

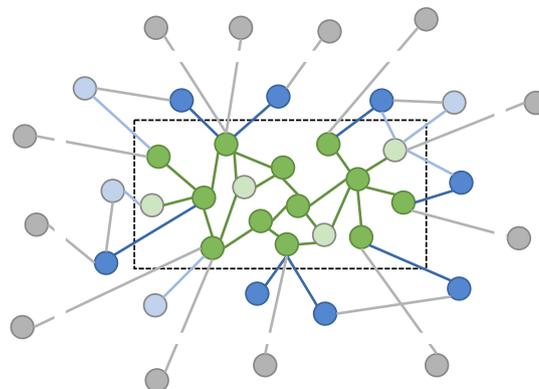
# Systems Engineering Transformation: Accelerating transformation to a model-based discipline

Paul Schreinemakers, INCOSE Technical Director

Troy A. Peterson, Assistant Director SE Transformation

2 maart 2016

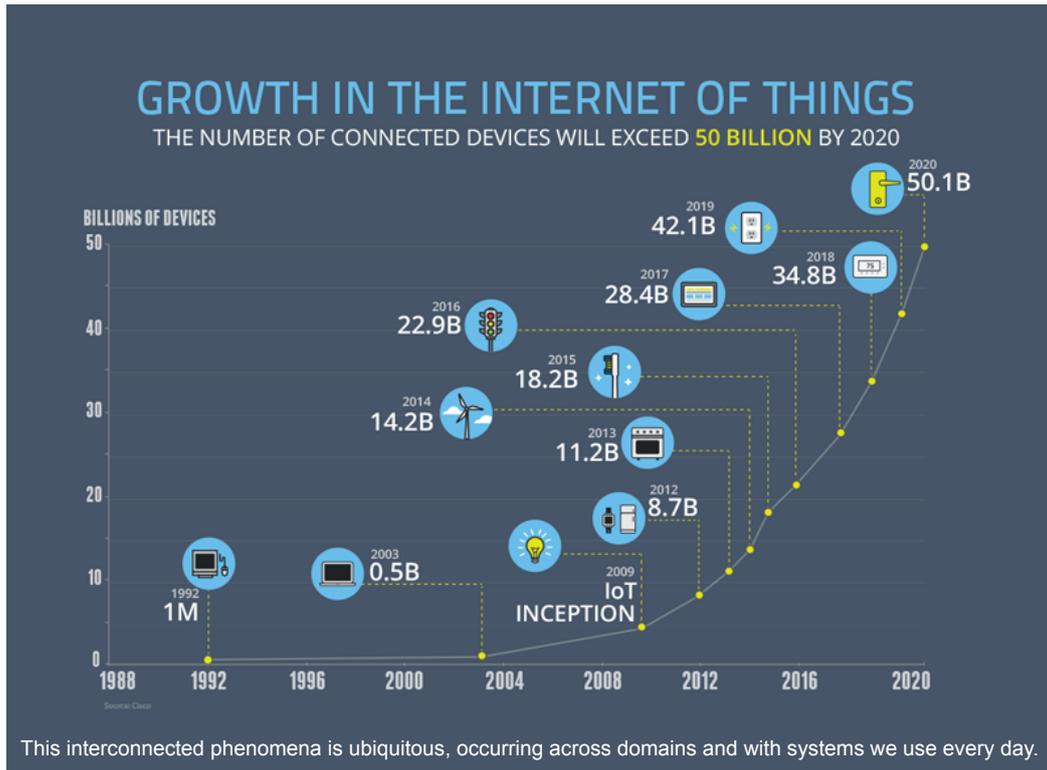
## The Pervasive Systems Phenomenon



**System Elements & Interactions**  
**External Elements & Interactions**

**Increased Density of System Elements & Interactions**  
**Increased Density of System External Elements & Interactions**  
**Increased Interactions Between External Elements**  
**Expanding System Domain Boundary Increasing Interactions**

