

**Hochschule Bremen**  
**City University of Applied Sciences**



## **Agile needs Systems Engineering**

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31. Mai 2023, Universität Hildesheim

Workshop "Software Engineering in Cyber-Physical Production Systems"

**01** | **What is Agility?**

**02** | **What is Systems Engineering?**

**03** | **Agile vs. Systems Engineering – comparing Apples and Oranges**

**04** | **Better agile with Systems Engineering**

**05** | **Who we are – Working Group Agile SE at GfSE**



# 01



## What is Agility?

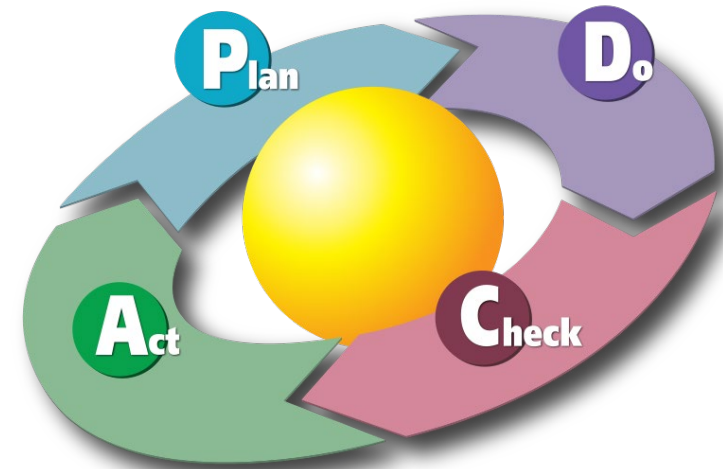
## What is Agility?

**A rapid whole-body movement with change of speed or direction in response to an impulse, but without loss of control.**

**[Sheppard und Young, 2006]**

# Agile Approach

Iterative incremental way of working  
 Self-organized cross-functional teams  
 Early and continuous delivery to the customer  
 Continuous improvement through reviews/re-evaluation  
 → An „Inspect & Adapt“ Framework



