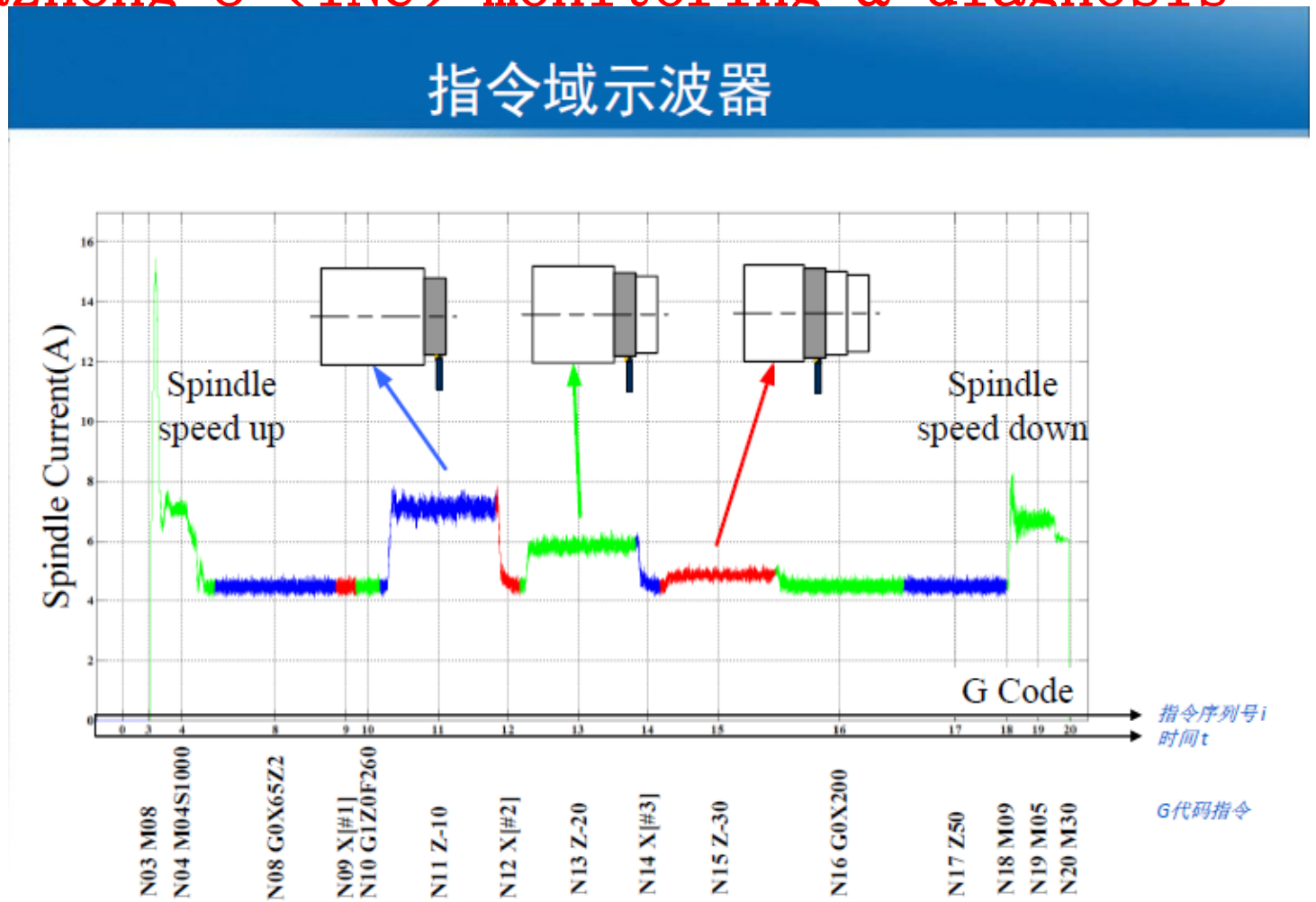
百米短跑“心电图”



数控加工“心电图”

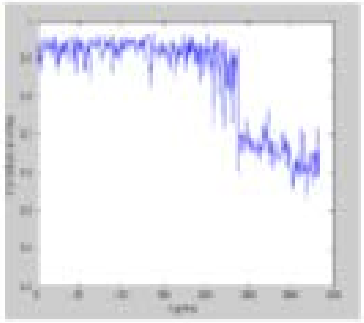
Intelligent Numerical Control

Huazhong 8 (iNC) monitoring & diagnosis

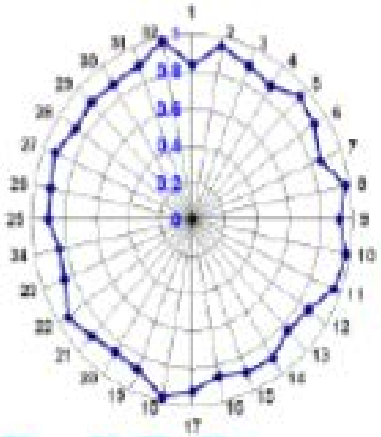


Huazhong 8(iNC) ,feed axes monitoring

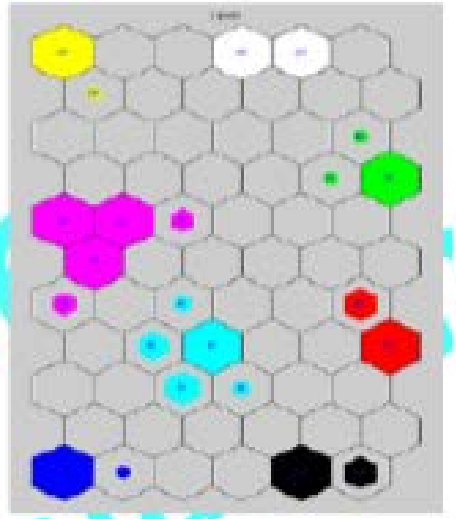
Results of Smart Prognostics Tools for Asset Health Information



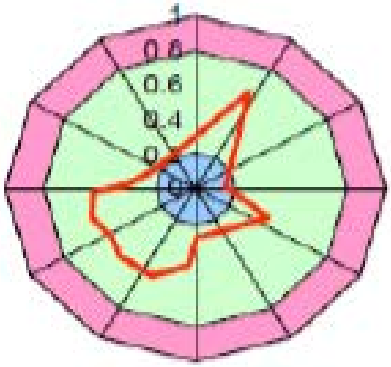
Confidence Value for performance degradation assessment (0-1)



