EMS Summit 2018
Maintenance 4.0
The Future of Maintenance

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About AECOM
FULLY INTEGRATED SERVICES

PROJECT MANAGEMENT

ARCHITECTURE  INTERIOR DESIGN  MEP  INDUSTRIAL DESIGN  CONSULTING

BIM MANAGEMENT
In numbers

150+ Countries
500+ Offices Worldwide
US$20B+ FY2018 Revenue
90,000+ Total employees

Industry leader
One of the world’s largest engineering and construction companies

Ranked #2
2018 top global design firms survey by Engineering News-Record

Most admired
Considered one of the world’s most admired companies by Fortune for the fourth consecutive year

Integrated
Integrated delivery capabilities covering all four components of the in-project lifecycle: design, build, finance and operate
Best in class technical teams provide market leading services worldwide

Industrial Centres of Excellence

- Calgary
- Denver
- Cleveland
- St Louis
- Houston
- Austin
- Mexico City
- Portland
- Stuttgart
- Bucharest
- Abu Dhabi
- Delhi
- Shanghai
- Singapore
- Rio de Janeiro
- Durban
- Moscow
- Manchester
- Swindon
- Stuttgart
- Melbourne
- Abu Dhabi
- Stuttgart
- Bucharest
- Delhi
- Shanghai
- Singapore
- Rio de Janeiro
- Durban
- Moscow
- Manchester
- Swindon
Key projects
Automotive and Industrial

**Heavy equipment manufacturing**

**Caterpillar**
Facility and production maintenance contract spanning 35 locations on a global platform. AECOM has approximately 1200 employees providing maintenance services.

**Automotive assembly plant**

**BMW Mexico**
Greenfield assembly plant. Services include master planning, project management of design, construction management, and start-up services.

**New electric vehicle**

**Faraday Future in Nevada**
Design/build 3 million square foot greenfield electric car plant. Services include master planning, design packages, engineering, procurement, and construction.

**Engine manufacturing**

**Pratt & Whitney**
Facility Management and waste water treatment services supporting complex jet engine manufacturing processes. This contract services multi locations.
The Future of the Customer
Industry 4.0 in the Cyber future

Product request or Market trend
Selected through best fit simulation
Sub-assemblies
The Future of Factories
Smart Factories

- Modular and adaptive designs for rapid expansion or reconfiguration of both product and location
- Designs that encourage greater openness, integration and collaboration
- Optimised relationship between building, machinery and production processes
- Circular economy strategies including whole life-cycle approaches - feasibility, design, maintenance and decommissioning
- Sustainable practices to reduce environmental impact

Source: https://www.engelglobal.com
The Future of Production
Builds upon Mature Production Methods and Optimizes Asset use

Disruptive technologies
Changed production processes through Rapid 3D printing or light-based manufacturing

Flexible production
Increased flexibility of production to meet customer demand

Automated logistics
Automated logistics processes using AGVs, smart conveyors and automatic warehousing

Information flow
Increased process transparency through inter-connection of assets and holistic controls
The Future of Process led Design
Integrated Engineering Services

0. Strategic Definition
1. Preparation and Brief
2. Concept Design
3. Developed Design
4. Technical Design
5. Construction
6. Handover and Close Out
7. In Use

- Process and Automation
- Architecture
- Programme + Cost Management
- Environment + Planning
- Building Engineering
- Construction
The Future of Maintenance

Dr. Frank Keul
Is AECOM doing Maintenance 4.0 for our Clients?
AECOM’s blueprint approach

- Mobile service requests
- Online service requests
- Live data collection
- Data-driven decision making
- Programmatic approach
- Reliability Roadmap
- Progress Tracking
- Maturity Level
- In-depth analysis & condition based assessment
- 24/7 live support
- Digital job plan
The AECOM Maintenance approach
Reliability Centered Maintenance (RCM)

**RCM Implementation Process**

1. System Selection and Information Collection
2. System Boundary Definition
3. System Description and Functional Block Diagram
4. System Functions and Functional Failures
5. Failure Mode and Effects Analysis (FMEA)
6. Logic (Decision) Tree Analysis
7. Task Selection
8. Task Packaging
9. Measurement and Update ("Living Program")

**Change in Maintenance strategy per task type**

- **Non-intrusive**
  - Time-based: +63%
  - Condition-based: 30
  - Failure Finding: 0
  - Run to Failure: 30

- **Intrusive**
  - Time-based: +143%
  - Condition-based: 0
  - Failure Finding: 11
  - Run to Failure: 9

- **Non-intrusive**
  - Old Plan: 49
  - New Plan: 73

- **Intrusive**
  - Old Plan: 30
  - New Plan: 0

- **New Tasks**
  - Old Plan: 140
  - New Plan: 58

- **% Change**
  - New Plan vs. Old Plan:
    - 59% decrease
    - 143% increase

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EMS Summit 2018
Defining Maintenance 4.0
The future of maintenance uses key aspects of Industry 4.0

**Maintenance 1.0**
Reactive Mode
Run to Failure then Repair

**Maintenance 2.0**
Preventive Maintenance Activities
on Calendar Basis

**Maintenance 3.0**
Condition Based Activities Based of Predictive Maintenance

**Maintenance 4.0**
Interconnected Assets Analysed as a Whole System
The foundation of Maintenance 4.0
Capturing complete data allows optimization on multiple levels

Captured
Collection and access to asset information builds the foundation of Maintenance 4.0

Controlled
Data access availability to strategic partner allowing continuous improvement

Transparent
Cost, stock, activities and productivity is recorded for human and machine assets

Complete
Data capture for all assets at all sites gives the complete picture of activities
Revising activities in Maintenance 4.0
Using the data foundation holistic maintenance can be redesigned

- **Defined**: Data analytics allows identification of failure modes and definition of actions
- **Holistic**: Data capture for all assets at all sites to enable organizational learning

- **Modified**: Modification of corrective actions and existing maintenance schedules
- **Predictive**: Building on past experience new activities are derived to prevent occurrence

**Maintenance 4.0**

**Data**

**What is done**

**How it is done**
Refining activities in Maintenance 4.0
Through disruptive technologies activities are optimized

**Maintenance 4.0**

- What is done
- How it is done
- Data

**Connected**
Vendor agnostic interconnection of assets allows access to all necessary information

**Efficient**
Increased efficiency through feedback loops to equipment designers

**Learned**
Instantaneous adaptation of activities by communication between assets

**Augmented**
Using augmented reality tools for virtual upskilling of personnel and CIP

**Flexible**
Rescheduling

**Automation**

Maintenance 4.0 in a nut shell  
Building on well established continuous improvement principles

**Standardized**  
Unified methodologies to define maintenance activities dynamically on case-by-case

**Comparable**  
By defining company-wide KPIs, comparability is achieved at all levels

**Transparent**  
Cost, stock, activities and productivity is recorded for human and machine assets

**Self-Improving**  
By using Artificial Intelligence system wide experiences are used to improve activities
Closing Remarks
Dr. Frank Keul