# Iterative and Incremental

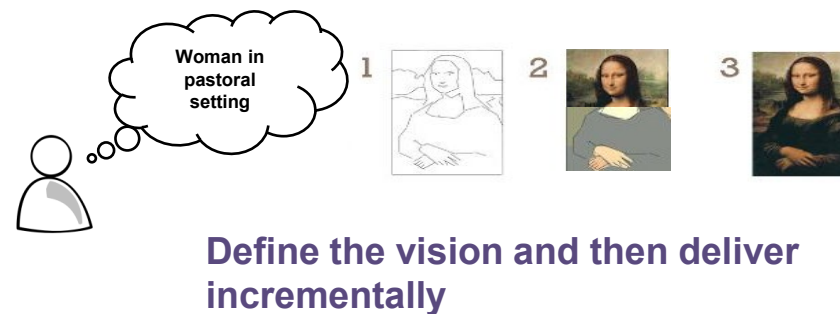
## Iterative



## Incremental



## Iterative Incremental



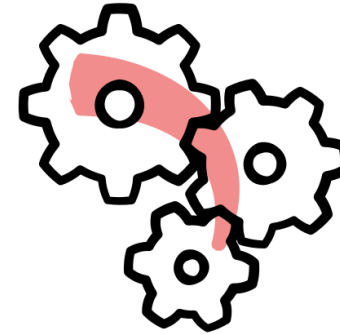
# Agile Approach



Mindset