Health Radar Chart for multiple components degradation monitoring



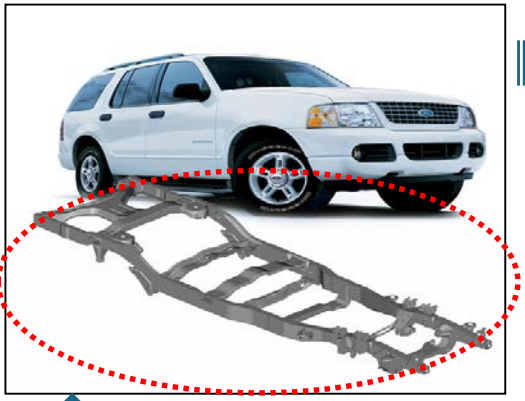
Health Map for potential issues and pattern classification

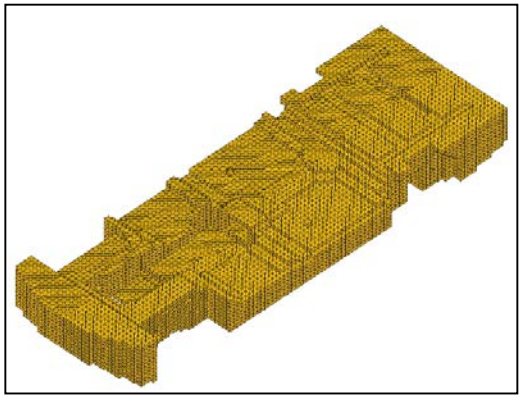


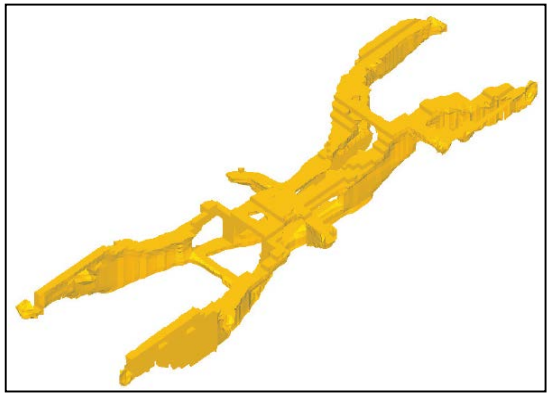
Risk Radar Chart to Prioritize Maintenance Decision

Reducing resource consumption, energy saving

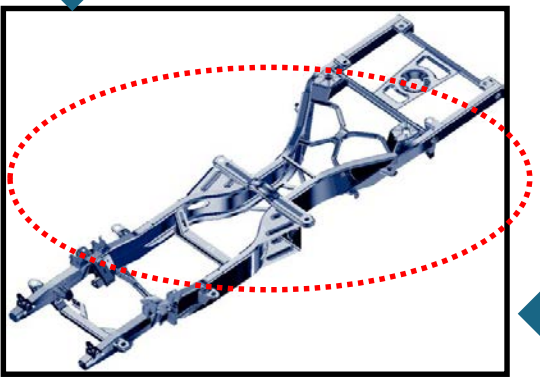
Original design | Design space | Topology optimization

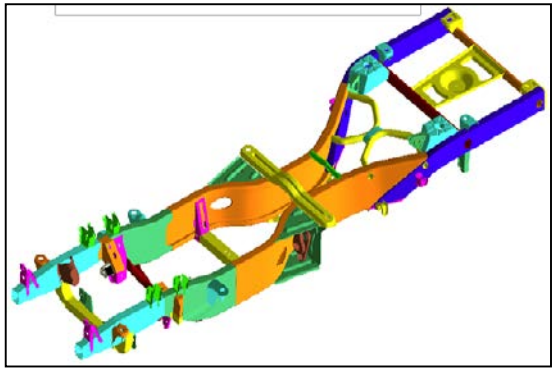


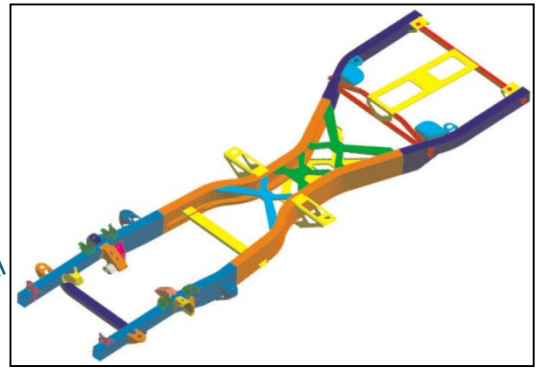




Intelligent design process with topology optimization as its drive



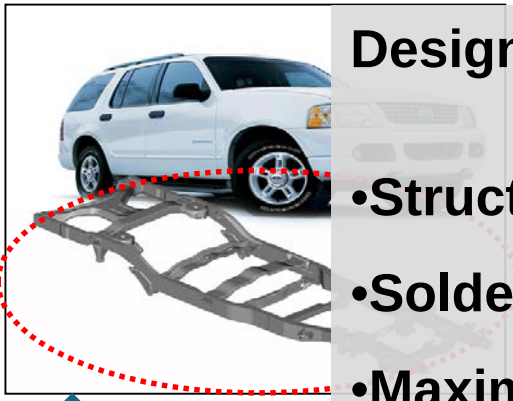


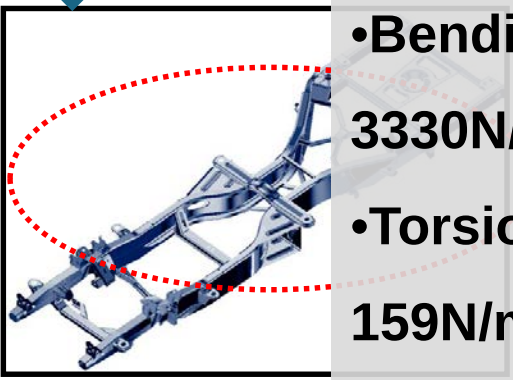


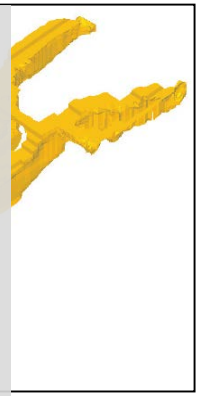
Final design | Detailed design | CAD & CAE

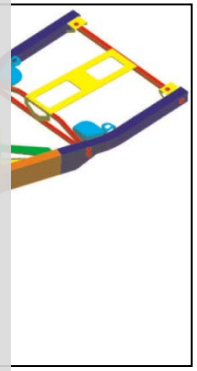
Reducing resource consumption, energy saving

