Smart Factories, Using the Digital Thread from Design to Production to Quality

Kingsley Edgar
&
Shripathi Vittal Rao
MSC Software
56 years of Innovation
Where It All Began: The 10 Original Software Companies

In compiling a list of the world’s oldest software companies, one comes face to face with an inevitable question: Namely, what is it? What the heck is this thing we call “software”?

We searched the darkest corners of our brains and perused the online dictionaries for options and styles and never really could come up with a single, all-purpose answer. Is it the entirety of what’s inside of a computer? Anything that is not hardware but is used with hardware? Or the seemingly too-limiting: “The programs used to direct the operations of a computer?” How about this metaphysical beauty: “Unlike hardware, software can’t be touched.” Ouch. That makes our heads hurt.

Whichever way you slice it, Windows or Office or even the warranty dismemberment of Dead Space 2 are obvious examples of software, where does one draw the line? Did software, for instance, exist before the advent of computers? In our minds, it did. Though the concept of altering the performance of mechanisms by feeding them independent sets of instructions has clearly become rampant in the computer age, it in fact started long before that—the early 19th century, to be exact. And that is precisely where we start our journey.

Please remember as you read this software—sort of like meter, computers—were with us long before the desktop PCs that so radically changed everything. Moreover, just because Joe Blow in some dungeon in Joe Blow Land cranked out a few lines of code before one of the key players, we’re elected for the purposes of this article to ignore, Joe and highlight instead those companies that history will see as having made a serious impact. Erge, our countdown may seem a bit scattered. It isn’t. It’s perfect.

MSC SOFTWARE

In May of 1963, President John F. Kennedy proclaimed: America would by the end of the decade place a man on the moon. Just a year and a half later, the world had lost one of its great leaders. Yet there was no shortage of folks ready to keep Kennedy’s grand dream alive over the course of the next six years. Certainly MSC Software was in there doing its share. Declaring in 1963 as MacNeal-Schwendler Corporation, the company specialized in the development of structural analysis, developing software for pre-Pc computers that revolutionized the functionality of complex engineering designs. Its first product, SADASAN (Structural Analysis by Digital Simulation of Analog Methods), was designed specifically for the aerospace industry, and by 1986, MSC was involved heavily with NASA.

Today, MSC Software employs over 1,500 people in 20 countries and says it can count virtually every OEM manufacturer in the world as an MSC customer.

MSC Corporation will celebrate its 50th Anniversary in February 2013.
MSC Software Company History & Evolution

1960 – 1980

1965 | NASA Contracts MSC to develop Nastran
1987 | NASA uses MSC Nastran

1990 – 2000

1971 | First Commercial Version of Nastran
1999 | MSC Acquires Marc (Nonlinear FEA)
2002 | MSC Acquires MDI (Mechanical Dynamics)

2010 - 2019

2011 | MSC Acquires FFT (Acoustics)
2012 | MSC Acquires e-Xstream engineering (Materials)
2014 | MSC Announces MSC Apex (Next Generation CAE System)
2015 | MSC Acquires Simufact Engineering (Manufacturing Process)
2016 | MSC Acquires Software Cradle (CFD)
2017 | MSC Acquires VIRES (Virtual Test Drive)
2017 | HEXAGON Acquires MSC Software
2019 | FTI becomes part of MSC Software

Acquires MSC Software
Completion of Hexagon's acquisition of MSC Software

Stockholm, Sweden, 26 April 2017 - Hexagon AB, a leading global provider of information technologies that drive productivity and quality across geospatial and industrial enterprise applications, today announced the completion of the previously announced acquisition of MSC Software ("MSC"), a US-based leading provider of computer-aided engineering (CAE) solutions, including simulation software for virtual product and manufacturing process development. Completion of the transaction was subject to regulatory approvals and other customary conditions, which have now been obtained.
**Hexagon AB**
- ~ US$4.5 Bn Net Sales in 2018, 10-12 % of Net Sales invested in R&D
- Headquarters in Stockholm, Sweden, 20,000 employees in 50 countries
- Wide range of Portfolio, including Auto, Aero, Shipbuilding, Electronics, GeoSpatial
- Balanced revenues between Geospatial and Industrial solutions

**Hexagon Manufacturing Intelligence**
- Part of Industrial solutions, ~ US $2.2 Bn in sales
- Focused on Quality in Manufacturing
- Headquarters in London
- Includes AICON 3D Systems, Leica cameras, Forming Technologies Inc. (FTI), etc.

