New Paradigm of Digital Transformation for Petrochemical Enterprises

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The first element of change is awareness.

T. Harv Eker
Challenges & Requirements

Petrochemical Enterprises

New Paradigm of Digital Transformation
Recent Development of Petrochemical Industry

2018H1 → 2019H1

Main business income: Growth of 2.2%
Industry profit: Drop of 18.3%
Net profit rate: Drop of 1.3%

Change of raw material industry main business income margin from 2015 to 2019H1 (%)

- 2015: 3.17
- 2016: 4.16
- 2017: 4.87
- 2018: 5.01
- 2019H1: 3.82

Starting to go down

Source: China Petroleum and Chemical Industry Federation (CPCIF)
Booming of Refining integrated installations

Refinery

Chemical plant (ethylene + aromatics)
- Complicated process
- Hard to operate
- Hard to control
- Huge energy consumption
- Environment & Safety

Self-generation power plant
How to Go From Industry 3.0 to Industry 4.0?

Challenges of Digital Transformation for Petrochemical Enterprises

- Production insecurity
- Strict environmental protection standard
- High labor cost
- High energy consumption
Benchmark of Enterprises’ Transformation and Upgrading

2007-2017 Q1 Facilities have better performance (of 118 global ethylene plants)

Integrated Facilities Have Better Performance

- 8% less energy consumption
- 9% less cash operating expense
- 10% fewer personnel
- 25% higher ROI

Benchmark of Ethylene Plant
Intelligent Automation Application

Ethylene + Propylene Utilization
Product Value
Energy
Energy Efficiency Index
Maintenance Cost Index
Reliability Indicator
Personnel
Personnel Cost

Less energy consumption
Less cash operating expense
Fewer personnel
Higher ROI
Future for China’s Petrochemical Enterprises

Safety  Quality  Cost  Efficiency  Green

PT + ET + OT + AT + IT

(Process)  (Equipment)  (Operation)  (Automation)  (Information)

Five goals for intelligent plant
Creating value for customers
Challenges & Requirements

New Paradigm of Digital Transformation

Petrochemical Enterprises
1. **WHY** digital transformation?

Before digital transformation, we have 4 questions.

2. Have the **Ability** and **Foundation** for digital transformation?

3. Future **Core Business Scenarios** for digital transformation?

4. Internal **Successful Experience**? External **Mature Mode**?
## Focus of Petrochemical Enterprise Digital Transformation

### Safety Management
- Active monitoring on site
- Linkage emergency command
- Full life-cycle environmental management

### Production Control
- Production control coordination and integration
- Production control optimization and automation level improvement
- Continuous improvement of production technology

### Equipment Management
- Full life cycle standard management of equipment
- Automatic fault diagnosis and predictive maintenance
- Maintenance strategy from system/management/execution/evaluation/optimization of closed-loop management

### Energy Optimization
- Online real-time energy monitoring and calibration
- On-line optimization of capacity and utilization
- Construction of energy management evaluation and analysis system

### Supply Chain Optimization
- Monitoring and analysis of supply chain information
- Plan & production coordination optimization
- Efficient coordination of supply chain

### Operating Decision
- Quick and effective analysis of daily profit
- Comprehensive monitoring of production and operation performance
- Forecast and analysis of enterprise risk control
Business data flattening and equalization

**Traditional factory**

Data hierarchy; Passing step by step

- **L5:** Enterprise decision-making; Production planning
- **L4:** Supply and marketing; Finance; Planning; Management
- **L3:** Production scheduling; System optimization
- **L2:** Advanced control; Process optimization
- **L1:** Unit automation; Simple control

**Digital factory**

Data flattening; Same layer interaction

**Industrial IoT**

- Equipment Management
- Energy Management
- Safety Management
- SCADA
- PLC
- DCS
- EAM
- OA
- WMS
- SCM
- PLM
- Industrial AI
- Industrial Big Data
- BI

**Breaking Data Island**

**Realizing Effective Synergy**

ISA99/IEC62443 Factory Level Standard

Purdue Model
New IT architecture for digital transformation

<table>
<thead>
<tr>
<th>Traditional IndustryAPPS + Innovative IndustryAPPS</th>
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<tbody>
<tr>
<td>Application service oriented to Internet business</td>
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<tr>
<td>e-Commerce service</td>
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<td>Marketing service</td>
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<td>After-sale service</td>
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<td>Platform service oriented to Internet business</td>
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<td>Big data / AI application services</td>
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<td>Business data</td>
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<td>industrial operating system supOS (Model + Algorithm/Operation environment + Development environment)</td>
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<td>Process data</td>
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<td>Personal data</td>
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<td>Safety and environmental data</td>
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<td>Geographic information data</td>
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<td>Business data</td>
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<td>Public cloud platform</td>
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- **Industrie 1 SaaS**
  - Application service oriented to Internet business
  - e-Commerce service
  - Marketing service
  - After-sale service
- **Industrie 1 PaaS**
  - Business data
  - industrial operating system supOS (Model + Algorithm/Operation environment + Development environment)
- **Industrie 1 Data Integration**
  - IT Infrastructure
  - Hybrid cloud platform
  - Cloud control center
  - Cloud security
  - Big data platform
  - Public cloud platform

- **Power**
- **Logistics / Warehousing / Production**
- **Equipment**
- **Installatio**
- **Employee / Knowledge**
- **Business /**
Engine of Digital Transformation: Industrial Operating System

- Enterprise private cloud
- External Internet
- Industrial APP
  (MES, ERP, WMS, etc.)
- Hardware & software separation
- Communications connectivity
- Hardware virtualization
- Original hardware architecture

Industrial APP Store

- SCADA
- LIMS
- DCS
- PLC
- RTU
Problems Industrial Operating System Solves

Lack of data formation and transformation
- Lack of experience & knowledge sharing
- Aging of professional workers
- How does historical data add value?