Original design | Design space | Topology optimization









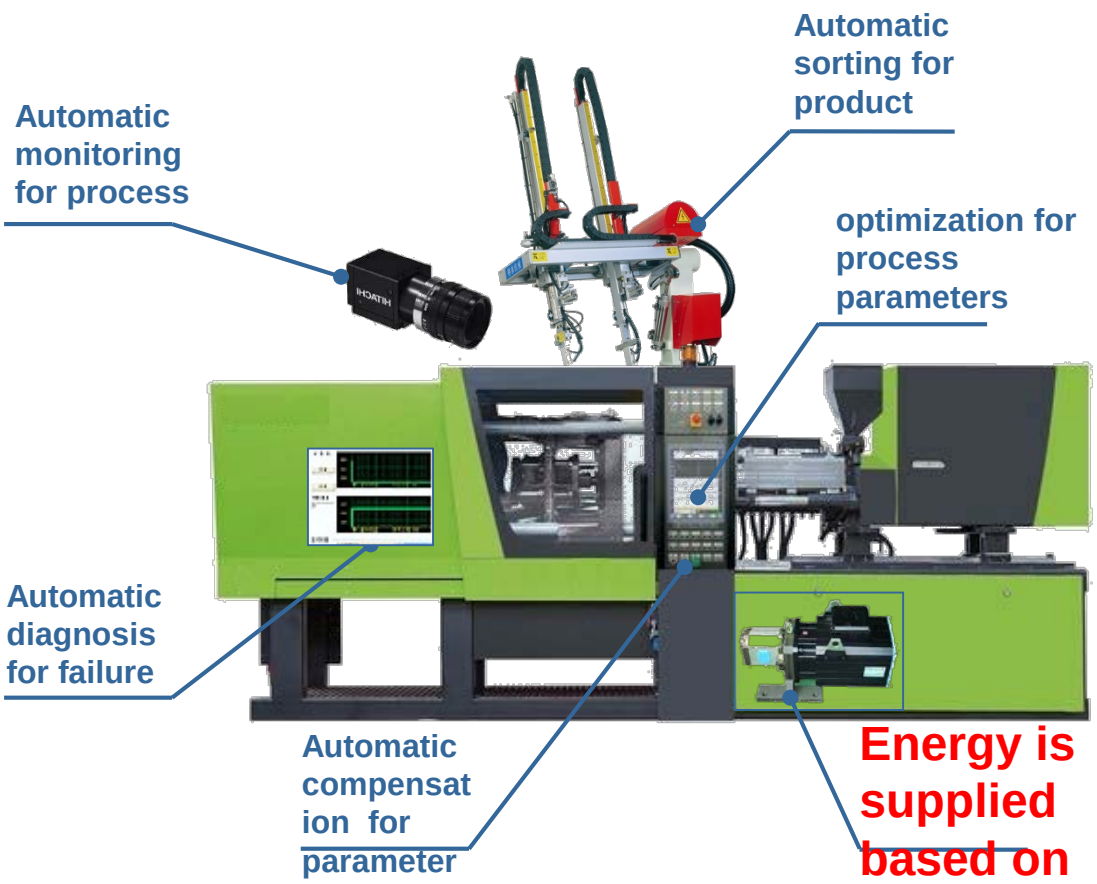
Design results

- Structural weight is reduced by 23%
- Soldered dot weight is reduced by 50%
- Maximum stress is reduced from 475MPa to 320MPa
- Torsional mode is intensified by 34% (25Hz)
- Vertical mode is intensified by 3%
- Bending stiffness is increased from 3226N/m to 3330N/m
- Torsional stiffness is increased from 121N/m to 159N/m

Final design | Detailed design | CAD & CAE

Reducing resource consumption, energy saving

Ex：Intelligent NC Injection Molding Machine



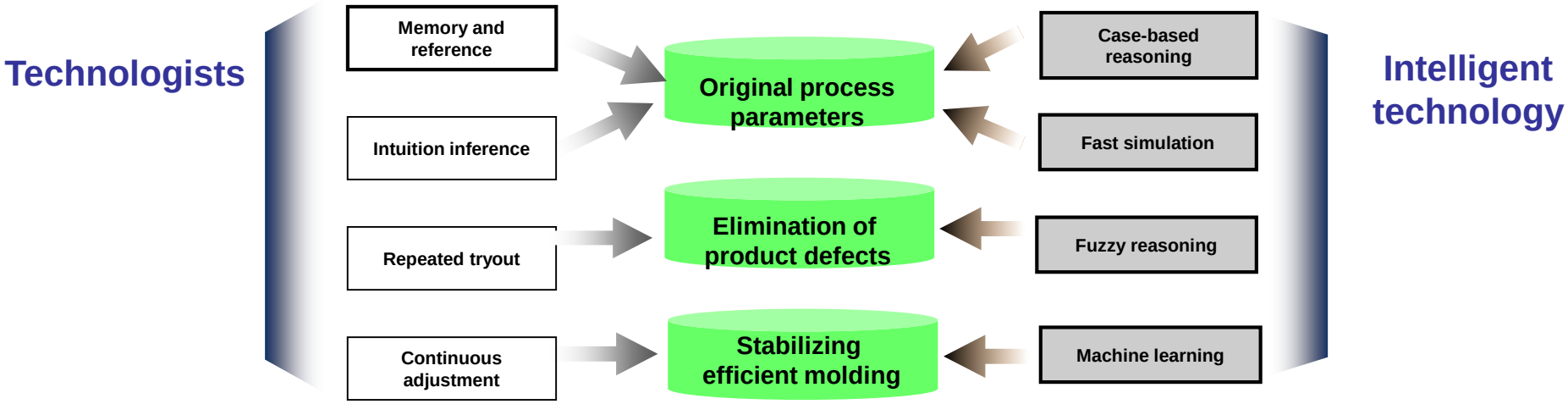
High automation → High efficiency

Great anti-disturbance → High precision

High energy efficiency → Energy saving

Quality, efficiency, energy saving

- **Intelligent technology is an effective way for realizing the deep integration of molding process and injection molding machine**