**MSC Software**
- Headquarters in Newport Beach, California
- 1,400 employees in 23 countries
- CAE Pioneer and Leading Global Player
- Wide range of Portfolio, including Auto, Aero, Machinery, Defense & Shipbuilding

**MSC Software Business Units / Acquired companies**

<table>
<thead>
<tr>
<th>Year</th>
<th>Unit/Company</th>
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<tbody>
<tr>
<td>2011</td>
<td>FFT</td>
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<td>2015</td>
<td>Simufact Forming</td>
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<td>2016</td>
<td>Cradle Tetra - Stream CFD</td>
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<td>Forming Additive, Welding</td>
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<td>2016</td>
<td>Tetra - Stream CFD</td>
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<tr>
<td>2017</td>
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Enabling Technologies

Meta-Materials
Edge Technology
Cloud Computing
Bluetooth
Internet of Things
Open Source
LiFi Technology
WiFi Technology
Big Data
5G
Advanced Battery Technology
Meta-Materials
Edge Technology
Cloud Computing
Bluetooth
Internet of Things
Open Source
LiFi Technology
WiFi Technology
Transformative Technologies
Enabling the efficient production of highly complex components and providing customers with numerous benefits, from material-saving, weight reduction and efficient, cost-effective production. AMendate's technology eliminates the inefficient manual effort that significantly slows today's workflows, allowing work steps to be completed in days that would otherwise take several weeks.
Machine Learning & Artificial Intelligence (AI)

Leverage user’s experience and historical results to boost CAE productivity

- AI-powered **Real-time CAE** to accelerate product design and development
- Reduced Order Modeling (ROM) techniques to **accurately predict outcomes** and allow to focus only on relevant scenarios and design options
- Capture and leverage your **CAE knowledge**, boost your engineering team productivity
Hexagon Autonomous Vehicle Simulation & Testing Solution Suite

Real World Testing & Measurement

[Image of autonomous vehicle with sensors]

Digital Twin Simulation & Analysis

HPC Cluster

- Vehicle Model
- AI Driver
- Traffic
- Sensors
- 3D Environment

X 100

[Images of digital twin simulation and analysis technologies]

Mobile Mapping

[Image of mobile mapping equipment and software]

Content Program

[Image of content program and digital mapping]

Leica

Luciad
Emerging.. take aways

- Additive manufacturing
- Autonomous

Thank You.
Smart Connected Factories

Shripathi V
Technical Manager, Aerospace
MSC Software Indo-Pacific
Leading a Revolution
From Automation to Autonomy

Autonomy is the ultimate form of putting data to work.
The Road to Autonomy
Our core capabilities
Smart Factories
that learn and adapt quickly to changing conditions in real time, pursuing perfect quality with optimised design, requiring fewer inputs and producing zero waste.

SUSTAINABLE VALUE CREATION
• Fewer inputs
• Zero waste
• Perfect quality

PRIMARY APPLICATIONS
• Aerospace
• Automotive
• Electronics
• Medical
• Heavy industry
• Power & energy

Did you know?
Each year, Hexagon technology touches:
• 90% of aircraft produced
• 85% of smart phones produced
• 75% of cars produced

We have expertise in and connect all stages of the manufacturing lifecycle:

DESIGN AND ENGINEERING (CAE)
Optimise designs and ensure manufacturability

PRODUCTION (CAD/CAM)
Deliver on design intent and product quality with minimal waste

METROLOGY HARDWARE/SOFTWARE
Capture real-world data for positioning and inspection
Industrial Metrology Applications: World Leader in Quality Measurement
CADCAM to address metal, sheet metal and woodworking industries

MES for die/mold processes, small scale ERP tools, machine simulation technologies