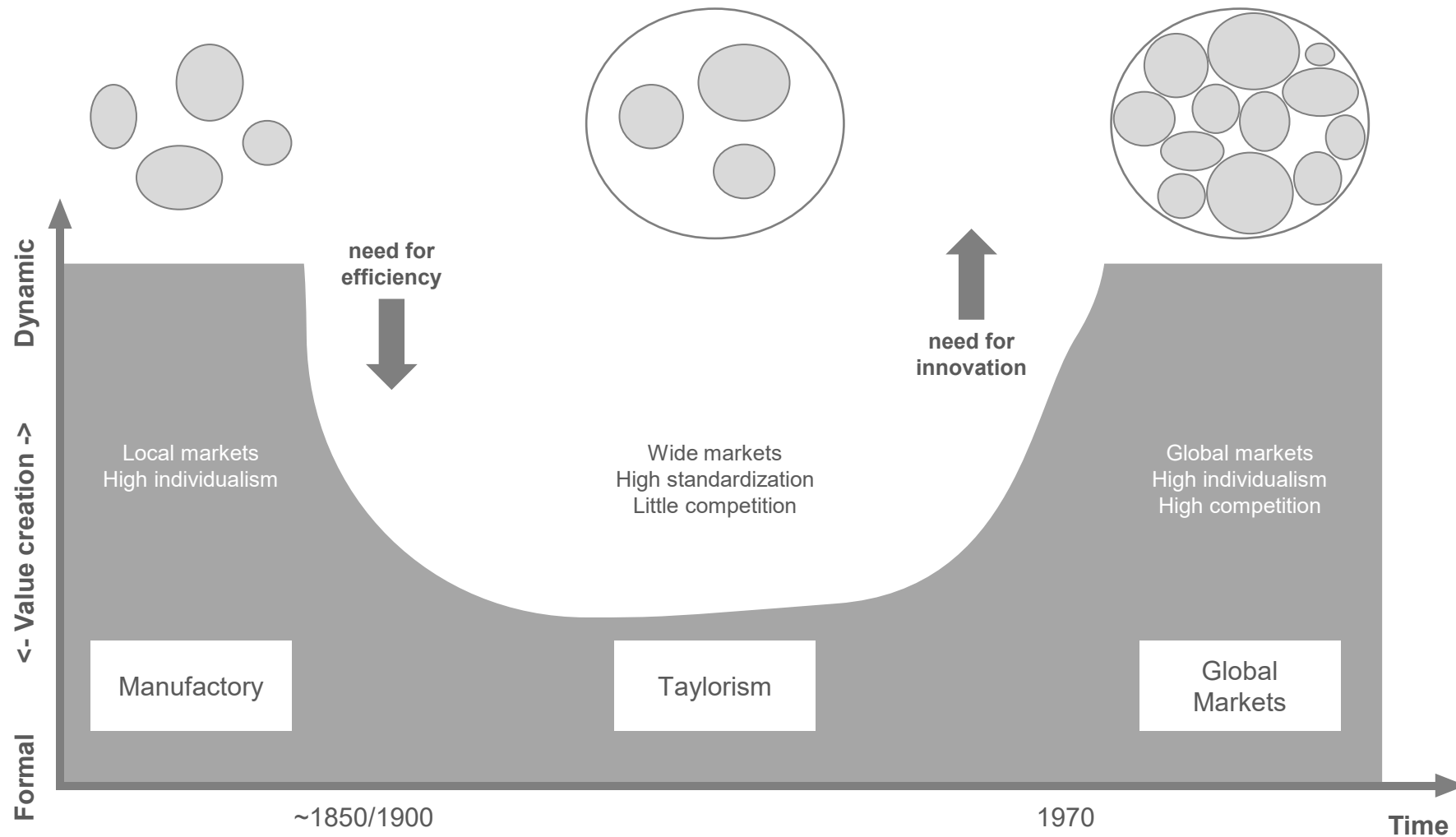
4 Values  
12 Principles



Frameworks  
Tools  
Methodologies

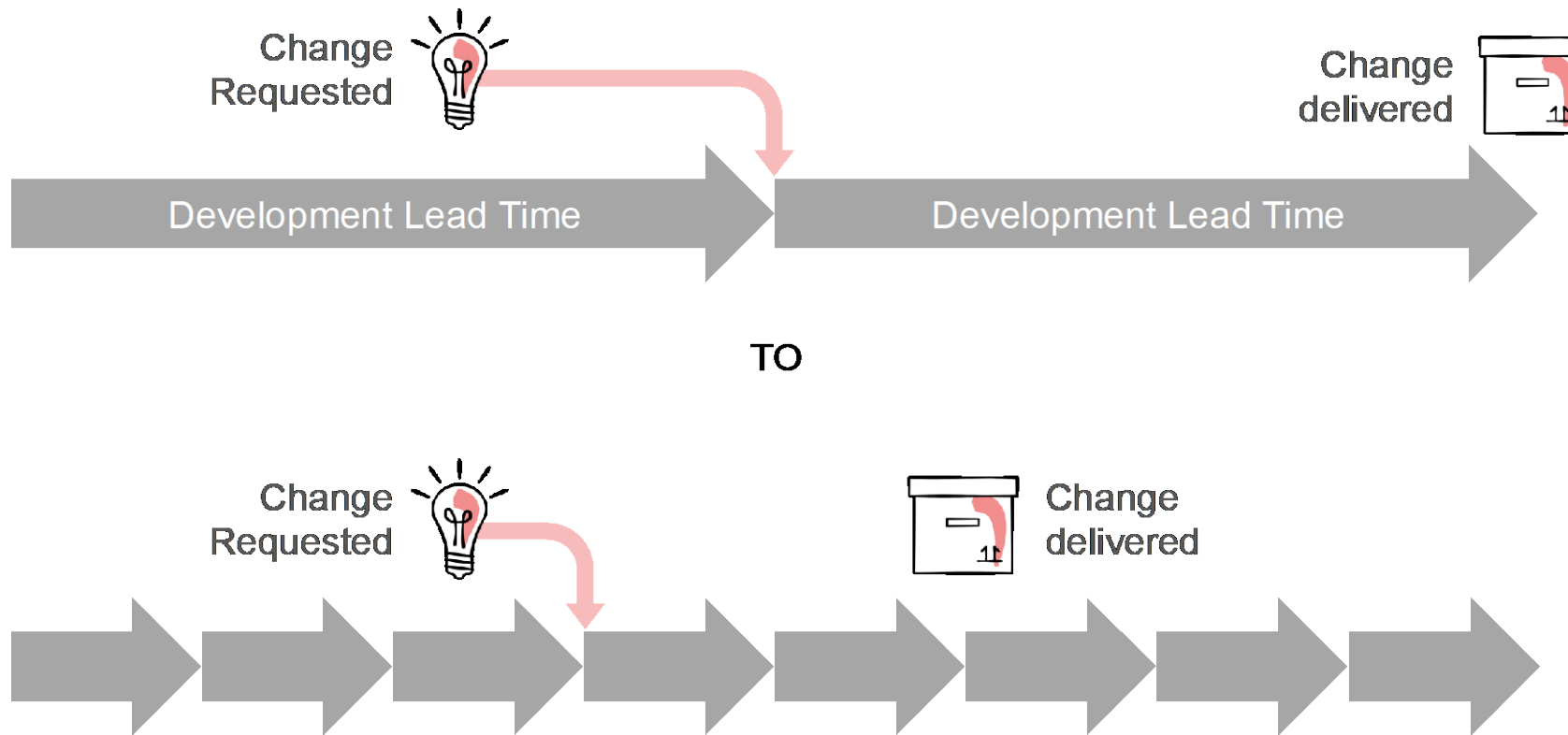
The real challenge is to **BE** Agile rather than **DOING** Agile

