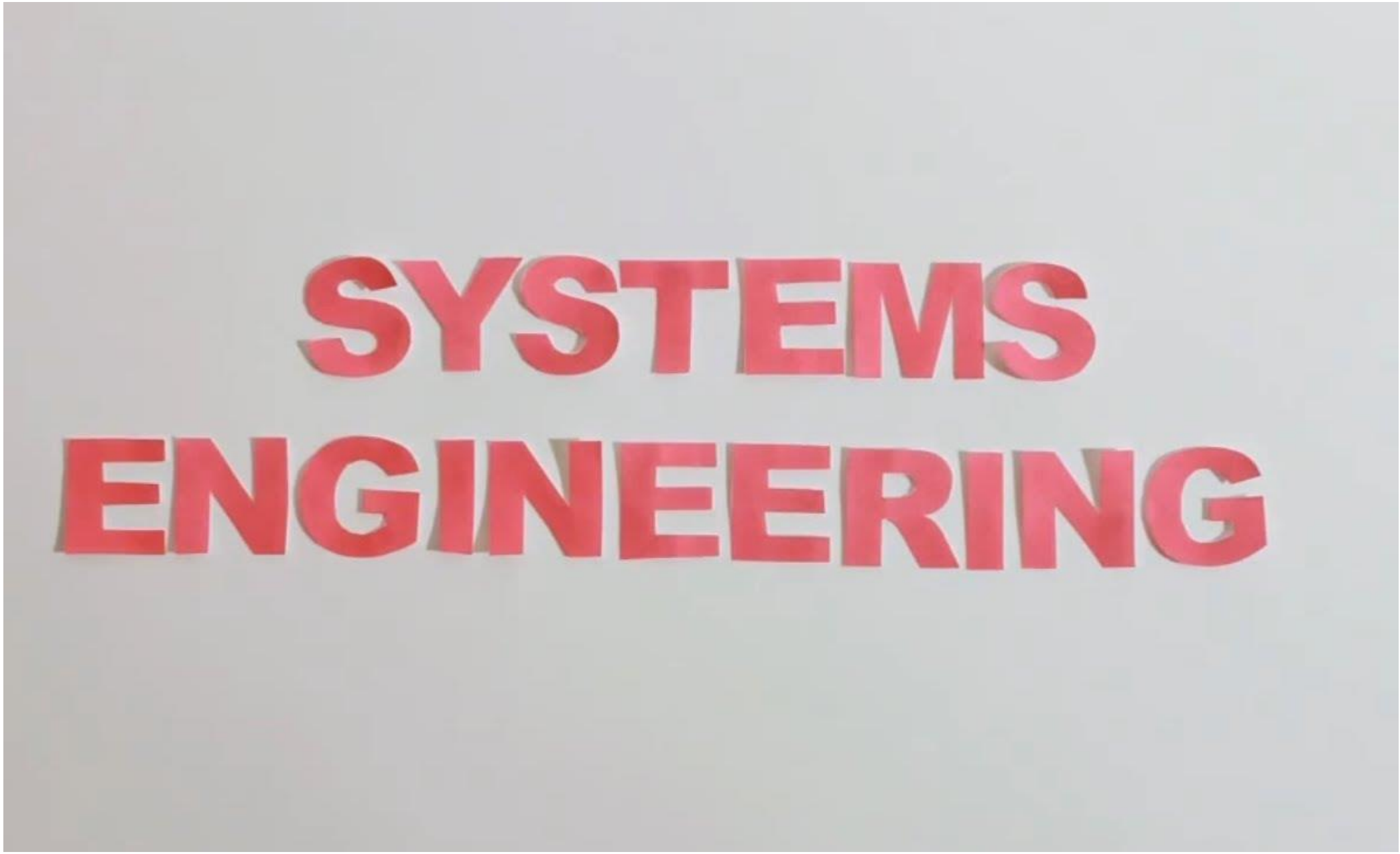
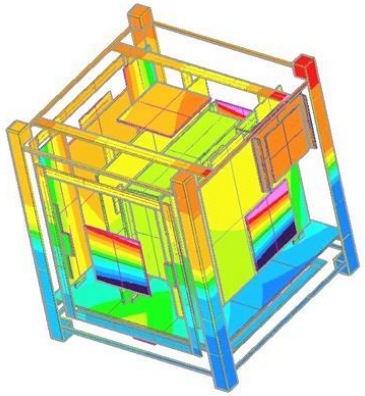
FECHAMENTO