Direct offices in 13 countries, development teams in 7 countries, 700+ employees, 140 resellers in 45 countries

Strong relationships with all the largest machine tools OEMs
MSC’s Virtual Factory Ecosystem

- Casting
  - Interface to leading third party products
- Metal Forming
- Machining
- Joining & Assembling
- Coating
- Changing Material Properties
- Additive Manufacturing

- Sheet Metal Forming
- Bulk Metal Forming
- Welding / RSP
- Mechanical Joining
- Heat Treatment, Carburization
- Additive Manufacturing
Challenges faced by Manufacturing Industry

Connected Plant Floor to Improve Operational Efficiency
Manufacturers are missing out on a critical opportunity: Leveraging real-time data on cycle times, quality yields by machines, production run, utilization and other metrics to improve Operational Efficiency of the plant.

Preventive maintenance without affecting throughput
Keeping equipment functioning is an essential part of running a manufacturing facility. By collecting real-time data, and comparing with failure scenarios, it is possible to predict the appropriate time frames that the machines in the factory should be maintained.

Connected Quality for Final Inspection
Process of quality assurance, quality control, and QC inspections need to be optimized to increase productivity and lower costs

Better supply chain visibility
It is essential to integrate all the business applications including ERP, CRM, PLM with MES systems for a better visibility of supply chain

Customer-facing self-service applications
An organization’s customers typically consist of end-customers, partners (or service providers), and sub-contractors, or any combination of these. These customers have different needs, concerns and requirements for working with and interacting with manufacturers.

References
10 greatest Manufacturing Challenges for CIOs
Top five challenges facing Manufacturing Industry
Six challenges facing Modern Manufacturing Companies
Introducing Xalt

One of our major R&D initiatives is a technology framework called Xalt, which will eventually underpin all of our solutions – making them faster, easier to use, more connected, and autonomously intelligent.

Xalt framework:
- Artificial intelligence
- Edge computing
- Mobility
- Advanced visualization
- Enterprise integration
Autonomous Connected Ecosystems with
Infinite Connectivity for Disconnected Data

**CLOUD ENABLEMENT**
Connecting B2B with an orchestrated microservice framework and cloud analytics for big, fast data.

**EDGE CONNECTIVITY**
Processes, combines, and analyses IoT and sensor data at the edge of the network and puts it to work with AI.

**ENTERPRISE INTEGRATION**
Plug-in enterprise integration for legacy connections, databases, and IT systems, equipped with middleware for messaging, file, system, and database connectivity and transformation.

**MOBILITY**
Secure and nimble framework that is native iOS- and Android-ready with zero client footprint and network-optimized for visualization of multiple georeferenced 3D & 2D data sets.

**UBIQUITOUS A.I.**
Multiple AI data sources including imagery, video, and big data for applications such as predictive maintenance, change, and anomaly detection.

**VISUALIZATION**
Visualizes 2D/3D data, including point clouds, and is optimized for all mainstream OS, mobile, and web platforms. Augmented reality applications are validated on HoloLens, Daqri, and Oculus, and can process enormous datasets at high speeds.

**Security without Rigidity:** Xalt is HIPAA and PCI-compliant, is SOC2 certified, and has passed the United States Department of Defense regulatory process.
### Addressing the Complex Real-life Challenges in Manufacturing – not just Connectivity

<table>
<thead>
<tr>
<th><strong>THE BIG DATA DISCONNECT</strong></th>
<th><strong>QUALITY / COST INVERSION</strong></th>
<th><strong>4.0 MODELS &amp; MARKETS</strong></th>
</tr>
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<tbody>
<tr>
<td>Organizations have limited visibility to at-source data</td>
<td>Produce more at higher quality; deliver it faster at lower costs</td>
<td>Lost revenue due to untapped, data-driven models and channels</td>
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<tr>
<th><strong>PROCESS OPTIMIZATION</strong></th>
<th><strong>SMART QUALITY ASSURANCE</strong></th>
<th><strong>CONNECTED WORKERS</strong></th>
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<tbody>
<tr>
<td>Real-time logistics, line uptimes, edge analytics of machinery</td>
<td>Real-time updates and alerts for on-premises, cloud, and sensor assets</td>
<td>Real-time mobile access to consolidated data (sensors, alerts, and workflows)</td>
</tr>
</tbody>
</table>
Leverage Your Existing OS