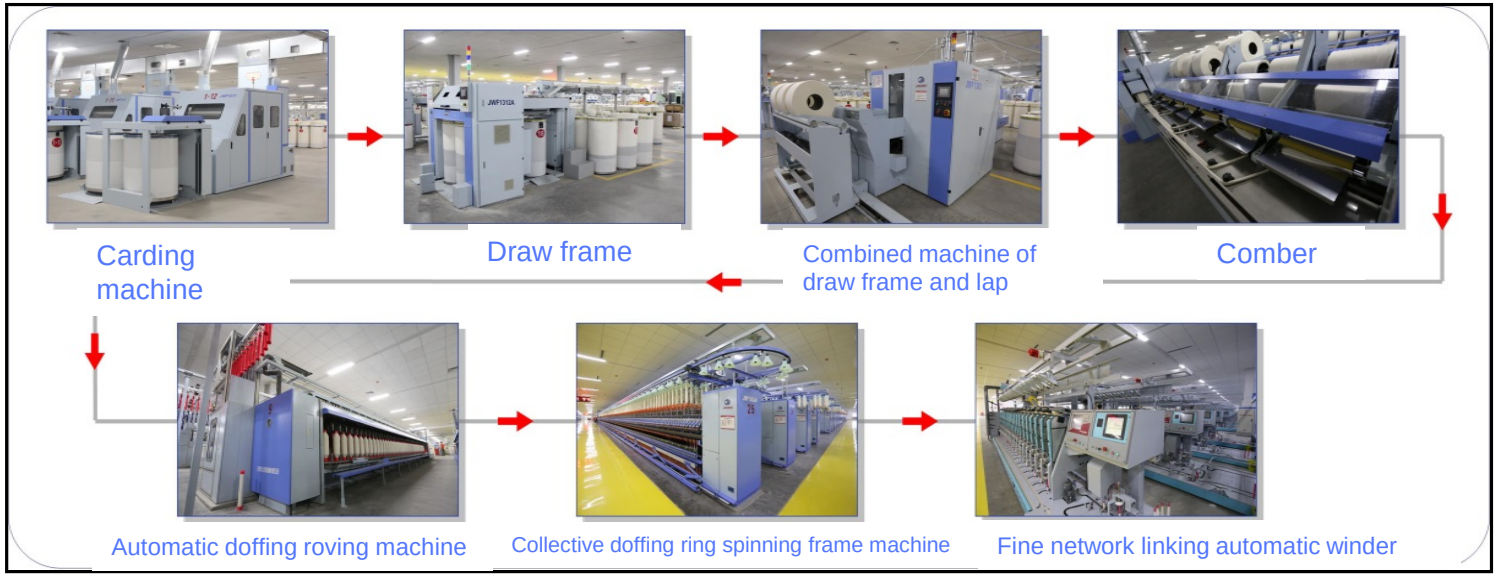
- **Research difficulties**

1. **Strong nonlinearity:** process parameters and product quality
2. **Strong coupling:** process parameters and product defects
3. **Time-variant:** process parameters and product quality

Reducing resource consumption, energy saving

Example: NC during the whole process of spinning

- NC for all spining machines and various auxiliary equipment
- for every 10000 spinning frames: laboris reduced from 80 workers to 28, and **the comprehensive energy consumption is reduced by more than 10%** for every ton of yarns



R&D:collective intelligence (Haier)


沈阳冰箱互联工厂


郑州空调互联工厂


佛山滚筒互联工厂


胶州空调互联工厂


青岛水圈互联工厂


FPA电机互联工厂


青岛模具互联工厂

Intelligent Development

Take advantage of collective intelligence

Example: "Internet development" model of Xiaomi

- **Lead the new trend of "maker" design model**
- **One of the fastest growing companies, with sales of RMB 80 billion in 2014 alone**
- **R&D personnel improve the products based on netizens' demands collected from channels like microblogs, WeChat, forums, etc.**
- **Four fifth updates of the mobile phone system are realized through suggestions of netizens, and one third are directly created by its users**

Digital workshop of Sany Heavy Industry

Overview:

Intelligent processing equipment

Intelligent robot

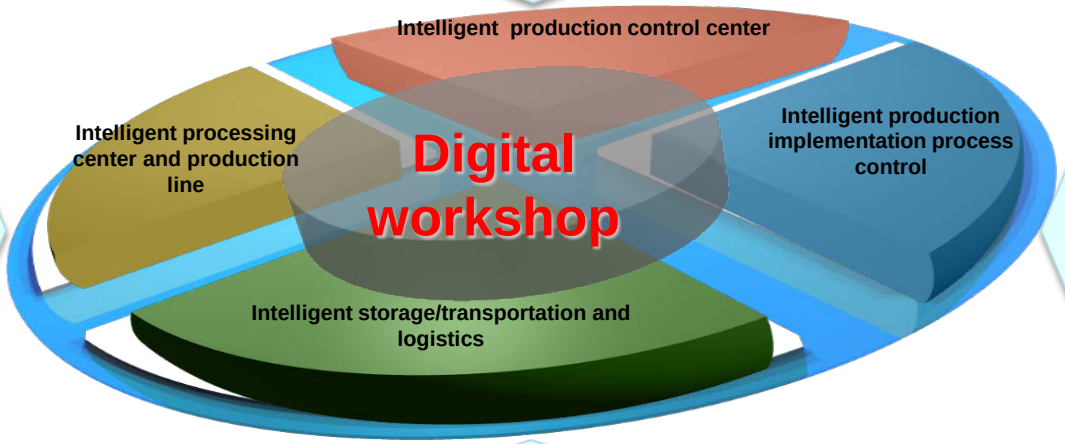
DNC

Intelligent tool management

Central control room

On-site Andon

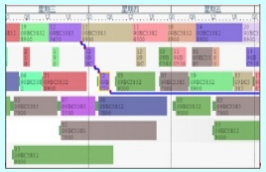
On-site monitoring device



Automated stereoscopic warehouse

AGV intelligent carts

Public resource positioning system



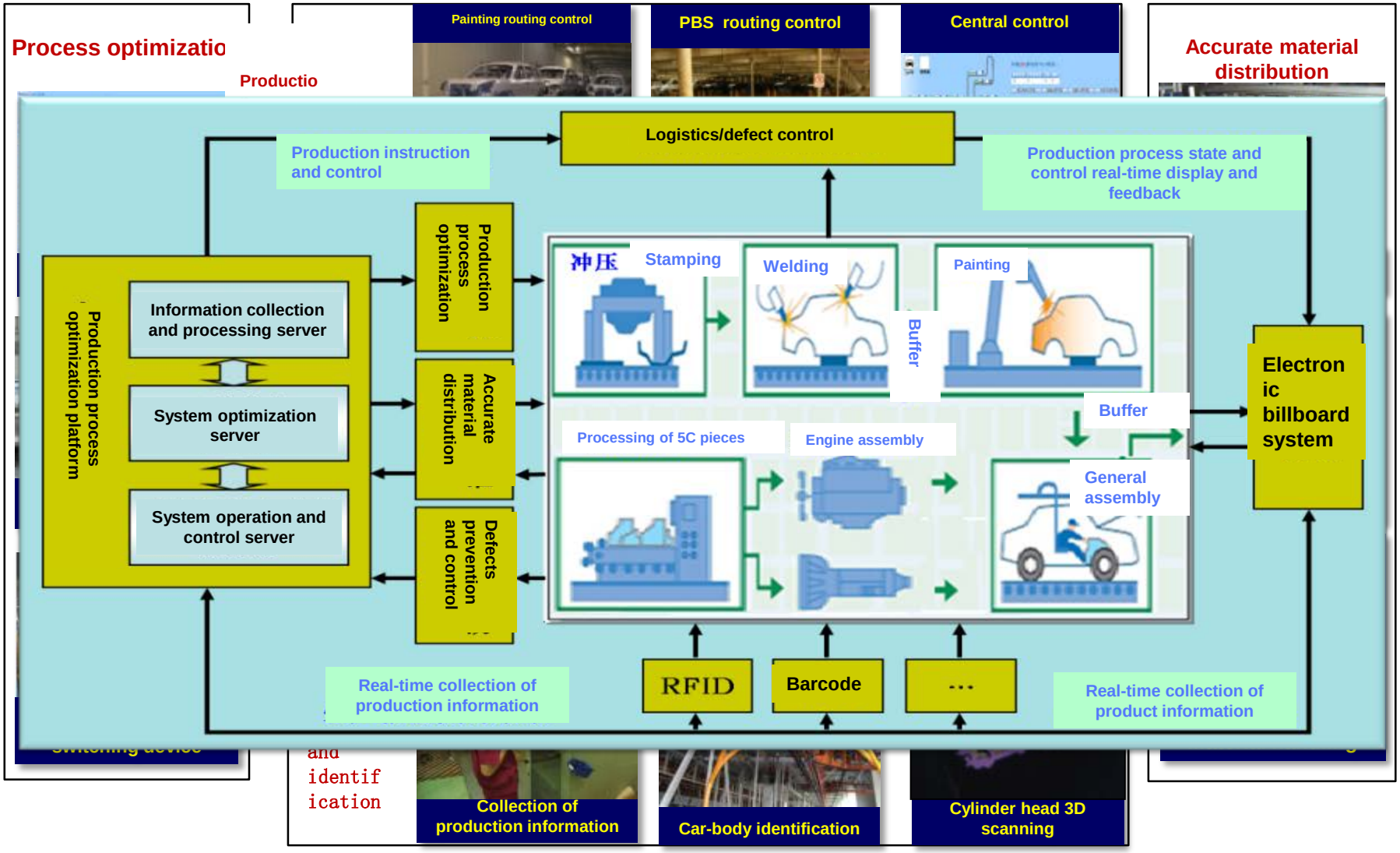
Advanced planning and scheduling

Implementation process control

Digital logistics control

Digital quality inspection

Example: auto industry production implementation system A²MES



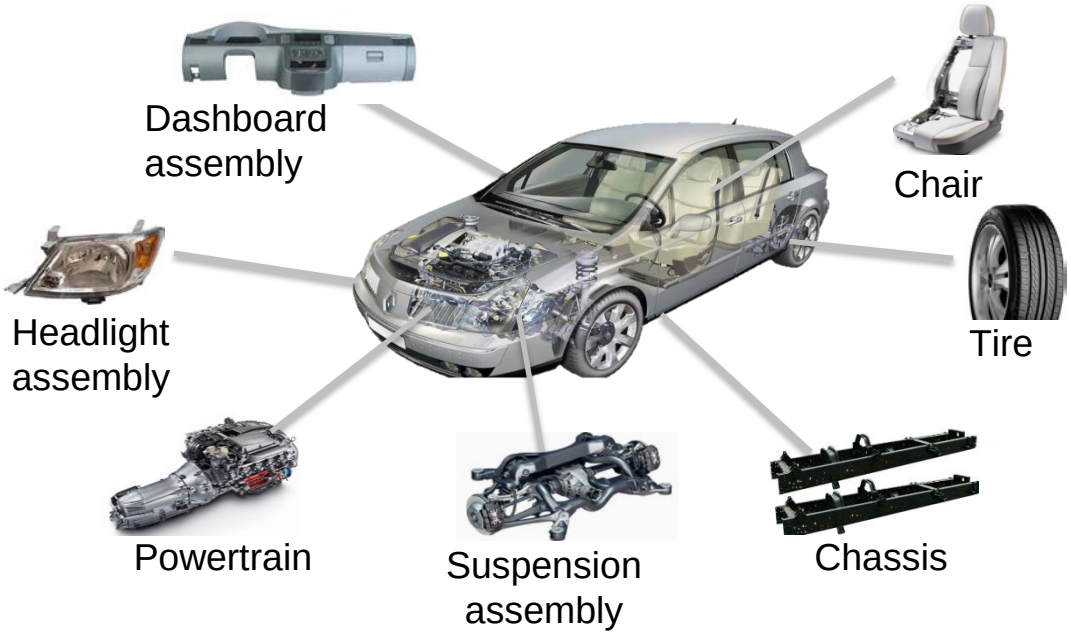
Example: control on the supply chain

plant and suppliers: physical distance and information distance

– **Let's take JAC as an example:**

- **Parts supply nest** **260 enterprises from seven regions, including Australia, Taiwan and Hong Kong, have signed contracts to settle here**
- **At present, JAC has already implemented material pulling platform**