Data Island
- Chimney architecture, data incompatibility and inconsistency between systems
- Inefficiencies caused by manual data entry

Professionals need tools to do their best
- How software development meet rapid changes in demand
- How to transfer gold experience to professional algorithm

Unable to respond quickly to changes in external markets
- Inefficiency and lag of traditional data collection and analysis
- Unable to perceive market and industry dynamics

Internal optimization interconnection
External market driven
supOS Industrial Operating System

- Industrial Intelligence APP Configuration Development Platform
- Intelligent Service Operation Management Platform
- Industrial Big Data Integration Platform
- Industrial AI Engine Service
- Industrial Big Data Analysis Platform
- IoT Platform
Factory universal connector helps realize all-round information perception and effectively integrate production data, management data and operation data of the factory.

- Access to dozens of common industrial communication protocols
- Access to industrial real-time database, e.g. PI/Infoplus etc.
- ERP interface, e.g. Ufida /SAP etc.
- Latest IoT ways, e.g. OPC UA, MQTT etc.
Technical Feature 3: Graphical Configuration Industrial APP Development

- Apps can be built by drag and drop
- Data Analysis/Rapid design and development
- Simple tools and SDKs
Technical Feature 4: Big Data and AI Application (e.g. Voice interaction)

1. Interactive large screen solution (simple Q&A)
2. Voice statistics (key equipment information, security risk information)
3. Voice calculator (production load, key parameters)
4. Voice scheduling (utility adjustment, scheduling order, etc.)
5. Voice knowledge base (SOP operating materials and technical documents)
6. Voice production tracking (device production status)
7. Simple voice control (PH value, liquid level control, etc.)
8. Intelligent voice analysis (material balance, frequent alarm, etc.)
9. Mobile terminal voice interaction
Technology Feature 5: Mobile Terminal Collaboration

- Process Alarm
- Work Flow
- Video Surveillance
- Intelligent Inspection
- Mobile Inspection
- Safety Management
- Function Customization
- Flow chart browsing
- Report browsing
- Alarm notification

Building a “Handheld Factory”
Have key production conditions under control anytime and anywhere
Co-create Open Platform Ecosystem

Industrial APP store

supOS

Enterprise independent development
Third-party system integration
Best APP in the industry
Scenario Solution: **Safety management and emergency command platform APPs**

- **Area division**
  - Production facility layout
  - Distribution of emergency resources

- **Sensitive area division**
  - Fire protection arrangement
  - Distribution of emergency resources
  - CAD drawings

- **Satellite imagery**
  - Electronic map
  - Hazard source distribution

- **Hazard source monitoring**
  - Quick alarm
  - Mobile reminder
  - Map location
  - Video linkage

- **Personnel dynamic monitoring**
  - Real-time positioning
  - Track playback
  - Abnormal alarm
  - Personnel statistics

- **Video integration**
  - Streaming media technology
  - Personnel statistics

- **Safety operation monitoring**
  - Regional job distribution
  - Work unit information
  - Job process monitoring

- **Safety information visualization**
  - Safety and environmental protection management personnel
Scenario Solution: Equipment maintenance APPs

Dynamic Equipment Monitoring and Diagnosis Unified Platform

- BH5000C: Rotating equipment monitoring system
- BH5000R: Reciprocating compressor monitoring system
- BH5000P: Pump equipment monitoring system
- BH5000W: Wind turbine monitoring system
- BH5000E: Engine monitoring system

- BH3000: Wireless monitoring system
- BH550: Off-line monitoring system
Scenario Solution: Energy Management and Control APPs

Steam and Power System

Fuel gas system

Circulating water

Hydrogen system
Scenario Solution: Operation optimization APPs based on big data

1. Data collection
   - Index calculation
   - Data labels

2. Cluster by working conditions, generate case base, and select operation cases by KPI

3. Process parameter setting
   - APC
   - Operator

4. Operation execution deviation tracking

5. Data analysis, result review, operation case improvement

Process units

Support mainstream RTDB

- IP21
- PHD
- PIServer
- ISYS
- LIMS
Scenario Solution: 5G+ Video intelligent detection and analysis APPs

- Feed port machine vision
- Furnace flame scanning
- Pulley deviation detection
- Belt break detection and warning
- Online quality inspection
- Production area equipment status monitoring
Infinite Value
Digital Transformation of Petrochemical Enterprises
The world is changing very fast. Big will not beat small anymore. It will be the fast beating the slow.

Rupert Murdoch
Founder, News Corporation
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