2 maart 2016

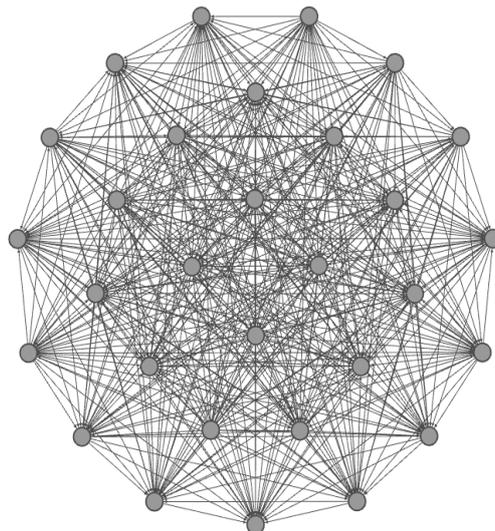


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## Why Transformation



Nodes = 30, potential links = 435, unique configurations =  $2^{435} = 10^{131}$

*“Today more and more design problems are reaching insoluble levels of complexity.”*

*“At the same time that problems increase in quantity, complexity and difficulty, they also change faster than before.”*

*“Trial-and-error design is an admirable method. But it is just real world trial and error which we are trying to replace by a symbolic method. Because trial and error is too expensive and too slow.”*

Christopher Alexander,  
*Notes on the Synthesis of Form*<sup>1</sup>,

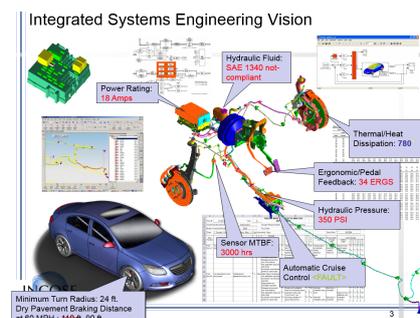
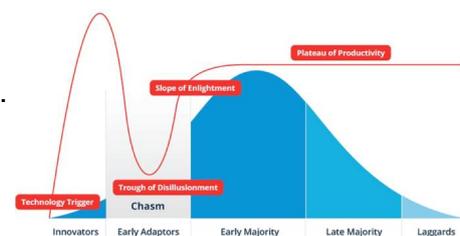
1. Christopher Alexander, “Notes on the Synthesis of Form” Harvard University Press, Cambridge Massachusetts, 1964

## SE Transformation Overview

### Objective:

INCOSE accelerates the transformation of systems engineering to a model-based discipline.

- Accelerates:
  - Understand the hype cycle<sup>1</sup> and bridge the chasm<sup>2</sup>...
  - Empower others to enlighten and influence adoption
- Transformation:
  - A marked change, as in appearance or character, usually for the better<sup>3</sup>. e.g. documents to models
  - Lead and support the community in crossing the chasm
- Model Based Discipline
  - System models of all types
  - Modeler Collaboration and Model Integration



1. Hype Cycle is a branded graphical presentation developed and used by IT research and advisory firm Gartner  
 2. Moore, Geoffrey A. “Crossing the Chasm – and Beyond” Strategic Management of Technology and Innovation Third Edition 1996  
 3. Excerpted from The American Heritage Dictionary of the English Language, Third Edition 1996 by Houghton Mifflin Company  
 4. Friedenthal, Sandy and Sampson, Mark - MBSE Initiative Overview - <http://www.omgwiki.org/MBSE/doku.php>

- Model Based Discipline
  - Models are not new to us
  - Transformation is not a wholesale change
  - Model based is the next evolutionary step
  - In some ways we're going "back to the future"
- Understand the Current State
  - Take inventory of current state of transition and progress toward becoming a model based discipline
- Envision and define the future state of SE:
  - Vision 2025, what are the business objectives, associated metrics, stakeholders, technology and transition needs, typical what if questions, priorities etc.
- Leverage Transformation and Change Management methods and frameworks