quality control of the whole industry chain



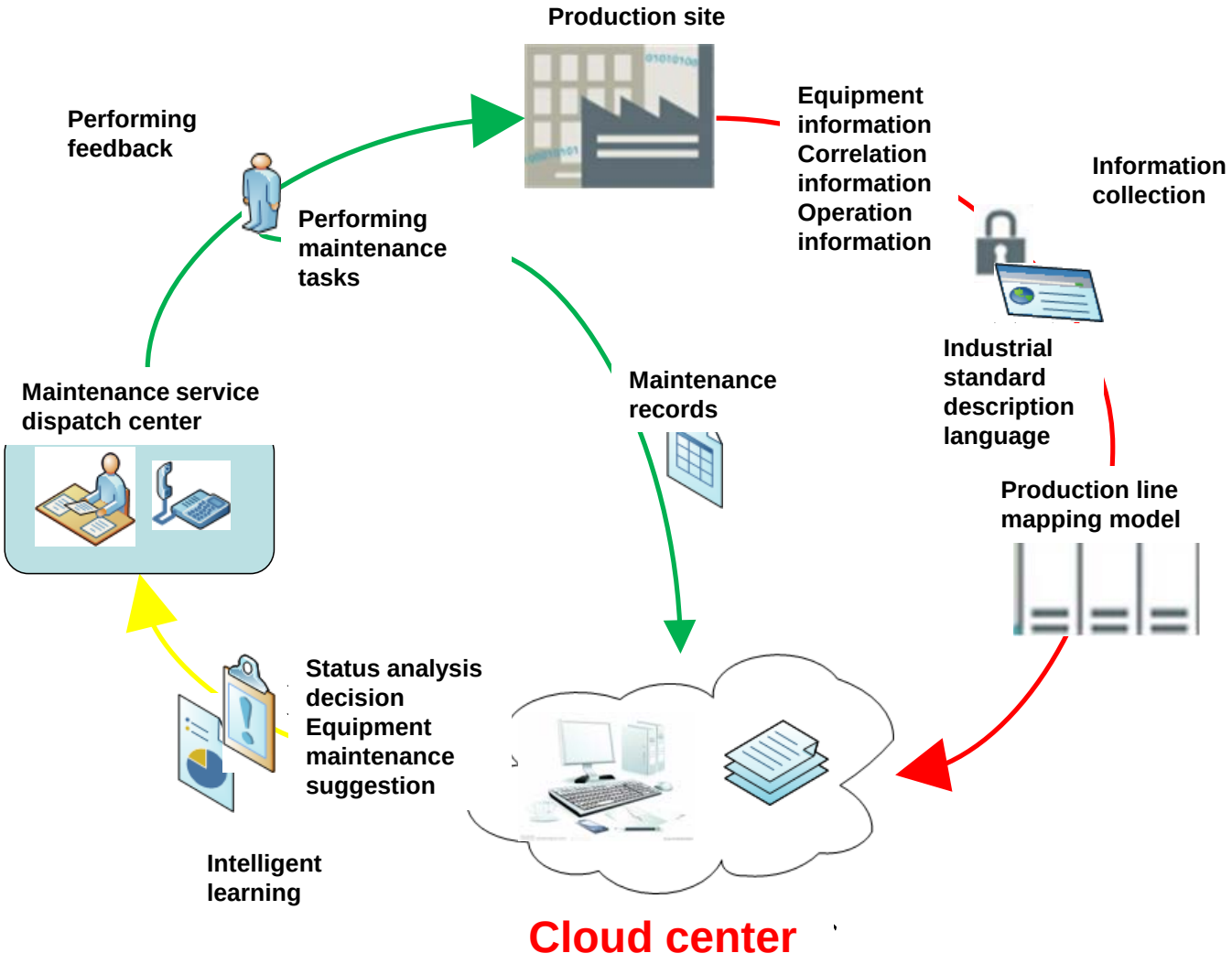
“Customer-centered”

Customer-centered

- **Transformation: from large-scale assembly line production mode to customized mass production**
- **Transformation: from production manufacturing to production-service manufacturing.**
- **Industrial pattern: from product-centered to customer-centered.**

“Customer-centered” （Miracle service）

Intelligent production line（Miracle, production service）



“Customer-centered” (Miracle service)

Sensing








- Chain,belt,
- Spindle,bearing block,
- Fastening
- Friction wheels
- ……

“Customer-centered” （Miracle service）

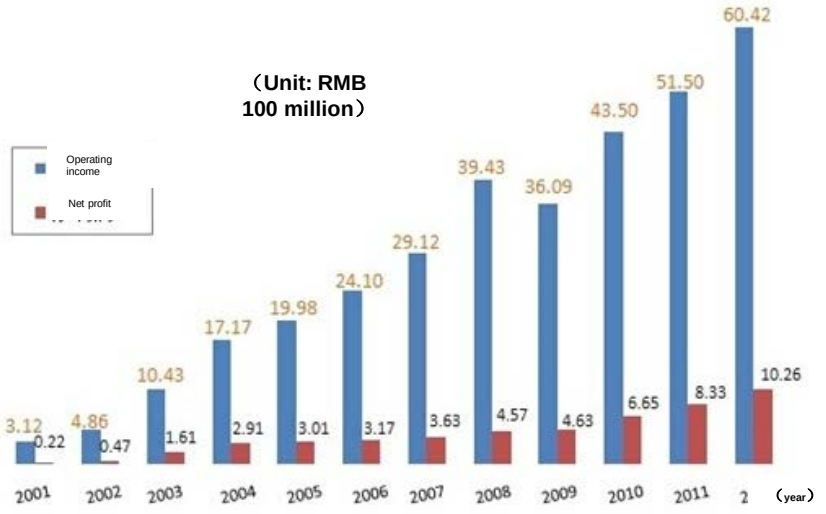
Intelligent production line（Miracle, production service）

- **condition monitoring and fault diagnosis for all production equipments.**
- **The data management expert system based on cloud platform realizes intelligent diagnosis management.**

“Customer-centered”（Shaangu service）

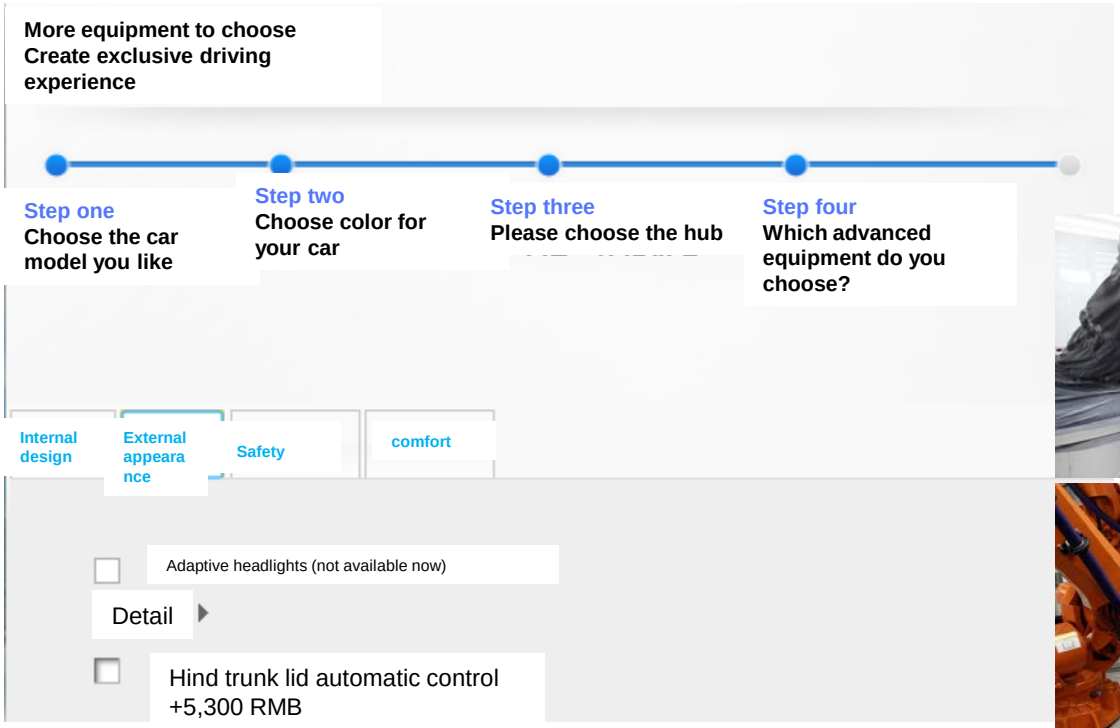
- **Since 2005, transformation from selling single products to the selling of solutions and system services, from product management to brand management. In 2013, power service and operation business orders account for 49.28% of the total volume; average operation profit per person reaches RMB 288,000, and are 1.43 and 1.23 times that of MAN Turbine Group and Siemens Oil & Gas Group respectively.**