# Why agile? – Taylor Tub

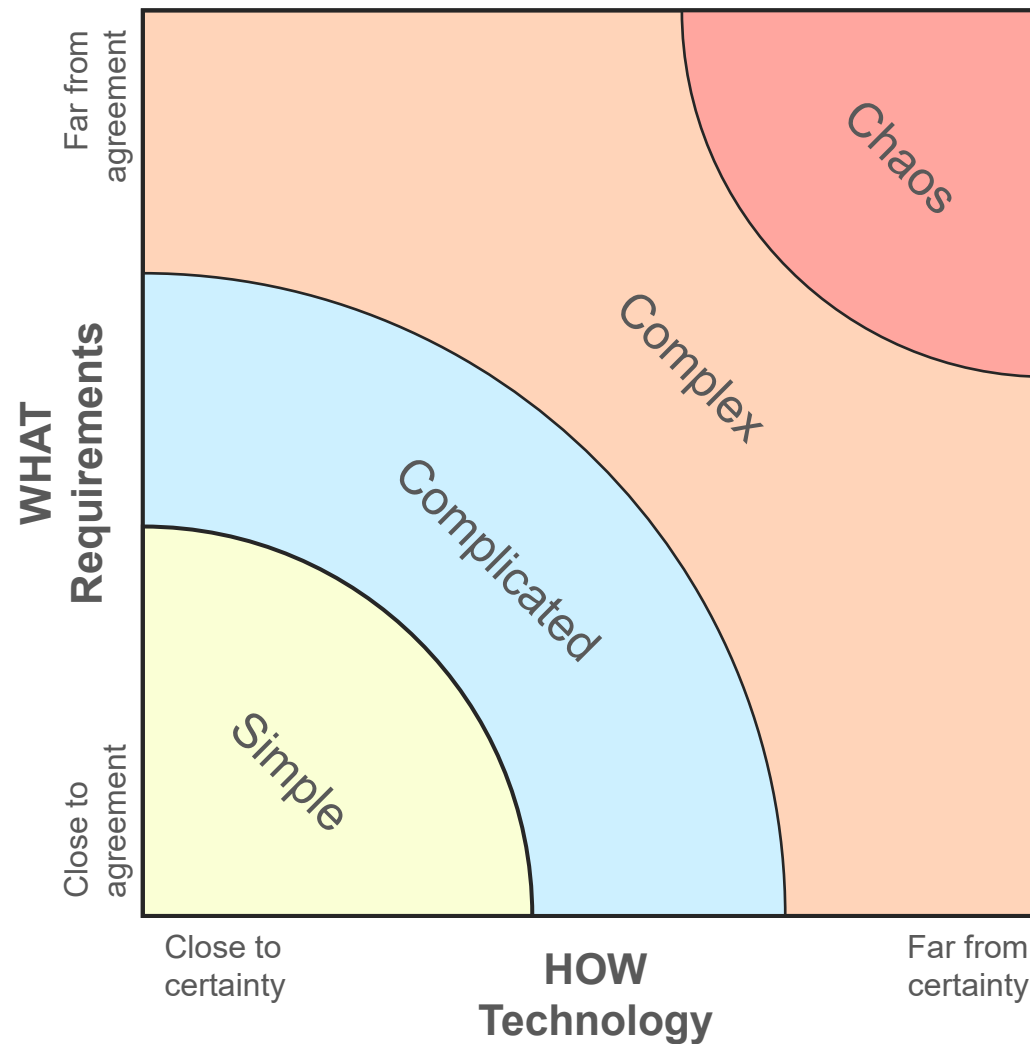




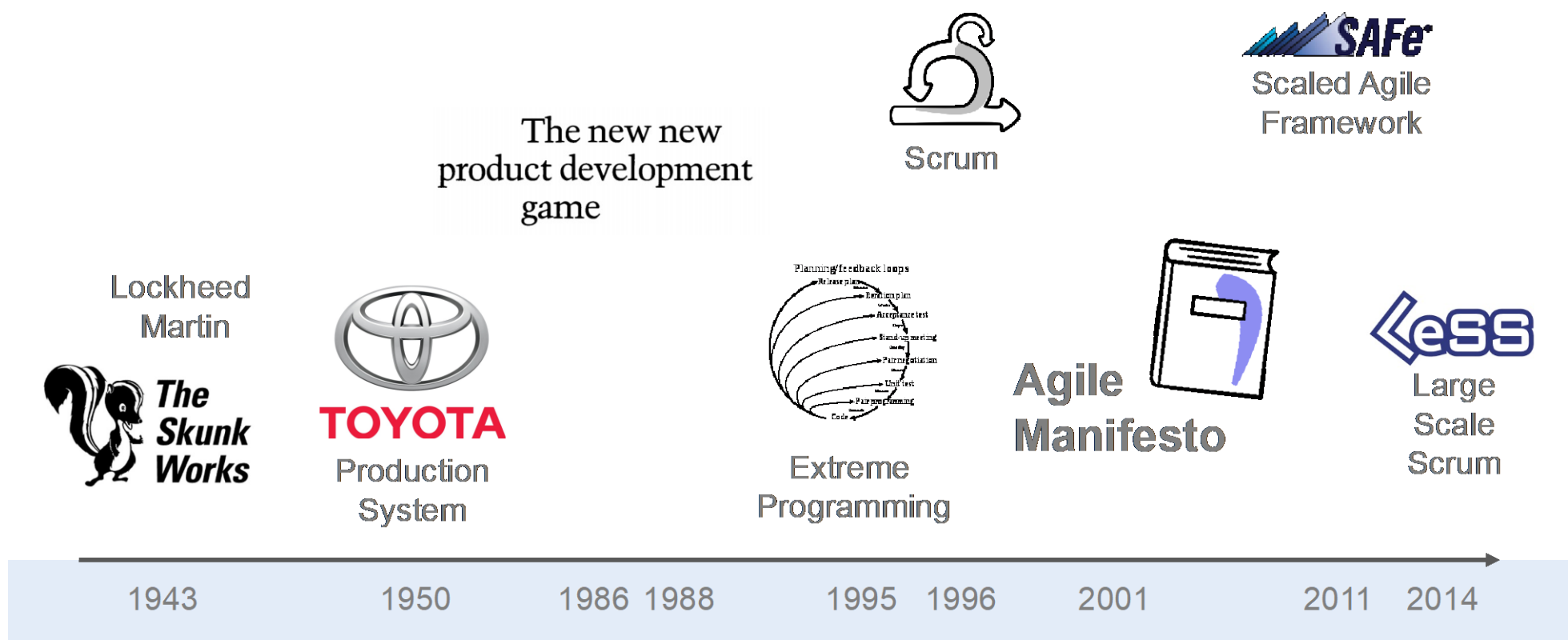
# Why agile? – Fast reaction to changes



# Why agile? – Stacey Matrix



# Roots of Agile



# 02

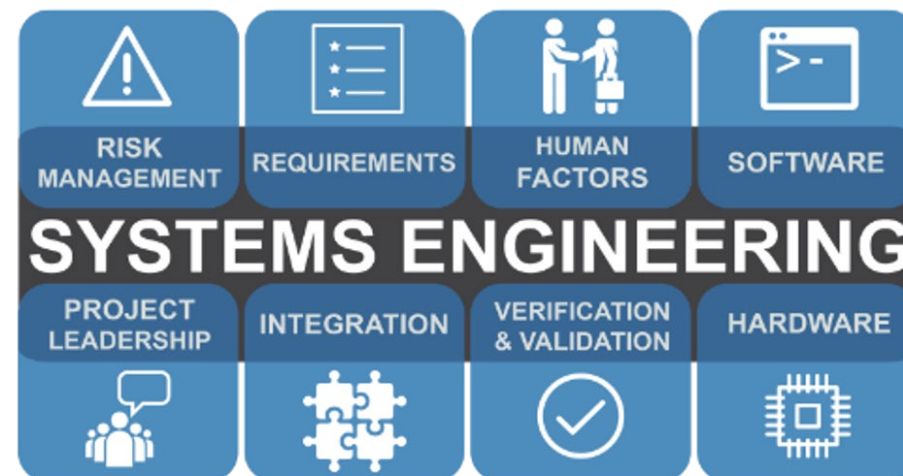


## What is Systems Engineering?

# What is Systems Engineering?

Systems Engineering is a **transdisciplinary** and **integrative** approach to enable the successful **realization, use, and retirement** of engineering systems, using **systems principles and concepts**, and **scientific, technological, and management methods**.

[INCOSE.org]



# Example – Space Systems Engineering



## Space engineering

System engineering general requirements

- Phase 0 – Mission Analysis/Needs Identification
- Phase A – Feasibility
- Phase B – Preliminary Definition
- Phase C – Detailed Definition
- Phase D – Qualification and Production
- Phase E – Operations/Utilization
- Phase F – Disposal



- Pre-Phase A – Concept Studies
- Phase A – Concept & Technology Development
- Phase B – Preliminary Design & Technology Completion
- Phase C – Final Design and Fabrication
- Phase D – System Assembly, Integration, Test, Launch
- Phase E – Operations & Sustainment
- Phase F – Closeout

# 03



## **Agile vs. Systems Engineering - Comparing Apples and Oranges**

## Manifesto for Agile Software Development

We are uncovering better ways of developing software by doing it and helping others do it. Through this work we have come to value:

Individuals and interactions over processes and tools  
Working software over comprehensive documentation  
Customer collaboration over contract negotiation  
Responding to change over following a plan

That is, while there is value in the items on the right, we value the items on the left more.

Kent Beck	James Grenning	Robert C. Martin
Mike Beedle	Jim Highsmith	Steve Mellor
Arie van Bennekum	Andrew Hunt	Ken Schwaber
Alistair Cockburn	Ron Jeffries	Jeff Sutherland
Ward Cunningham	Jon Kern	Dave Thomas
Martin Fowler	Brian Marick	

[[agilemanifesto.org](http://agilemanifesto.org)]

### SE Research Consortium

## NASA Systems Engineering Principles

Systems engineering postulates form the basis of the principles of systems engineering. Principles are accepted truths which apply throughout the discipline. These truths serve as a guide to the application of systems engineering.

Reference Section 3.2 in [nasa\\_tp\\_20205003644\\_interactive2.pdf](#)

- Principle 1: Systems engineering integrates the system and the disciplines considering the budget and schedule constraints.
- Principle 2: Complex systems build complex systems.
- Principle 3: A focus of systems engineering during the development phase is a progressively deeper understanding of the interactions, sensitivities, and behaviors of the system, stakeholder needs, and its operational environment.
  - Sub-Principle 3(a): Mission context is defined based on the understanding of the stakeholder needs and constraints.
  - Sub-Principle 3(b): Requirements and models reflect the understanding of the system.