Retrospectiva

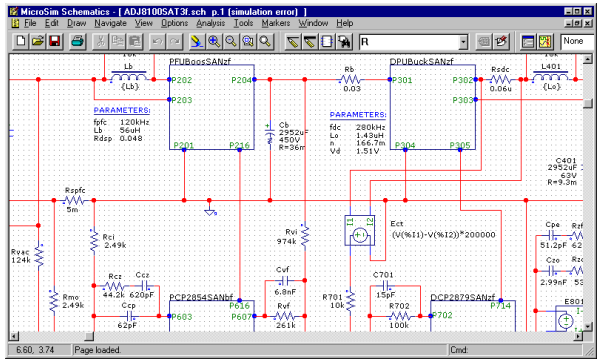

SYSTEMS
ENGINEERING

Linguagem possui uma estrutura lógica e semânticas significativas ➔ Modelo

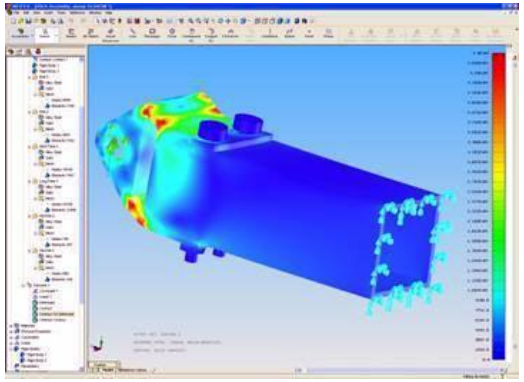
Engenharia Mecânica



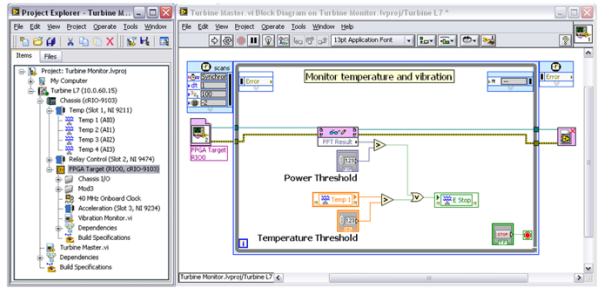
Engenharia Elétrica



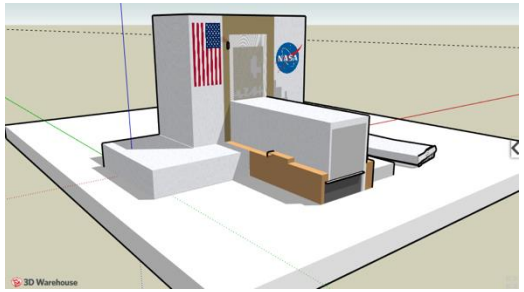
Engenharia Mecânica



Engenharia Automação

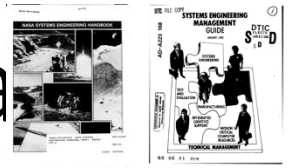


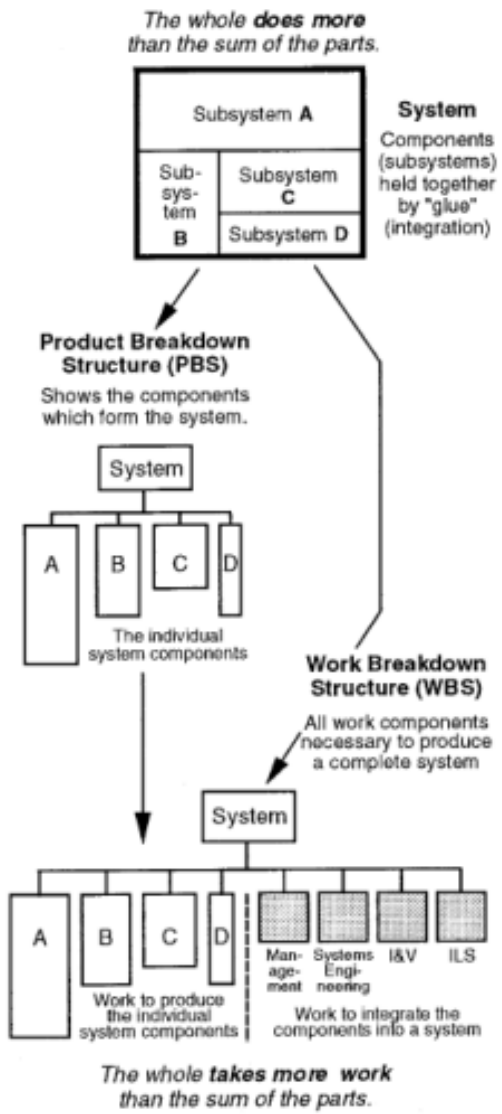
Engenharia Civil

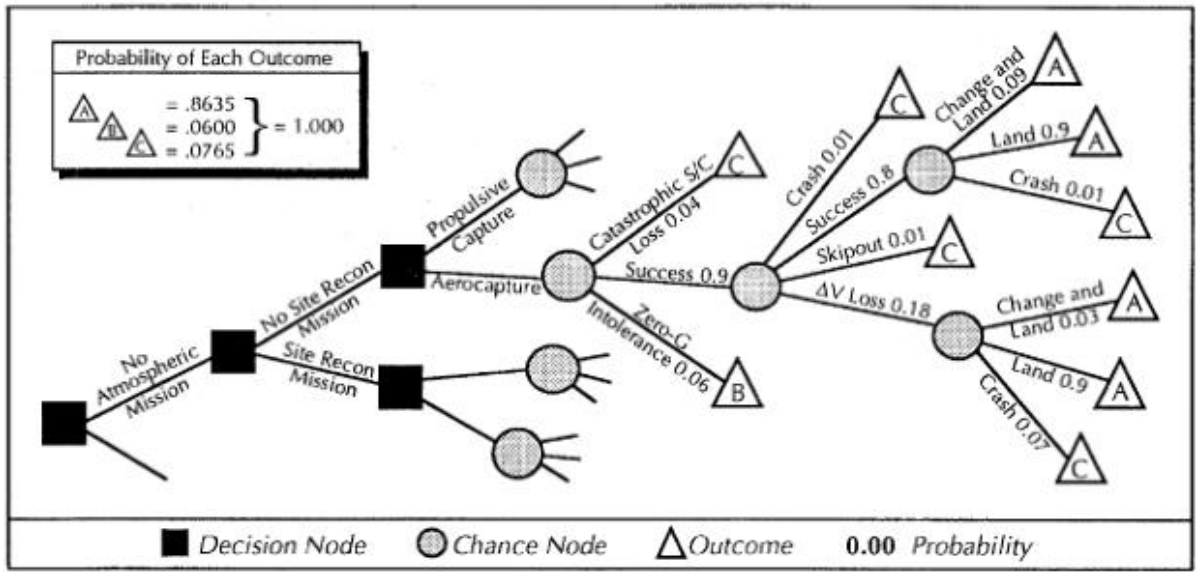


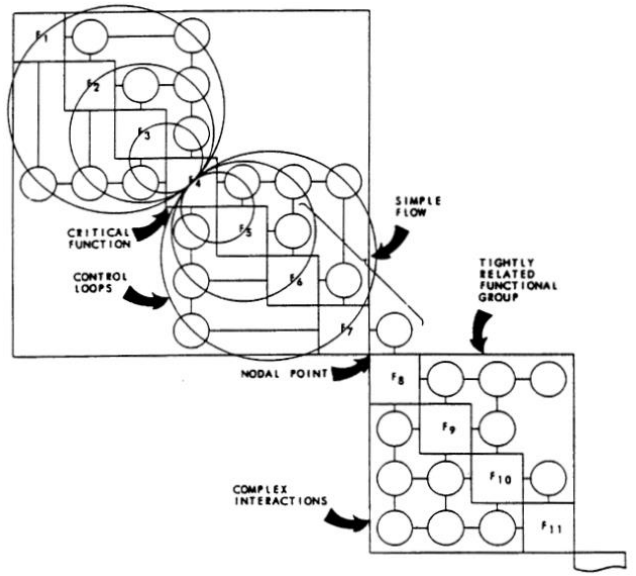
Engenharia de Sistemas

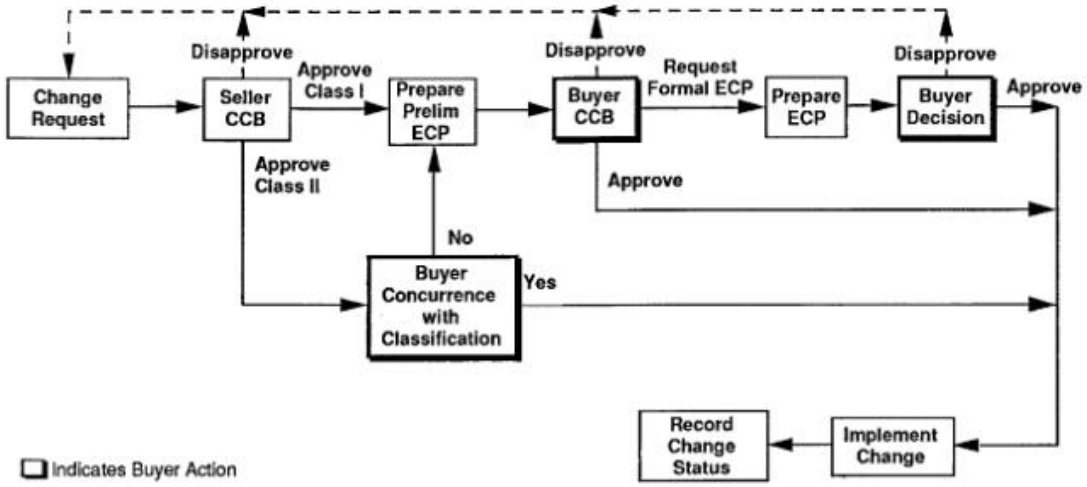
Qual a Linguagem da Engenharia de Sistema