2001-2012 operation performance of Shaangu Power



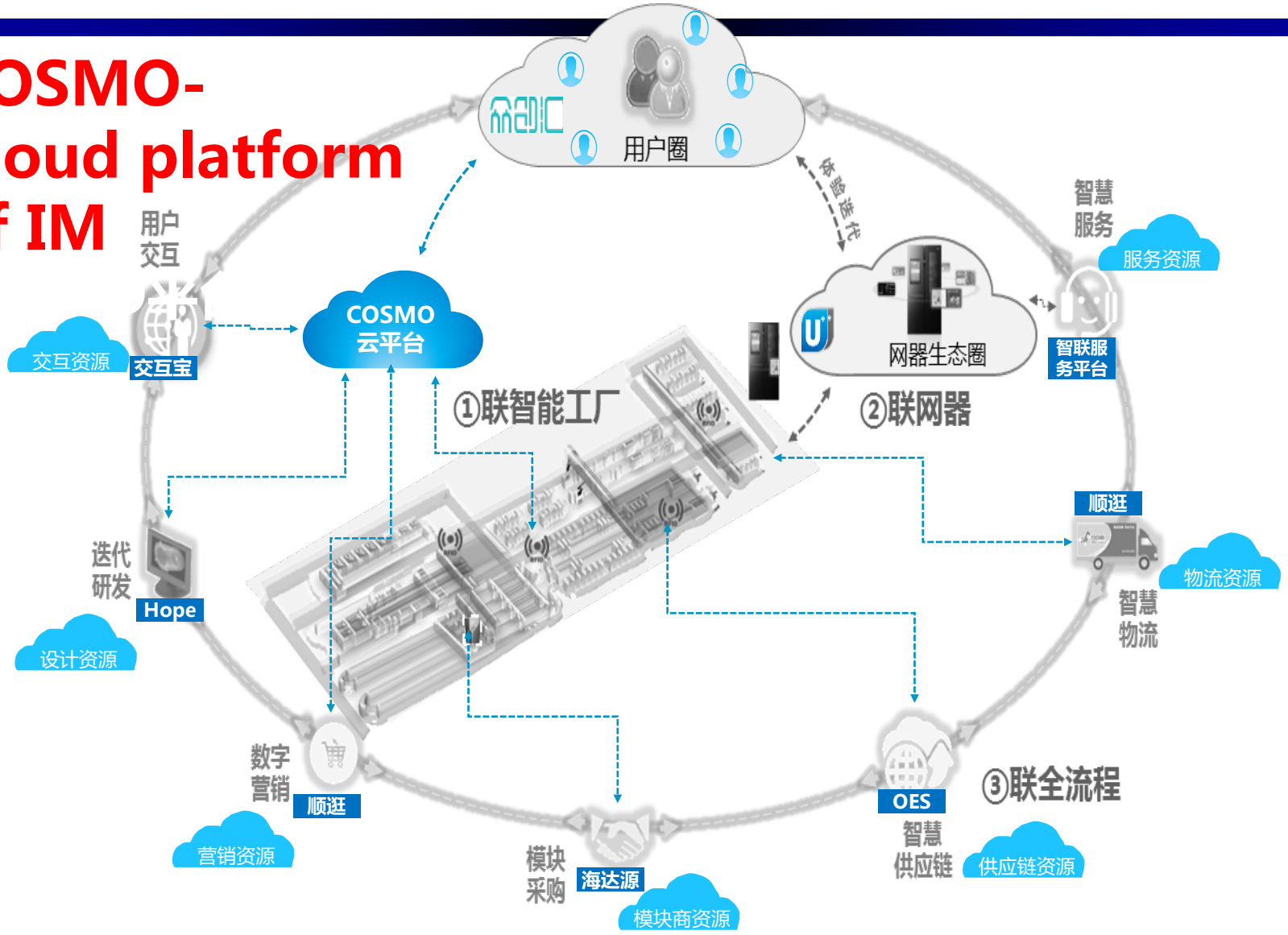
“Customer-centered” (BMW customization)

Clients can choose their demands through the menu, from external appearance to internal design, from driving dynamics to comfort features. BMW also provides full life cycle refined services to the clients.



“Customer-centered”(Haier)

COSMO-Cloud platform of IM



“Customer-centered” ——Rcollar

Personalized clothing data system established by Rcollar Group , coverage rate of personalized design demands has reached 99.9%.