  - Sub-Principle 3(c): Requirements are specific, agreed-to preferences by the developing organization.
  - Sub-Principle 3(d): Requirements and design are progressively elaborated as the development progresses.
  - Sub-Principle 3(e): Hierarchical structures are not sufficient to fully model system interactions and couplings.
  - Sub-Principle 3(f): A Product Breakdown Structure (PBS) provides a structure to integrate cost and schedule with system functions.
  - Sub-Principle 3(g): As the system progresses through development, a deeper understanding of the organizational relationships needed to develop the system are gained.
  - Sub-Principle 3(h): Systems engineering achieves an understanding of the system's value to the system stakeholders.
  - Sub-Principle 3(i): Systems engineering seeks a best balance of functions and interactions within the system budget, schedule, technical, and other expectations and constraints.
- Principle 4: Systems engineering has a critical role through the entire system lifecycle.
  - Sub-Principle 4(a): Systems engineering obtains an understanding of the system.
  - Sub-Principle 4(b): Systems engineering defines the mission context (system application).
  - Sub-Principle 4(c): Systems engineering models the system.
  - Sub-Principle 4(d): Systems engineering designs and analyzes the system.
  - Sub-Principle 4(e): Systems engineering tests the system.
  - Sub-Principle 4(f): Systems engineering has an essential role in the assembly and manufacturing of the system.
  - Sub-Principle 4(g): Systems engineering has an essential role during operations, maintenance, and decommissioning.
- Principle 5: Systems engineering is based on a middle range set of theories.
  - Sub-Principle 5(a): Systems engineering has a physical/logical basis specific to the system.
  - Sub-Principle 5(b): Systems engineering has a mathematical basis.
  - Sub-Principle 5(c): Systems engineering has a sociological basis specific to the organization(s).
- Principle 6: Systems engineering maps and manages the discipline interactions within the organization.
- Principle 7: Decision quality depends on the system knowledge present in the decision making process.
- Principle 8: Both policy and law must be properly understood to not overly constrain or under constrain the system implementation.
- Principle 9: Systems engineering decisions are made under uncertainty, accounting for risk.
- Principle 10: Verification is a demonstrated understanding of all the system functions and interactions in the operational environment.
- Principle 11: Validation is a demonstrated understanding of the system's value to the system stakeholders.
- Principle 12: Systems engineering solutions are constrained based on the decision timeframe for the system need.
- Principle 13: Stakeholder expectations change with advancement in technology and understanding of system application.
- Principle 14: The real physical system is the only perfect representation of the system.