INCOSE: Systems Engineering Transformation



Transformation Life Cycle™ (TLC): Booz Allen Hamilton

Consider key dimensions of change

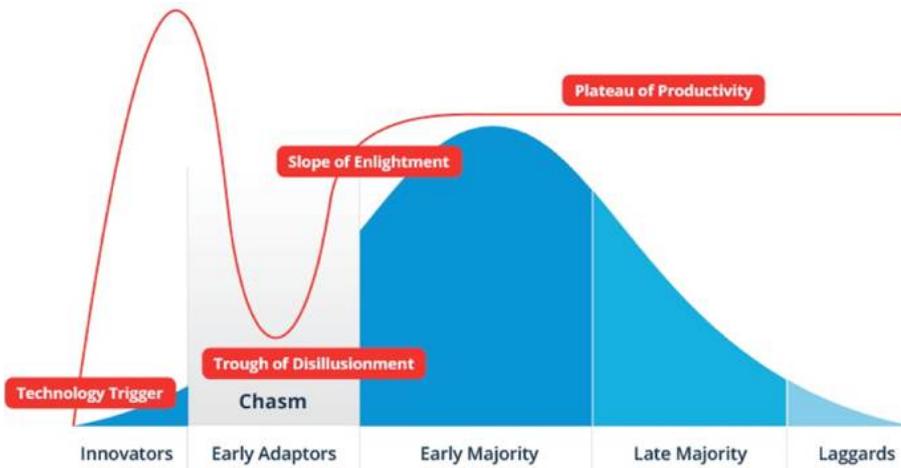
- People, Process, Technology, and Physical Infrastructure
  - Integrate dimensions of change
  - Addresses dimensions in parallel
  - Leverage concurrency to encourage cross dimension trades
  - Build ownership at the grass-root level

Consider:

$$ABP = CM(OE + BPR + IT)$$

- ABP = Achieving Breakthrough Performance
- OE = Organizational Environment
- BPR = Business Process Reengineering
- IT = Information Technology
- CM = Change Management

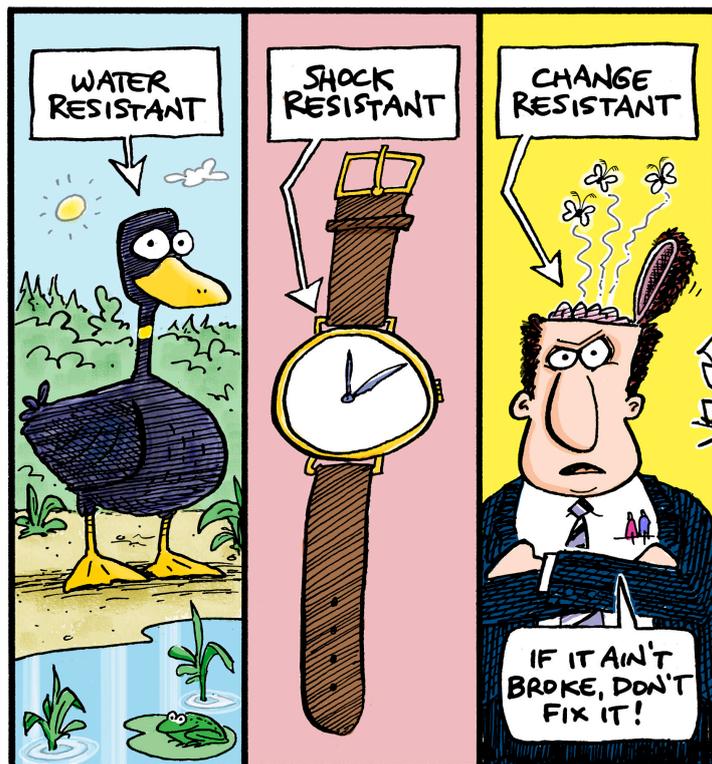
Transformation is very much a people focused endeavor.



Acceleration is very much about sharing, communicating and learning

Where would you plot your organization today?

1. Hype Cycle is a branded graphical presentation developed and used by IT research and advisory firm Gartner
  2. Hype Cycle Graphic: [https://en.wikipedia.org/wiki/Hype\\_cycle](https://en.wikipedia.org/wiki/Hype_cycle)
  3. Moore, Geoffrey A. "Crossing the Chasm – and Beyond" Strategic Management of Technology and Innovation Third Edition 1996
  4. Hype Cycle, Chasm Combined Graphic: <http://www.datameer.com/blog/big-data-analytics-perspectives/big-data-crossing-the-chasm-in-2013.html>
- INCOSE: Systems Engineering Transformation



***If you want to truly understand something – try to change it.***

**Kurt Lewin**

***The best way to manage change is to create it.***

**Peter Drucker**

INCOSE: Systems Engineering Transformation

**From:**

Model-based systems engineering has grown in popularity as a way to deal with the limitations of document-based approaches, but is still in an early stage of maturity similar to the early days of CAD/CAE.