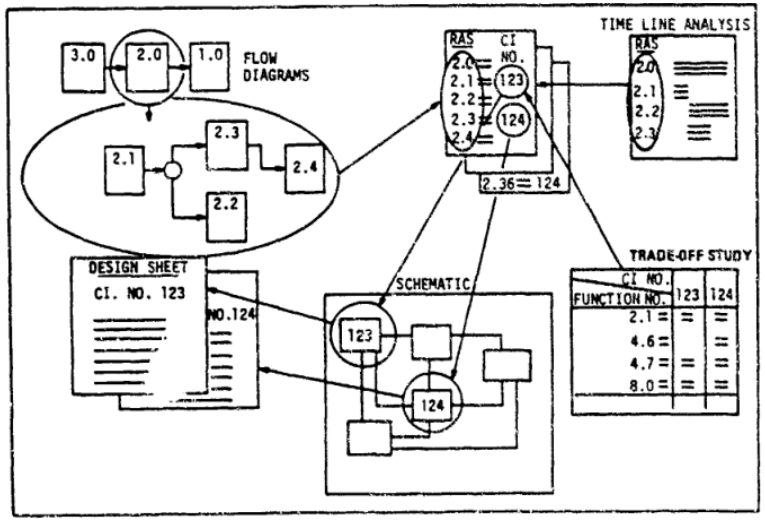




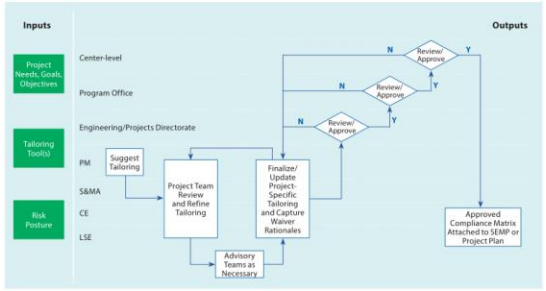


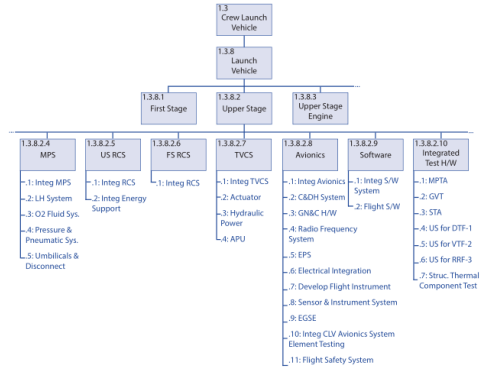


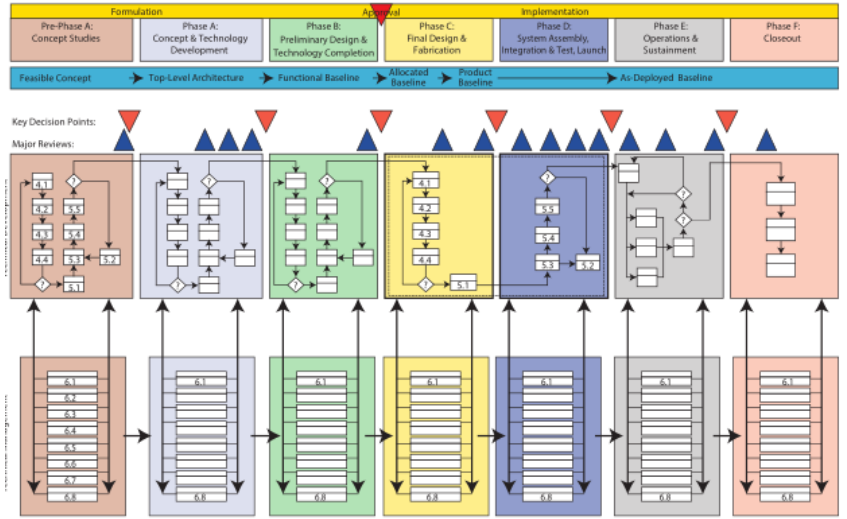


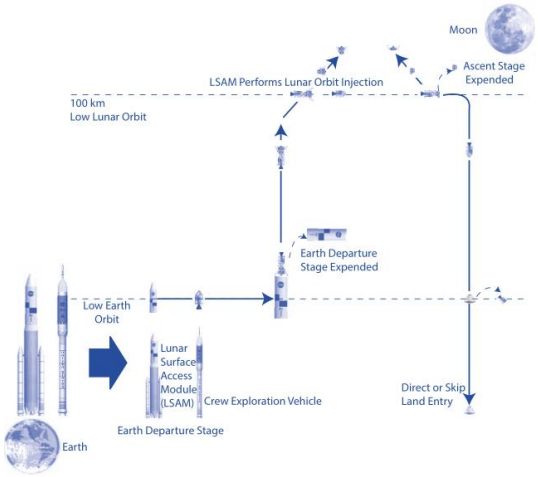


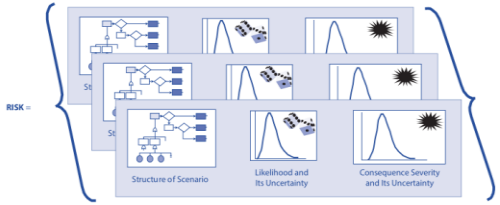
Com o tempo …
Digitalização da linguagem…











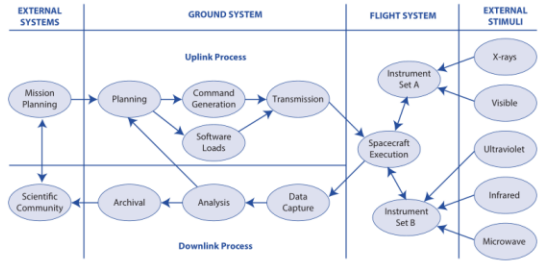


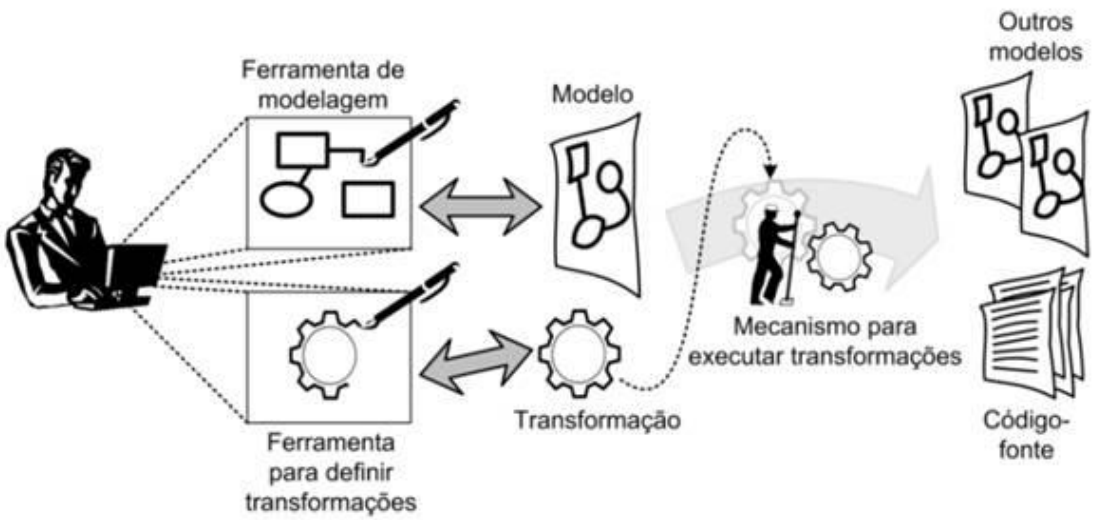
TABLE D-1 Requirements Verification Matrix

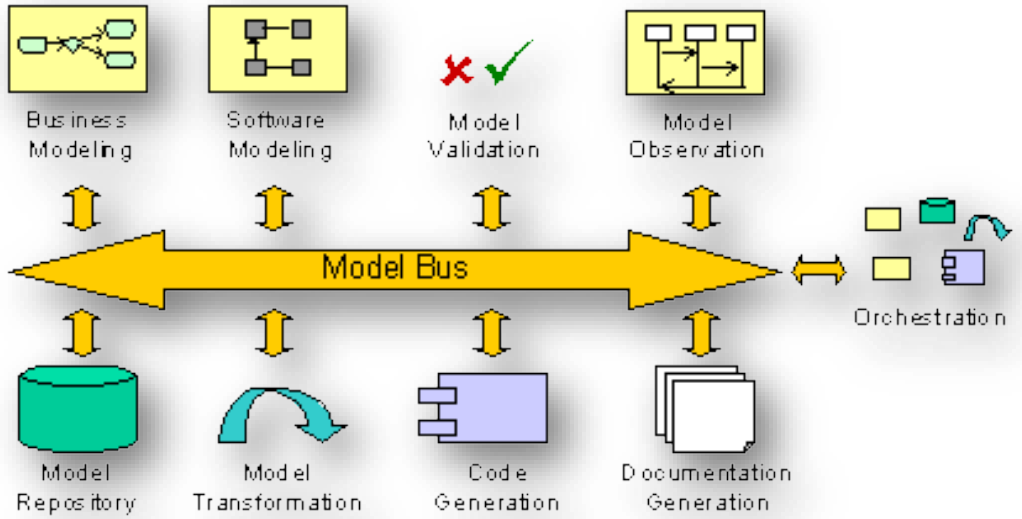
Requirement No.	Document	Paragraph	Shall Statement	Verification Success Criteria	Verification Method	Facility or Lab	Phase*	Acceptance Requirement?	Preflight Acceptance?	Performing Organization	Results
Unique identifier or each requirement	*Document number the requirement is contained within*	*Paragraph number of the requirement*	*Text (within reason) of the requirement, i.e., the "shall"*	*Success criteria for the requirement*	*Verification method for the requirement (analysis, inspection, demonstration, test)*	*Facility or laboratory used to perform the verification and validation.*	*Phase in which the verification and validation will be performed.*	*Indicate whether this requirement is also verified during initial acceptance testing of each unit.*	*Indicate whether this requirement is also verified during any pre-flight or recurring acceptance testing of each unit*	*Organization responsible for performing the verification*	*Indicate documents that contain the objective evidence that requirement was satisfied*
P-1	xxx	3.2.1.1 Capability: Support Uplinked Data (LDR)	System X shall provide a max. ground-to-station uplink of…	1. System X locks to forward link at the min and max data rate tolerances 2. System X locks to the forward link at the min and max operating frequency tolerances	Test	xxx	5	Yes	No	xxx	TPS xxxx
P-i	xxx	Other paragraphs	Other "shalls" in PTRS	Other criteria	xxx	xxx	xxx	Yes/No	Yes/No	xxx	Memo xxx
S-i or other unique designator	xxxxx (other specs, ICDs, etc.)	Other paragraphs	Other "shalls" in specs, ICDs, etc.	Other criteria	xxx	xxx	xxx	Yes/No	Yes/No	xxx	Report xxx