[[www.nasa.gov/consortium/SystemsEngineeringPrinciples](http://www.nasa.gov/consortium/SystemsEngineeringPrinciples)]



## AGILE PRINCIPLE 1

Our highest priority is to **satisfy** the **customer** through early and continuous delivery of valuable software.

## SYSTEMS ENGINEERING PRINCIPLE 3

A focus of systems engineering during the development phase is a progressively deeper **understanding** of the interactions, sensitivities, and behaviors of the **system**, **stakeholder needs**, and its operational environment.

**The customer as one stakeholder is in central focus of the development of the product in both viewpoints.**

## **AGILE PRINCIPLE 2**

Welcome **changing requirements**, even late in development. Agile processes harness change for the customer's competitive advantage.

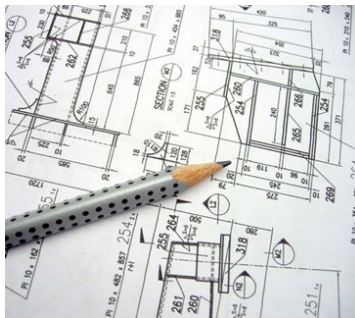
## **SYSTEMS ENGINEERING PRINCIPLE 13**

**Stakeholder expectations change** with advancement in technology and understanding of system application.

**Changing requirements is part of the system evolution.**

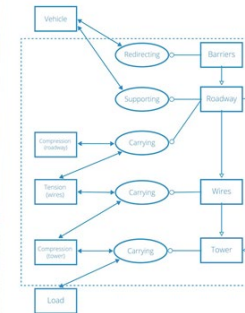
## AGILE PRINCIPLE 9

Continuous attention to **technical excellence** and **good design** enhances agility.



## SYSTEMS ENGINEERING PRINCIPLE 7

Decision quality depends on the **system knowledge** present in the decision-making process.



Thrive for excellence and good decision by design.

## **AGILE PRINCIPLE 10**

**Simplicity** - the art of maximizing the amount of work not done - is essential.

## **SYSTEMS ENGINEERING PRINCIPLE 2**

**Complex** systems build **complex** systems.

**The main driver of useless complexity is the complexity of the organisation, who is building the system.**

**[inspired by Conways Law]**

**Use Conways Law instead of being haunted by it!**

## AGILE PRINCIPLE 3

Deliver **working software solutions frequently**, from a couple of weeks to a couple of months, with a preference to the shorter timescale.

## AGILE PRINCIPLE 7

**Working software solution** is the primary measure of **progress**.

## AGILE PRINCIPLE 8

Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a **constant pace** indefinitely.

## SYSTEMS ENGINEERING

Systems Engineering methods do **not** define the **time-frame** or **cycle** of development as this is to be defined by the used development process (e.g., agile).

BUT they do provide the definition of **working solution**.

**Systems Engineering provides the definition of the working solution and thus enables agile methods.**

## AGILE PRINCIPLE 4

Business people and developers must **work together daily** throughout the project.

## AGILE PRINCIPLE 6

The most efficient and effective method of conveying information to and within a development team is **face-to-face conversation**.

## SYSTEMS ENGINEERING

Systems Engineering does emphasize the **interdisciplinary collaboration** and **communication tasks** of systems engineers.

**Communicate, communicate,  
communicate...**

# 04



## **Better Agile with Systems Engineering!**

## „TWEAK“ THE AGILE MANIFESTO VALUES

**Individuals and interactions** over processes and tools

**Working software solutions** over comprehensive documentation

**Customer collaboration** over contract negotiation

**Responding to change** over following a plan

## FOUNDATION OF COMPLEX SYSTEMS ENGINEERING

**Multifunctional teams** over engineering silos

**Focus on purpose** over focus on requirements

**Empowered teams** over tasked individuals

**Early learning** over late failures

„Agile Systems Engineering Manifesto“  
[[agile-systems-engineering.com](http://agile-systems-engineering.com)]





Agile as development leadership mindset focusing on how the Organization is shaped and how the team operates and interacts.