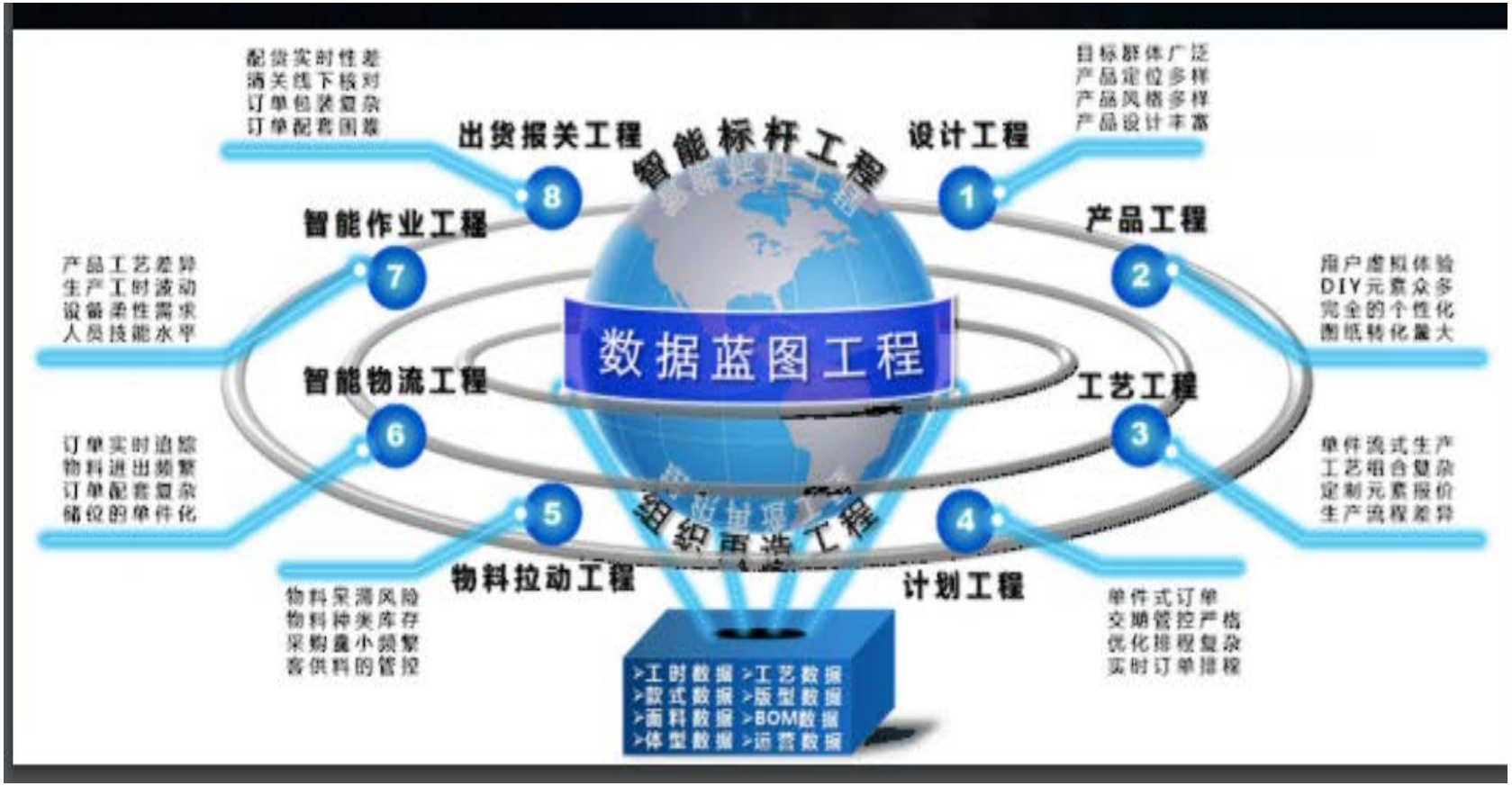
The client should only collect 22 figures of 18 parts of the body based on the body measuring method of Rcollar. Clients can independently determine the craft and technique, price and service mode.

“Customer-centered” ——Rcollar

Personalized clothing data ,Internet+

“Customer-centered” ——Rcollar

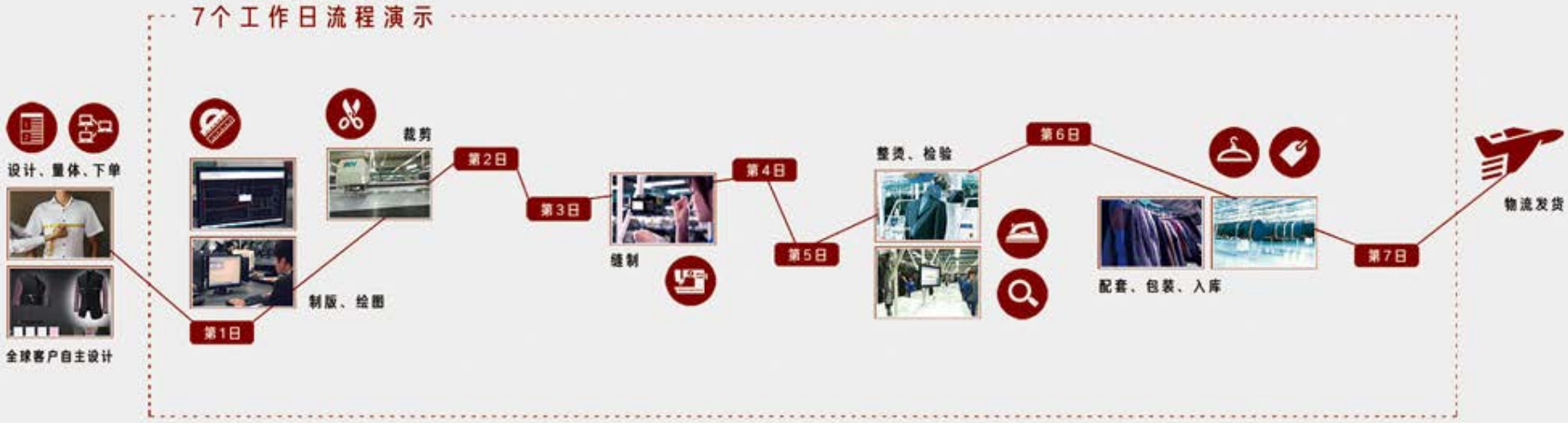
Data driven by Rcollar Group



“Customer-centered” (Rcollar)

Garment data are automatically disassembled to various procedure and move to every station with electronic labels; Delivered in seven days; The cost of personalization is only 10% higher than batch manufacturing, but its returns are at least two times higher; Growth rates of both the average annual sales revenue and growth rate of profits are greater than 150%; Dozens of orders can be accomplished in one minute; in the New York market alone have reached 400 sets per day

Full personalization process
Process demonstration of seven working days



Case : Customized production of sweater

Dalang Town, Dongguan City

- **integrating with the sweater CAD/CAM**
- **NC sweater machine**
- **customized requirements through the electronic commerce**
- **zero inventory**
- **quick adaption to change of the market demand improves the competitiveness**

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Problems & Questions

Problems in Chinese Industry:

- Most manufacturing companies in China are on the stage of “Industry 2.0”
- To Chinese companies:
  - “Industry 2.0”-make up missed lessons
  - “Industry 3.0”-popularization
  - “Industry 4.0”-set example

Let’s start with digitalization and NC!

Problems & Questions

Problems in Chinese Industry:

- Enabling technologies of IM—backward
  - NC
  - Robot
  - Sensor
  - PLM, MES,…
- Solution capability for IM in China is limited
- Not much attention to fundamental data

Problems & Questions

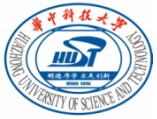
Questions:

- To Chinese government
  - What kind of role to pay?
  - How to support our own enabling technologies?
  - Machines might be substitute for human -- what will be the results?

Problems & Questions

Questions:

- To Chinese industry
  - How to train workers of high quality？
  - Lack of IM—— real bottle-neck?
  - How to control quality in the supply chain?
  - How will IM affect enterprise management?



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Thank you!