**To:**

Formal systems modeling is standard practice for specifying, analyzing, designing, and verifying systems, and is fully integrated with other engineering models. System models are adapted to the application domain, and include a broad spectrum of models for representing all aspects of systems. The use of internet-driven knowledge representation and immersive technologies enable highly efficient and shared human understanding of systems in a virtual environment that span the full life cycle from concept through development, manufacturing, operations, and support.

INCOSE: Systems Engineering Transformation

## Objective: Accelerate the transformation to a model-based discipline

- Decision makers ask for models (based information) rather than documents
- Advance and mature the MBSE Practice
- Mainstream Model Based Systems Engineering
- Evolve to a cohesive MBSE language, applicable to multiple domains
- Promote and advance the role of MBSE in global Model Based Engineering (MBE)
- Connect to other MBE cross domain standards like Building Information Modeling (BIM)
- Get authoritative information on MBSE out to practitioners and the broader community
- Align with SE Vision 2025 (see page 38-39)



INCOSE: Systems Engineering Transformation

## Team

### Assistant Director for Transforming SE to a Model Based Discipline

- Troy Peterson

### Core team of experts supporting the effort – Meet one or two times a month...

- Jeff Bergenthal
- Sandy Friedenthal
- Joachim Fuchs
- John Gill
- Mark Sampson
- Bill Schindel

### Adding stakeholder representatives to obtain diverse perspectives

- INCOSE CAB, IOB, Tech Ops, Working Groups etc.
- Strong connection to the INCOSE MBSE Initiative
- Representatives from targeted MBE applications (NAFEMS, BIM, ....)
- Domain representatives

***Please let me know if you are interested***

INCOSE: Systems Engineering Transformation

# What do we consider a successful outcome



## What Success looks like at IW 2016 and/or IS 2016

- New AD for transformation selected
- Strategy defined for implementing the Transformation
- First steps taken to mainstream MBSE
  - Partial MBSE workshop @ IW + MBSE topics addressed during (WG) meetings
  - Explicit have MBSE activities displayed during ongoing WG activities
- Work on explicit connecting products between MBSE and NAFEMS as well as the Building Information Modeling

## What Success looks like at the end of 2019 (5 years)

- Decision makers ask for models (based information) rather than documents
- MBSE is not a separate track at IS and IW but integrated in all WG activities
- Systems Engineering is a Model Based discipline, explicitly connected to X# of MBE applications

*I think we can do more!*

INCOSE: Systems Engineering Transformation

# Accomplishments: Transformation Page



**Go to: <http://www.incose.org>**

Will update with developed strategy, new products created etc.

Page links to the MBSE Initiative Working Group page

INCOSE: Systems Engineering Transformation

The screenshot shows the INCOSE website navigation menu with 'Chapters & Groups' selected. The main content area features a 'Working Groups' section with a diagram titled 'Sources of Knowledge' showing 'Knowledge', 'Processes', and 'Technology' leading to 'Systems Engineering', which then leads to 'Domains of Industry, Academia, and Government'. A red box highlights the 'MBSE Initiative' link within this diagram.

## Model Based Systems Engineering (MBSE) Initiative

Home / Chapters & Groups / Working Groups / MBSE Initiative

MBSE Initiative - Sandy Friedenthal and Mark Sampson

Link to [SE Transformation](#) site

Click Link to view project site

### Challenge Teams

FILE	DESCRIPTION	DATE	WEBSITE
Modeling and Simulation Interoperability	Russell Peak	01 Jul, 2015	<a href="#">Link</a>
Space Systems Modeling	Louise Anderson	01 Jul, 2015	<a href="#">Link</a>
Telescope Modeling	Robert Karban	01 Jul, 2015	<a href="#">Link</a>
Biomedical Device Modeling	Ajay Thakral	01 Jul, 2015	<a href="#">Link</a>
GEOS Modeling	Lawrence McGovern	01 Jul, 2015	<a href="#">Link</a>
Patterns	Bill Schindler	01 Jul, 2015	<a href="#">Link</a>

### Activity Teams

FILE	DESCRIPTION	DATE	WEBSITE
MBSE Usability	Bjorn Cole	01 Jul, 2015	<a href="#">Link</a>
Methodology and Metrics	John Watson	01 Jul, 2015	<a href="#">Link</a>
Model Management	Amit Fisher	01 Jul, 2015	<a href="#">Link</a>
Modeling Standards	Roger Burkhart	01 Jul, 2015	<a href="#">Link</a>
Ontology	Henson Graves	01 Jul, 2015	<a href="#">Link</a>
System of Systems/Enterprise Modeling	Ron Williamson/Matthew House	01 Jul, 2015	<a href="#">Link</a>
Model Based Test	Frank Abidraz	01 Jul, 2015	<a href="#">Link</a>