OPEN CONNECTORS + INTEGRATION + SMART WORKFLOWS

LOW/NO-CODE IMPLEMENTATION + FLEXIBLE DEPLOYMENT + DATA ACCESSIBILITY
Connected Worker
Innovating Work in the Field
Smart Factory
Sensor Fusion with
User Enablement
### Smart Factory Solutions

#### MANUFACTURING

**TRANSPORTATION**
- Body + Finished Good MFG
  - Motor Vehicle + Truck
  - Heavy Duty Vehicle
  - Specialty Vehicle
  - Aerospace

**METAL + MACHINERY**
- Packaging Machinery
- Door + Window
- Elevator + Convey
- Material Handling
- HVAC + Industrial Refrigeration

#### PLANT OPERATIONS

**ELECTRICAL**
- Sub Contracting Of:
  - Electrical Site Prep
  - Commercial Bldgs
  - Electrical Finishing
  - 100 Employees+

**MECHANICAL**
- Installation Of:
  - HVAC System
  - Plumbing + Piping
  - Drywall + Structural
  - Elevator + Equipment

**UTILITY SYSTEMS**
- Construction Of:
  - Oil + Gas Pipelines
  - Power + Comm. Lines
  - Water + Sewage Systems

#### Quality Inspections
- Inspection Plans
- Times Tests
- Shared File Specs
- Rework WOs
- Production to Delivery Tracking

#### Field Service Suite
- Workorder Mgmt
- Time Allocation
- Supply Reqs
- Inventory
- Mileage Tracking

#### Maintenance
- Workorder Mgmt
- Time Allocation
- Supply Reqs
- Inventory
- Emergent Alerting

#### Time Planning
- Jobsite HR
- Timesheets
- Payrate plan
- Project Time Budgeting

#### Material Requisitions
- Inventory
- Prefab Reqs
- Equipment Rentals
- Supplier Orders

#### Tool Tracking
- Asset Mgmt:
  - Tools
  - Equipment
  - Rentals
  - Maintenance Schedules

#### Project Reporting + Analysis
- Job Status
- Daily Site Reporting
- Project Budget
- Deadline Tracking
Connections to Business Applications

- CRM
- ERP
- SCM
- Mfg.
- HR
- PLM
- Others...

Xalt
Xalt | Integration provides interfaces to connect multiple software applications and a highly configurable no-code business rules engine to solve enterprise-level integration challenges.

It’s the glue that holds solutions together
Asset Management

Minimize Downtime. Maximize Efficiency.

• System Health
• Asset Utilization Charting
• Facility Environment Tracking
• “OEE”
• System Notifications
• HMI Service Connection
Scope
- Manage and see Assets in Smartphones
- Receive Notifications on CMM Started, Busy, Idle, Crash, Error
- Master complexity of setups in OEM environment
- Autodiscover assets
- Manage loads based on availability
Cutting tool & conditions management

Machining programs are archived on a corporate network

Machining simulation

Machining programs are archived on a corporate network

NC program life-cycle management

Program validation

Machine status monitoring
Real-time Status Monitoring

- Presents the chronology of the statuses per period
- Provides real-time indicators of machine activity
- Details the timeline of machines status
  - The horizontal axis indicates the times
  - The vertical axis indicates the days in the period
- Select a status to find out when it started and how long it lasted
- A user-friendly user interface to select the date and type of the period
Real-time Activity Monitoring & Control

Factory & Machines

Machining Process & G-Code Execution
Towards Predictive Maintenance

**SQ Health Concept**

- **Step 1:** Rules-based notifications on pre-defined thresholds
- **Step 2:** Condition monitoring on parameters based on statistical methods
- **Step 3:** Predictive maintenance with ML algorithms trained on historical telemetry (machine, environment), failure/service events and process data
Machine Learning / AI & Design Improvement

Feedback and Learning
Few Case studies to glance at........
Thank you