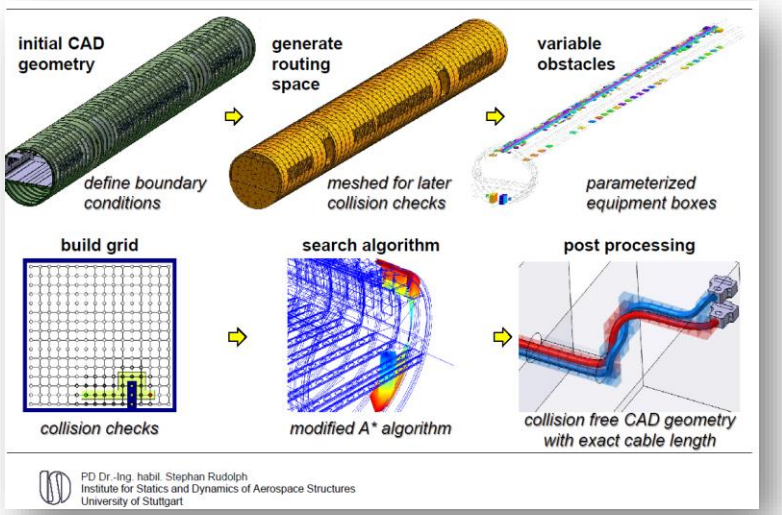
Red = Below TRL 3
Yellow = TRL 3, 4 & 5
Green = TRL 6 and above
White = Unknown
X = Exists

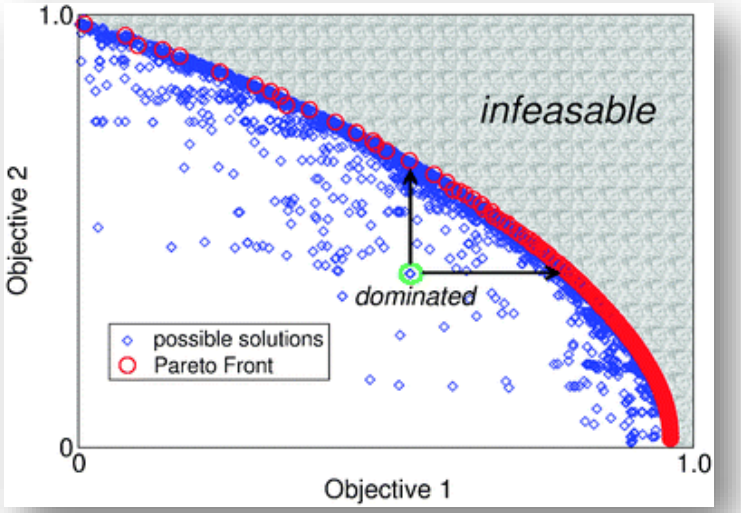
	Concept	Demonstration Units: Breadboard	Demonstration Units: Brassboard	Demonstration Units: Developmental Model	Demonstration Units: Prototype	Demonstration Units: Flight Qualified	Environment: Laboratory Environment	Environment: Relevant Environment	Environment: Space Environment	Environment: Space Launch Operation	Unit Description: Form	Unit Description: Fit	Unit Description: Function	Unit Description: Appropriatae Scale	Overall TRL
1.0 System															
1.1 Subsystem X															
1.1.1 Mechanical Components															
1.1.2 Mechanical Systems															
1.1.3 Electrical Components					X				X		X	X	X		
1.1.4 Electrical Systems															
1.1.5 Control Systems															
1.1.6 Thermal Systems							X				X	X			
1.1.7 Fluid Systems		X													
1.1.8 Optical Systems															
1.1.9 Electro-Optical Systems															
1.1.10 Software Systems															
1.1.11 Mechanisms	X														
1.1.12 Integration															
1.2 Subsystem Y															
1.2.1 Mechanical Components															