### Affiliated INCOSE Groups

FILE	DESCRIPTION	DATE	WEBSITE
Tool Integration and Interoperability		01 Jul, 2015	<a href="#">Link</a>
Tools Database		01 Jul, 2015	<a href="#">Link</a>
NAFEMS-INCOSE Systems Modeling & Simulation Working Group (SMSWG)		01 Jul, 2015	<a href="#">Link</a>
Association <a href="#">Exercise of INCOSE Systems</a>		01 Jul, 2015	<a href="#">Link</a>
MBSE SIG of INCOSE The Netherlands Chapter		01 Jul, 2015	<a href="#">Link</a>
UK Chapter MBSE Wiki		01 Jul, 2015	<a href="#">Link</a>
Tool Vendor Collaboration with MBSE Teams		01 Jul, 2015	<a href="#">Link</a>

Links take users to INCOSE / OMG MBSE Initiative Wiki. Page also points to the SE Transformation INCOSE page as well.

INCOSE: Systems Engineering Transformation

# MBSE Workshop Agenda & Logistics @ IW2016

	Start	End	MBSE Workshop: MBSE & Transformation	MBSE Workshop: Joint Sessions	MBSE Workshop: Model Lifecycle Mgmt (MLM)	MBSE Workshop: Healthcare, Critical Infra, Protection and Recovery, OPM	MBSE Workshop: Model Based Conceptual Design and Sys. Sci WGs	
Saturday	07:00	08:00	Opening Plenary					
	08:00	09:00						
	09:00	10:30	Break					
	10:30	11:00	MBSE Initiative: Overview & Status Salon E			Healthcare Working Group (HWG) Workshop Kickoff & Introduction Suite 4		
	11:00	12:00	Invited Speaker Steve Jenkins from JPL Salon E					
	12:00	13:00	Lunch					
	13:00	13:30	MBSE Context and SE Transformation Salon E					
	13:30	14:00	Joint Workshop: Patterns in System of Systems by SoS and Patterns WG Salon F		Model Lifecycle Management (MLM): Team Kickoff Exec Suite 1738	Healthcare WG: MBSE for Emergency Dept. - Stakeholders Suite 4	Systems Science WG: Modeling of Systems Processes Suite 10	
	14:00	15:00	MBSE 301 Salon E					
	15:00	15:30	Break					
	15:30	16:00	MBSE 301 Salon E	Joint Workshop: Patterns in System of Systems by SoS and Patterns WG Salon F	MLM: Team Kickoff Exec Suite 1738	HWG: MBSE for Emergency Dept. - Stakeholders Suite 4	Systems Science WG: Modeling of Systems Processes Suite 10	
	16:00	17:00						
17:00	18:00							
18:00	19:00							
19:00	21:00	INCOSE Foundation Wine Soiree sponsored by the Corporate Advisory Board						
Sunday	07:00	08:00	Town Hall: INCOSE 5-year Objectives: Transformation and Impactful products					
	08:00	09:00	SE Transformation Roundtable: Influencing Model Based Methods Salon E			HWG: MBSE for Emergency Dept. - Reference Architecture Salon C		
	09:00	10:00	Break					
	10:00	10:30	SE: MBSE Update Salon E					
	10:30	11:00	SE: MBSE Update Salon E			HWG: MBSE for Emergency Dept. - Reference Architecture Salon C		
	11:00	11:30	Space Systems WG: CubeSat Model Review Salon E					
	11:30	12:00	Lunch					
	12:00	13:00						
	13:00	13:30	Joint Workshop: Product Line Engineering - Patterns Salon G		MLM Activity Team (2016) Panel Working Session Exec Suite 1836	HWG: MBSE for Emergency Dept. - MBSE & Simulation Salon C	Model Based Conceptual Design Working Meeting Suite 244	
	14:00	15:00	Break					
	15:00	16:00	Joint Workshop: Review of Agile-2J Life Cycle Pattern Model Salon G		MLM: (2016) Panel Working Session Exec Suite 1836	HWG: MBSE for Emergency Dept. - MBSE & Simulation Salon C	Model Based Conceptual Design Working Meeting Suite 244	
	16:00	16:30						
16:30	17:00	Patterns: Discussion of 2016 Projects Salon G						
17:00	17:30							
17:30	18:00	MBSE Reception Salon G						
18:00	18:30	SEP's Reception for ASEP, CSEP, and ESEP.						