Systems Engineering as engineering discipline is focusing on what is to be developed and what are the outcomes / products to be delivered to achieve the working solution.



Neither Systems Engineering nor Agile dictate one or the other process model.

**WE WILL NEED AGILE SYSTEMS ENGINEERING**

**to develop complex systems in a rapid moving environment.**



## Who we are – Working Group Agile SE at GfSE

# Who we are – Working Group Agile SE at GfSE

**Kurzvorstellung Dirk Stüker**

**Motivation zur Mitarbeit Agile SE:**  
Eigenes Engineering lernen  
Brand Automotive

**Privates:** 47 Jahre, verheiratet, 3 Töchter, 1 Katze  
Hobbies: Jonglieren, Skifahren, Smart Home, Lego-Roboter, Rasp...

**Beruflicher Werdegang:**  
-2000: Informatik, Oldenburg – 2 terms Computer Science Exeter  
2000-2003 Dissertation: Sensordatenfusion (Radar, Kamera, Lidar)  
2003-2010 Volkswagen Forschung Fahrerassistenz und hochautomatisiertes Fahren  
2010-2015 Volkswagen ADAS Architektur und Vorentwicklung  
2015-2018 WABCO, ADAS Chief Engineer, Nutzfahrzeuge (Radar, 2018-2020 Volkswagen ADAS Architecture, Automated Driving and 2020-... Car-Software-Organisation, Systems Engineer

**Qualifikationen:**  
Certified Scrummaster, Certified Tester, Certified Requirements E...

**Jürgen Rambo**

Es geht mir darum ...  
**(sich) gemeinsam besser zu entwickeln**

**Privates:** 49 Jahre, verheiratet, 2 Kinder  
Hobbies: Joggen, Segeln, Wattenmeerschut

**Beruflicher Werdegang:**  
Studium Informatik mit Nebenfach Medizin  
Entwicklung Anästhesiegeräte bei Dräger Meuzmeccinix  
seit 2001 Berater, Trainer bei oose  
seit 2001 Mitglied OMG und Entwicklung von Standards UML, SysML, BPMN, ...  
2010-2012 Geschäftsführer von oose

**Kurzvorstellung Alexander Neng**

**Motivation zur Mitarbeit Agile SE:**  
Komplexe Systeme zu erschaffen erfordert bei der Umsetzung sondern auch einer sich ändernden Umgebungsvariablen, einen Austausch (erleben) welche „Go“

**Branche:**  
Medizin, Automotive, Industrie

**Privates:** 40 Jahre, verheiratet, zwei Kids, Wohnhaft in  
Hobbies: Triathlon, Bergsteigen (Sommer und

**Kurzvorstellung Thaddäus Dorsch**

**Motivation zur Mitarbeit Agile SE:**  
Agilität + SE = mehr als die Summe.

**Branche:**  
Beratung und Training, vor allem Automotive, Biotech, Telekom

**Privates:** wohnt in Landsberg am Lech (60 km westl. von München), 54 Jahre, verheiratet, 1 Tochter (15 J.), 1 (Stief)Sohn (30 J.)  
**Hobbies:** zeitgenössische klassische Komposition, Singen, Bratsche, Wandern, Fußball, Ski, Rad

**Beruflicher Werdegang:**  
1995 Elektrotechnik TU München, Fachrichtung Nachrichtentechnik  
2005 Promotion FAU Erlangen-Nürnberg Digitale Datenübertragung und Informationstheorie  
2005 - 2014: DLK, Audere, ACT, Airbus Defense, Robote & Schwarz  
seit 2015: HOOD GmbH als Berater und Trainer für SE, RE und Agilität mit Projekten u.a. bei BMW, Bosch, Sartorius

**Qualifikationen:** Certified CSEP (2013), IREB Requirements Engineer, IREB Requirements Manager, Scrum Master, SAFe Agile, Lehrbeauftragter TH Rosenheim

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Xing: [https://www.xing.com/profile/Thaddaeus\\_Dorsch/](https://www.xing.com/profile/Thaddaeus_Dorsch/)  
Agile Hardware and Systems Group (International) LinkedIn  
Agile Hardware and Systems - Xing Group

**Kurzvorstellung Jasminka Matevska**

**Motivation zur Mitarbeit Agile SE:**  
Agilität ist keine Methode, sondern eine Einstellung, die wir der jüngeren Generation weiter geben sollten