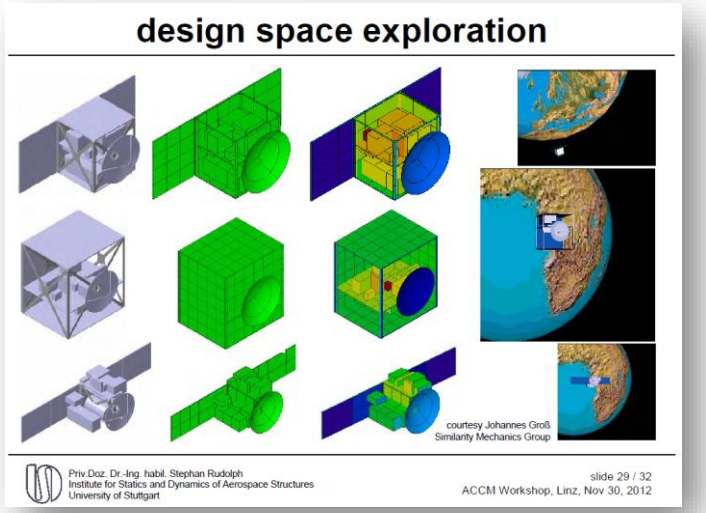
Model Driven Development



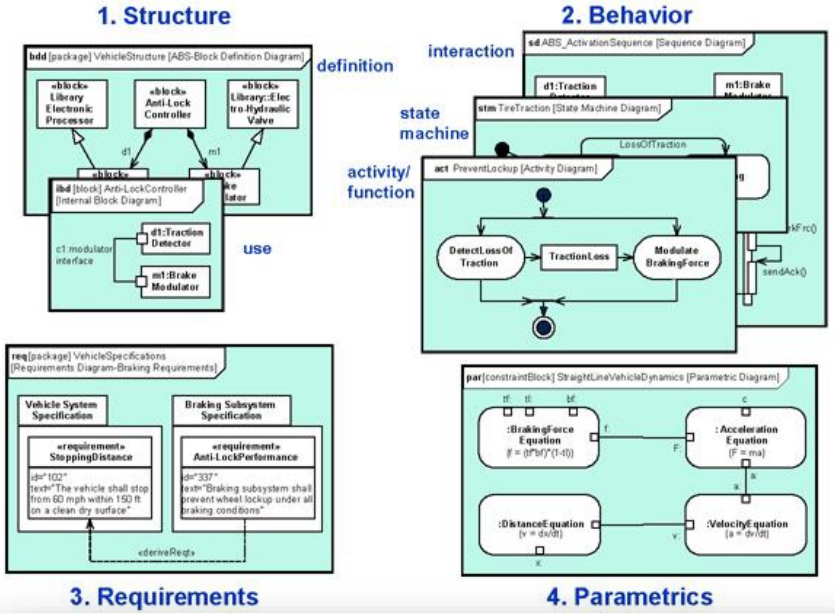


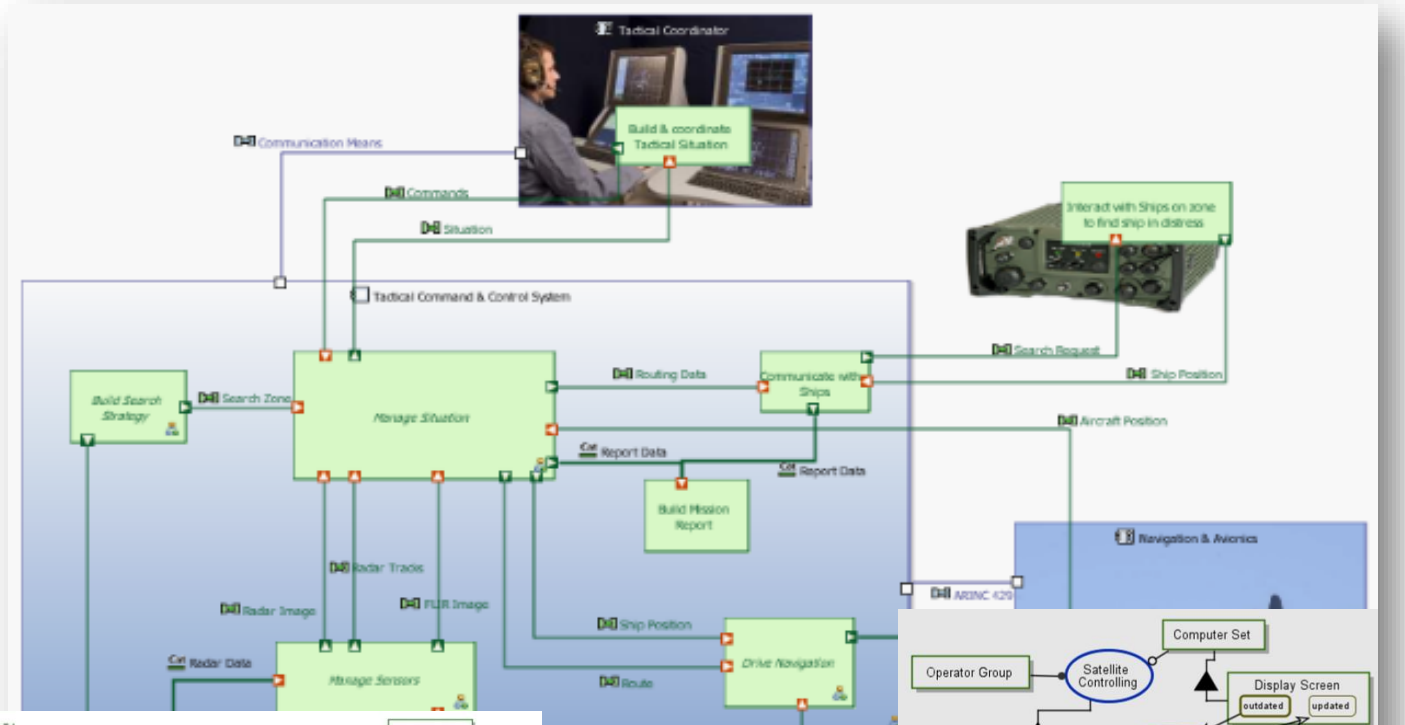


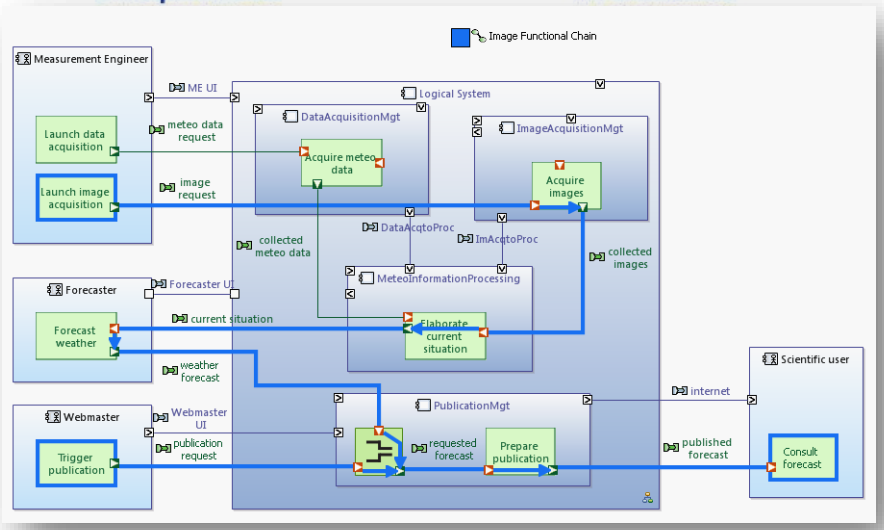


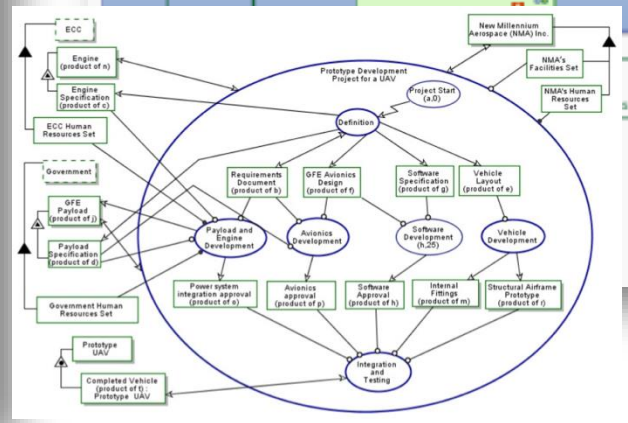


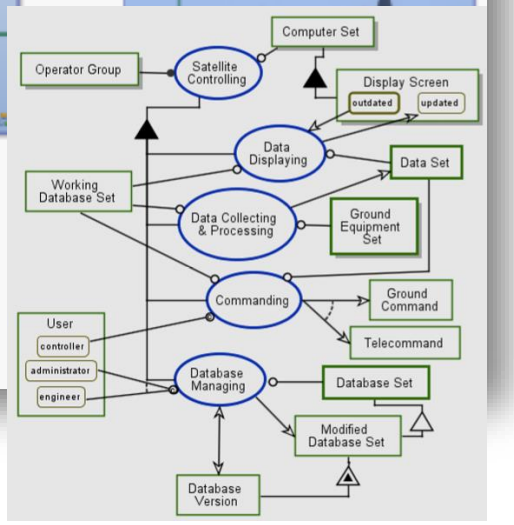
Model Based System Engineering (MBSE)

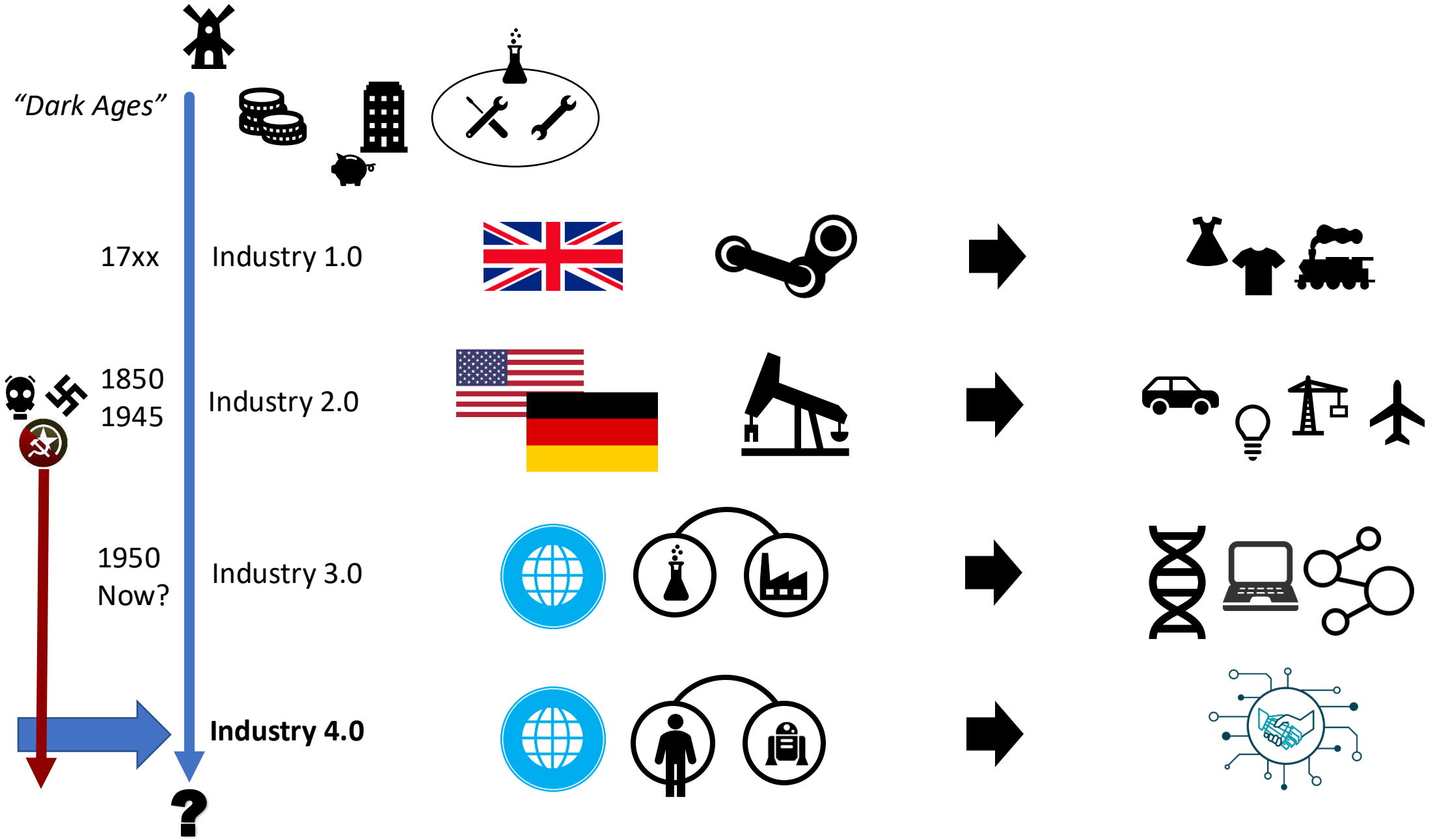











"Dark Ages"
17xx
Industry 1.0
1850
1945
Industry 2.0
1950
Now?
Industry 3.0
Industry 4.0
?