	Start	End	MBSE Workshop: MBSE & Transformation	MBSE Workshop: Joint Sessions	MBSE Workshop: Model Lifecycle Mgmt (MLM)	MBSE Workshop: Healthcare, Critical Infra, Protection and Recovery, OPM	MBSE Workshop: Model Based Conceptual Design and Sys. Sci WGs	
Monday	07:00	08:00	Town Hall: INCOSE 5-year Objectives: Transformation and Impactful products					
	08:00	09:00	Model-Based System Management in the Autonomy Era Exec Suite 1819	Joint NAFEMS-INCOSE Systems Modeling & Simulation WG Salon C				
	09:00	09:30	Break					
	09:30	10:00	SE Transformation Working Session (Closed) Exec Suite 1819	Joint NAFEMS-INCOSE Systems Modeling & Simulation WG Salon C	MLM Activity Team To-Be ConOps Working Session Salon G			
	10:00	10:30	Break					
	10:30	11:00						
	11:00	12:00	Lunch					
	12:00	13:00						
	13:00	13:30			MLM Activity Team To-Be ConOps Working Session Salon G		Systems Science WG: Is This System SDR Fit for Purpose? Suite 10	
	13:30	14:00					Systems Science WG: Systems Thinking/Modeling for Conceptual Design Suite 10	
	14:00	15:00	Break					
	15:00	16:00			MLM Session Cont.	Critical Infra, Protection & Recovery WG: Value of MBSE to Critical Infrastructure Protection & Recovery Salon F	Architecture WG: Architecture Framework Development/Updates Suite 4	
16:00	16:30					Architecture WG: Architecture and Human Factors Suite 4		
16:30	17:30							
Tuesday	07:00	08:00	Town Hall: INCOSE 5-year Objectives: Transformation and Impactful products					
	08:00	09:00						
	09:00	10:00	Break					
	10:00	10:30						
	10:30	11:00	SE Transformation Working Session (Closed) Suite 2		MLM Activity Team To-Be ConOps Working Session Exec Suite 1738		Systems Science WG: Warfield's Science of Generic Design and Structural Modeling Suite 10	
	11:00	11:30						
	11:30	12:00						
	12:00	13:00	Lunch					
	13:00	14:00			Model Lifecycle Management Activity Team (2016) Paper and Planning Session Exec Suite 1738			
	14:00	14:30						
	14:30	15:00	Break					
	15:00	16:00	MBSE Initiative Outbriefs Salon E					
16:00	16:30	Closing Plenary Closing Reception and Working Group Dinner / Market Place						

- MBSE:
  - Integreert meerdere interdisciplinaire modellen die gezamenlijk één systeem beschrijven
  - Is alleen mogelijk indien we beschikken over systeem architectuur
  - Is toe te passen op verschillende (gescheiden) abstractie niveaus
- MBSE ≠:
  - Equivalent aan SysML of UML
  - Eén model dat alles beschrijft
- BIM:
  - Sterke focus op geometrische modellen en veranderingen in de tijd
  - Wereldwijd diverse toepassingen en accenten

- MBSE en BIM kunnen elkaar versterken
  - Vastleggen van generieke systeem architectuur voor tunnels, sluizen, etc. met een 'dashboard' voor de bepalende parameters
  - Verbinden van diversiteit aan analyse technieken en expliciet maken van de cross-system effecten
  - Bevordert het nemen van besluiten op het juiste abstractie niveau
  - Effectief hergebruik van systeem concepten → kostenbesparing
  
  - Toepassing van MBSE is een 'nieuw' domein
  - Samenwerking met BuildingSMART bevordert draagvlak en standaardisatie in de bouw sector
  - Bredere internationale toepassing van SE in de sector
- Ik zie heel graag 'n bijdrage van de GWW sector aan het MBSE-BIM initiatief !!!

**“When the rate of external change exceeds the rate of internal change, the end of your business is in sight.”**

**Jack Welch**

**“It is not necessary to change. Survival is not mandatory.”**

**W. Edwards Deming**