**Branche:**  
Hochschulbildung  
Forschung und Entwicklung, vor allem in der Aerospace Domäne

**Privates:**  
53 Jahre, verheiratet, zwei Söhne (24 & 17), eine Katze ; )

**Qualifikationen:**  
Dipl.-Ing. der Elektrotechnik (Informations- und Automatisierungstechnik)  
Dr.-Ing. (Software Engineering), Universität Oldenburg  
ISTQB Certified Tester  
INCOSE CSEP (Certified Systems Engineering Professional)

**Beruflicher Werdegang:**  
Bis 04.2009 verschiedene Stellen (Softwareentwicklung, Netzwerkadministration, Laborbetreuung, Lehre, Forschung)  
2009 - 2016 Software und Systems Engineering, Teamleitung On-Board Software, technische Leitung und Projektleitung in der Raumfahrt (ISS, Columbus & EDRS-C)

**Kurzvorstellung Stephan Teutsch**

**Motivation zur Mitarbeit Agile SE:**  
Austausch von Erfahrungen Agilität und Systems Engineering vernetzen

**Branche:**  
Automotive, Softwareentwicklung, Qualitätsmanagement, Prozessentwicklung

**Privates:** Dipl. Physiker Univ.  
seit 2009 Prozessentwickler  
seit 2012 Qualitätsauditor  
seit 2012 Certified Systems Engineering Professional (CSEP)  
seit 2017 Provisional Assessor Automotive SPICE

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[https://www.xing.com/profile/Stephan\\_Teutsch/](https://www.xing.com/profile/Stephan_Teutsch/)

**Kurzvorstellung Eike Appel**

**Motivation zur Mitarbeit Agile SE:**  
spread the world „Agile Systems Engineering“

**Branche:**  
Automotive

**Beruflicher Werdegang:**  
Systems Engineer bei der CARAD SE im Bereich ADAS & AD  
Systemarchitekten bei der oose GmbH und Caravis GmbH für unterschiedliche Automobil  
Studium an HAW-Hamburg, Embedded SW Entwicklung

**Qualifikationen:**  
Dipl. Ing. Informations- und Elektrotechnik  
certified System Engineer Level 4

**Kontakt:**  
[eike\\_appel@caradtechnology.com](mailto:eike_appel@caradtechnology.com)  
<https://www.linkedin.com/company/carad/>

Interested?  
Drop us a line:  
**AGAgileSE@gfse.org**

- Sheppard und Young (2006) - <https://de.abcdef.wiki/wiki/Agility>
- Manifesto for Agile Software Development ([agilemanifesto.org](http://agilemanifesto.org))
- Agile Systems Engineering ([agile-systems-engineering.com](http://agile-systems-engineering.com))
- Systems Engineering Principles | NASA
- David F. McClinton: 25 Laws of Systems Engineering
- <https://www.sebokwiki.org/wiki>
- INCOSE Systems Engineering Handbook
- ISO/IEC/IEEE 15288:2015
- System and SE Definitions ([incose.org](http://incose.org))
- Melvin E. Conway: How Do Committees Invent? In: F. D. Thompson Publications, Inc. (Hrsg.): Datamation. Band 14, Nr. 5, April 1968, S. 28–31
- Matthew Skelton and Manuel Pais "Team Topologies"

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**City University of Applied Sciences**



Many thanks!

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Engineering and Management of Space Systems M.Sc.  
Informatik: Software- und Systemtechnik B.Sc.

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## Education

- **10.1987 – 06.1992** Dipl.-Ing. Electrical Engineering (Information and Automation), University of Skopje, Macedonia
- **08.2001 – 07.2009** Ph.D., Dr.-Ing. (Software Engineering, (summa cum laude), University of Oldenburg
- **since 12.2009** – ISTQB Certified Tester
- **10.2013 – 07.2014** Space Systems Engineering Qualification (SEQ), Airbus Defence and Space
- **since 04.2015** – INCOSE CSEP (Certified Systems Engineering Professional)

## Professional Experience

- **07.1992 – 04.2009** software development, network administration, responsible software engineering lab engineer, teaching, research (different positions and companies)
- **05.2009 – 02.2016** Team Lead Software Engineering, On-board Software; Software System Engineer, Systems Engineer, Technical Lead and Project Manager for the Columbus Module / International Space Station (ISS); Operations Architect for the European Data Relay Satellite (EDRS)-C at Airbus Defence and Space, Bremen
- **since March 2016** Software and Systems Engineering Professor; Head of Computer Science: Software- and System Engineering B.Sc. and Engineering and Management of Space Systems M.Sc. Study Programmes at the Bremen City University of Applied Sciences

**Private:** born 1969 in Gostivar, Macedonia, married, two sons (24 and 18), one cat ;-)