Movie: Hidden Figures (2016)
Portraits NASA's Mercury Program (~50s)

Homunculus de Penfield

Making Digital Tangible

The Battle Against the "Pixel Empire"

Digital Content EXPO 2020 Online

November 20 (Fri) 2020, 10-11 am JST

Hiroshi Ishii

MIT Media Lab
Tangible Media

@ishii_mit

ishii.mit

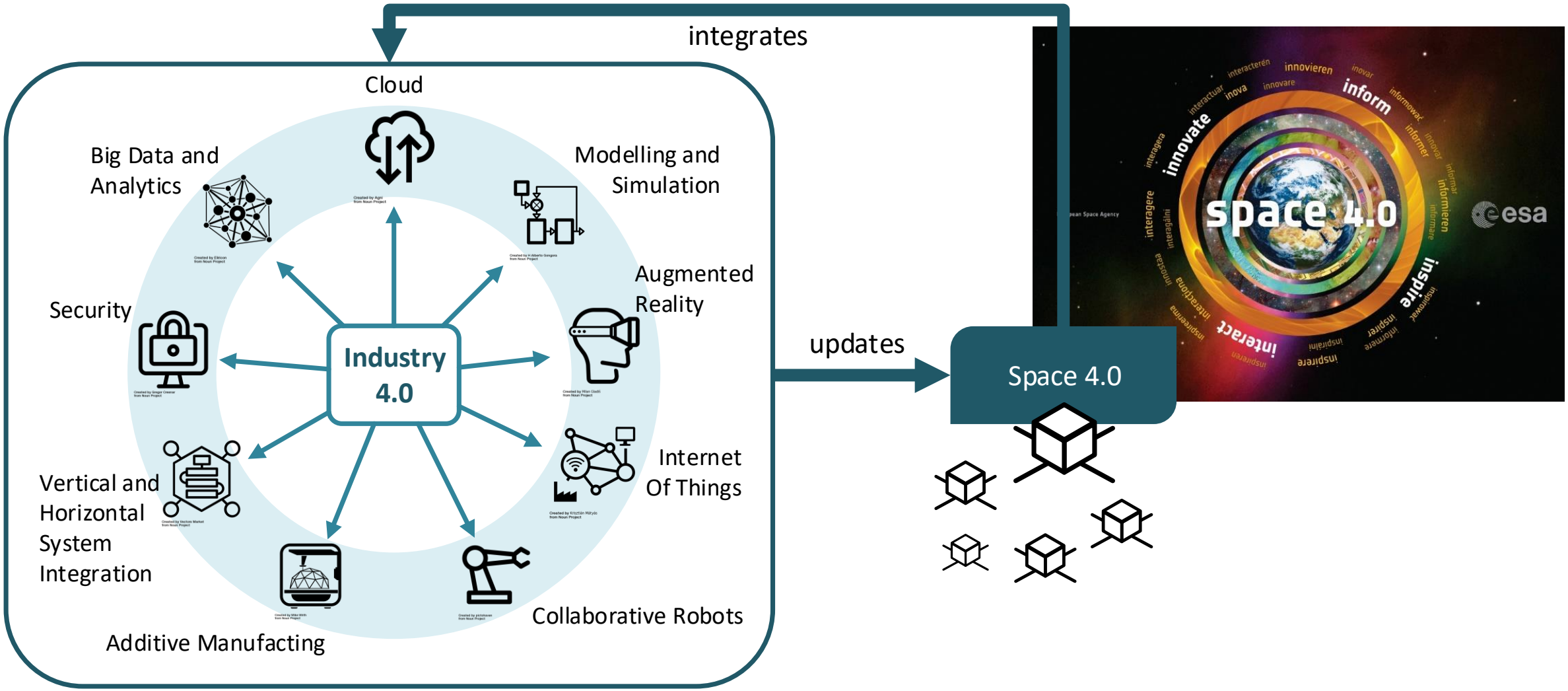
https://vimeo.com/389808503

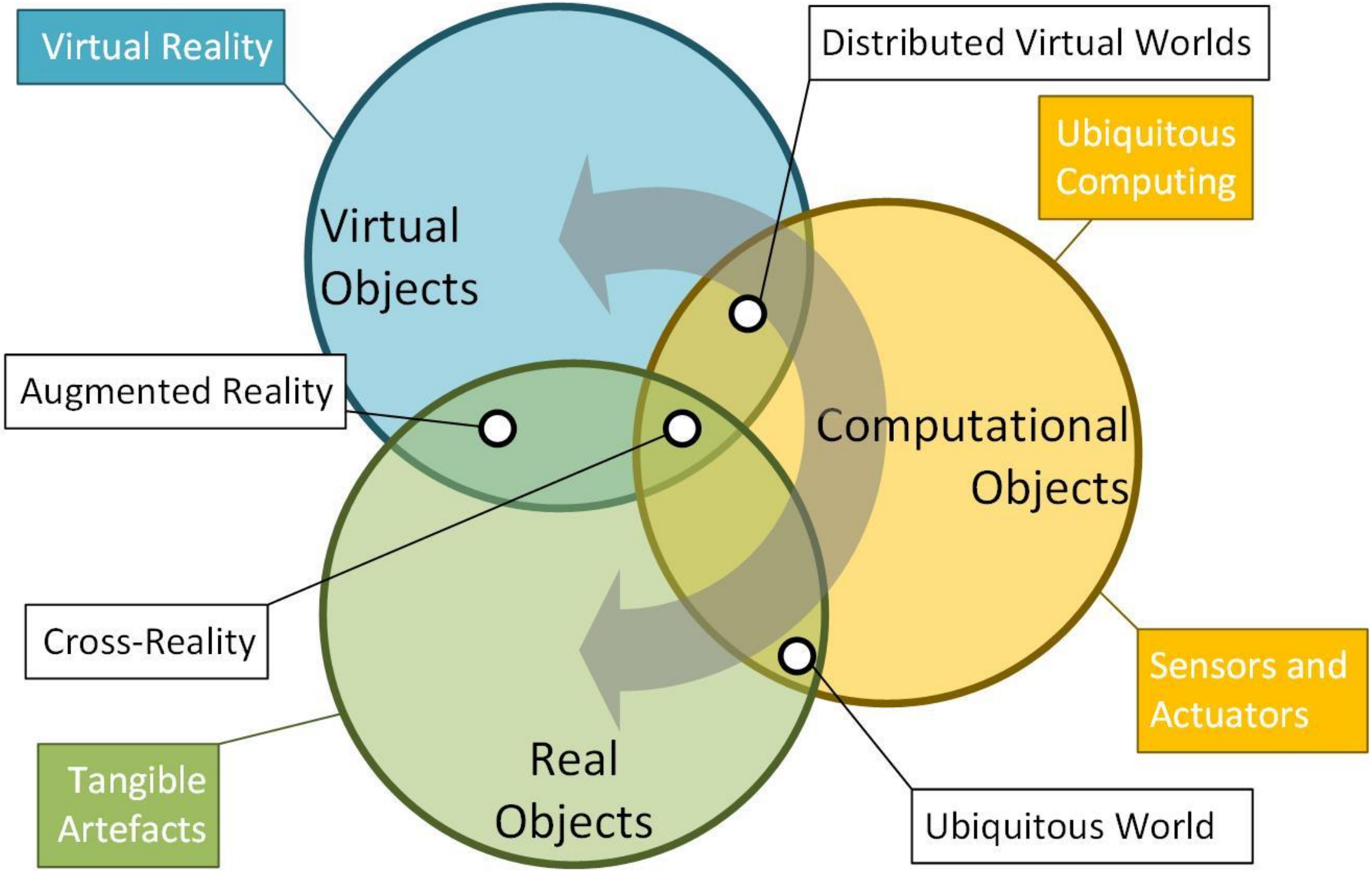
Photo courtesy of Nobukazu Kuriki

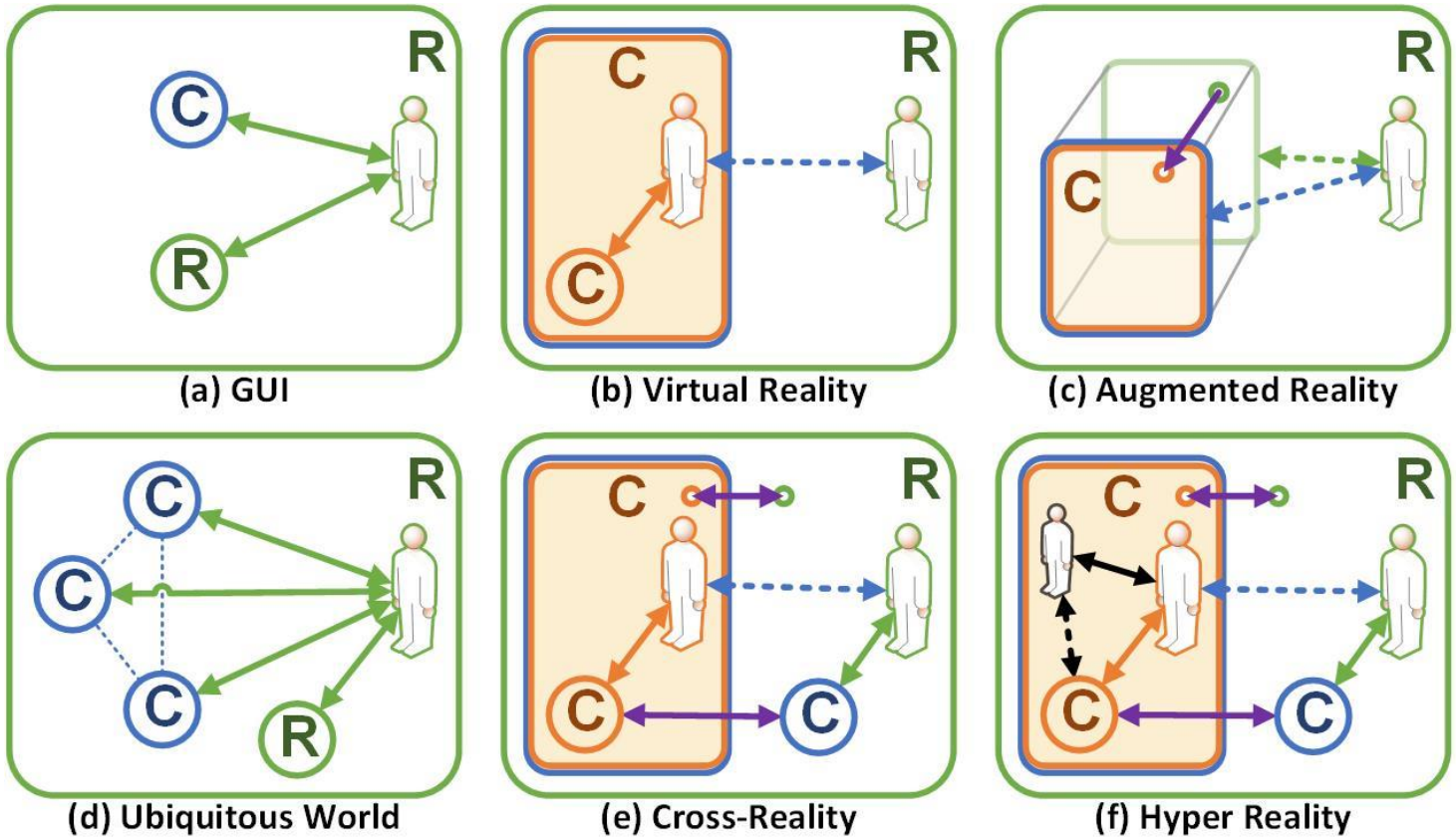
mit media lab

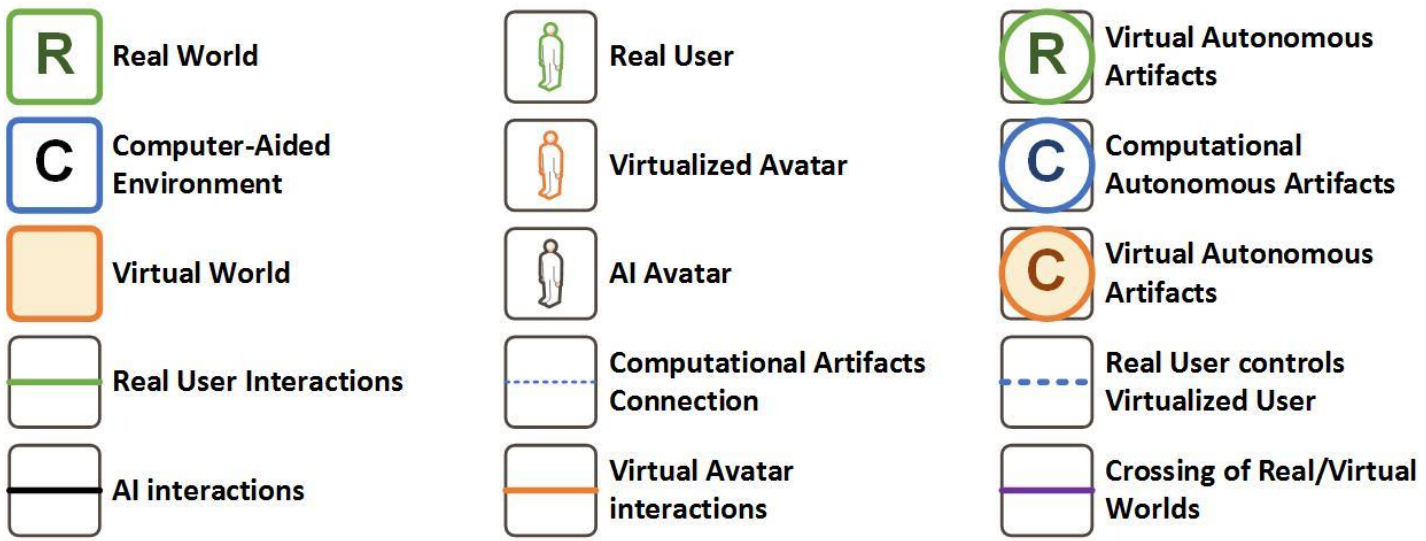
MBSE 4.0 (odeio o termo kkk)

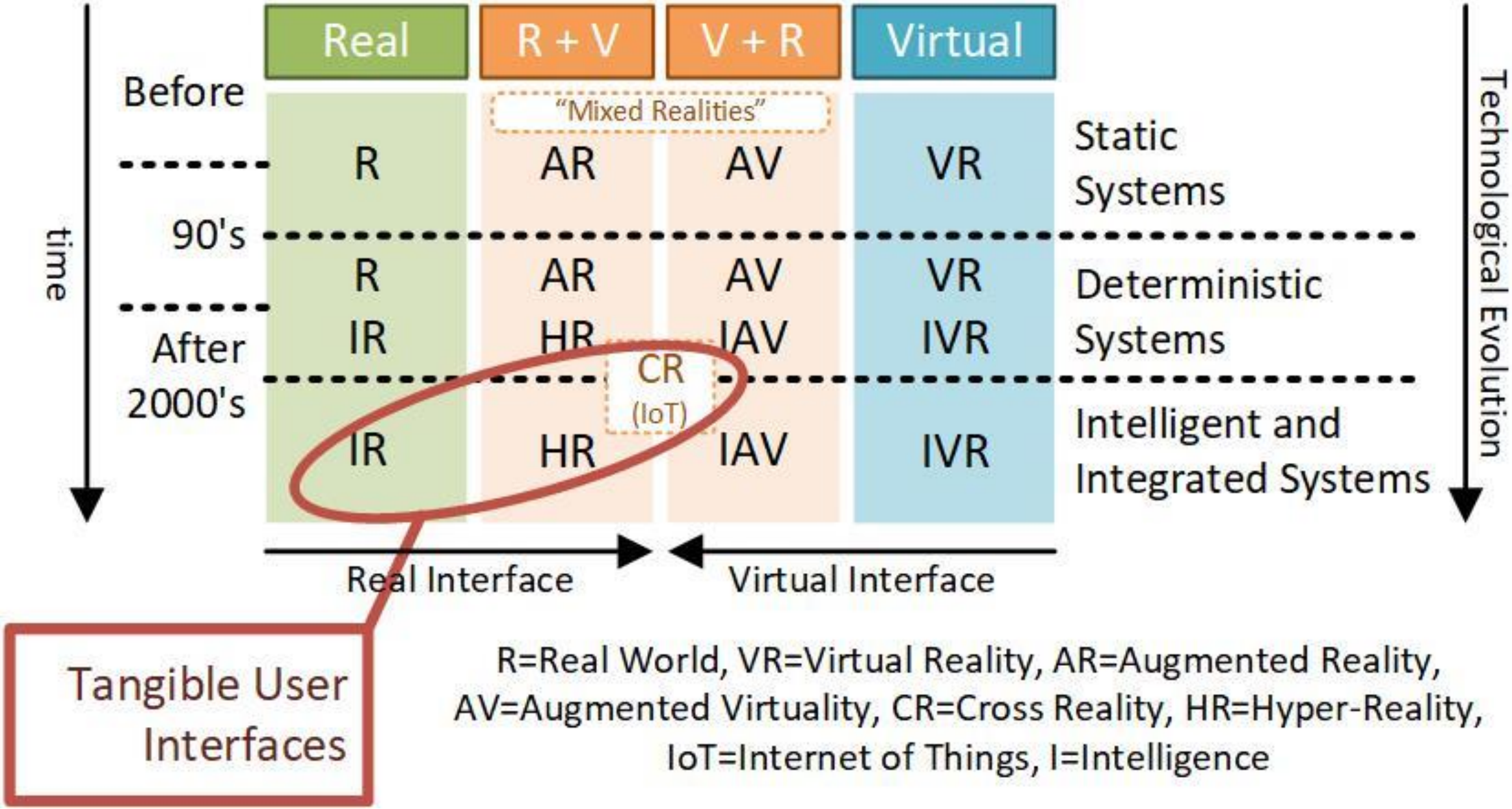
Future Motto: Creative Work Interconnection (INCOSE)




Virtual Reality
Distributed Virtual Worlds
Ubiquitous Computing
Virtual Objects
Augmented Reality
Computational Objects
Cross-Reality
Sensors and Actuators
Tangible Artefacts
Real Objects
Ubiquitous World

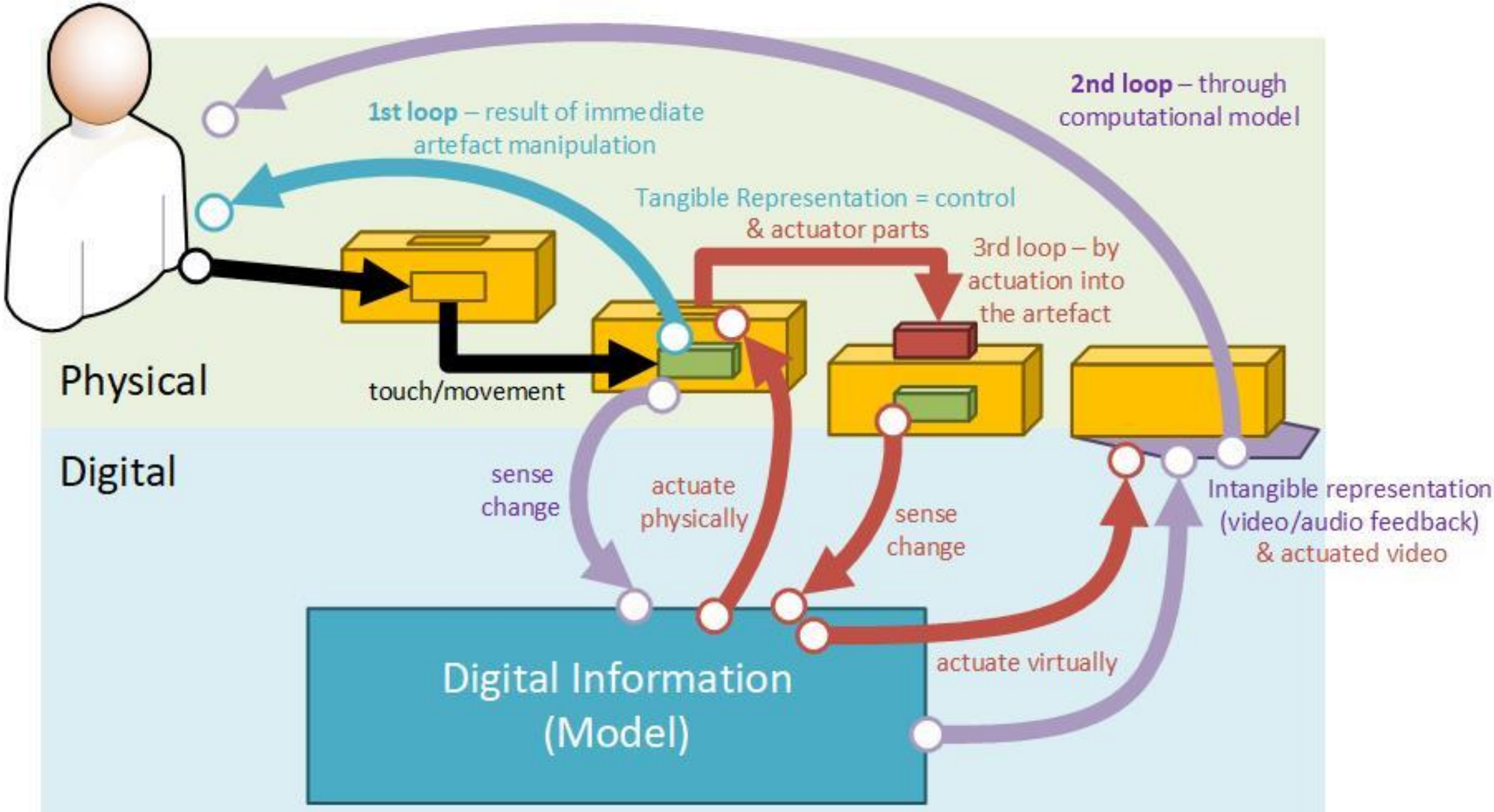

R
C
R
(a) GUI
C
R
C
(b) Virtual Reality
R
C
(c) Augmented Reality
C
C
C
R
(d) Ubiquitous World
C
R
C
C
(e) Cross-Reality
C
R
C
C
(f) Hyper Reality


R
Real World
C
Computer-Aided Environment
Virtual World
Real User Interactions
AI interactions
Real User
Virtualized Avatar
AI Avatar
Computational Artifacts Connection
Virtual Avatar interactions
R
Virtual Autonomous Artifacts
C
Computational Autonomous Artifacts
C
Virtual Autonomous Artifacts
Real User controls Virtualized User
Crossing of Real/Virtual Worlds

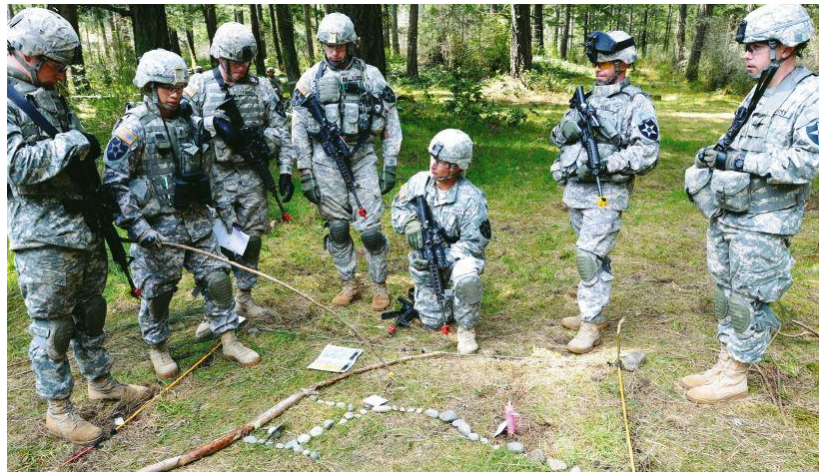

Real
R + V
V + R
Virtual
"Mixed Realities"
Before
90's
After
2000's
time
R
AR
AV
VR
Static
Systems
R
AR
AV
VR
IR
HR
IAV
IVR
Deterministic
Systems
CR
(IoT)
IR
HR
IAV
IVR
Intelligent and
Integrated Systems
Technological Evolution
Real Interface
Virtual Interface
Tangible User
Interfaces
R=Real World, VR=Virtual Reality, AR=Augmented Reality,
AV=Augmented Virtuality, CR=Cross Reality, HR=Hyper-Reality,
IoT=Internet of Things, I=Intelligence

Artefatos Tangíveis

MIT - Material

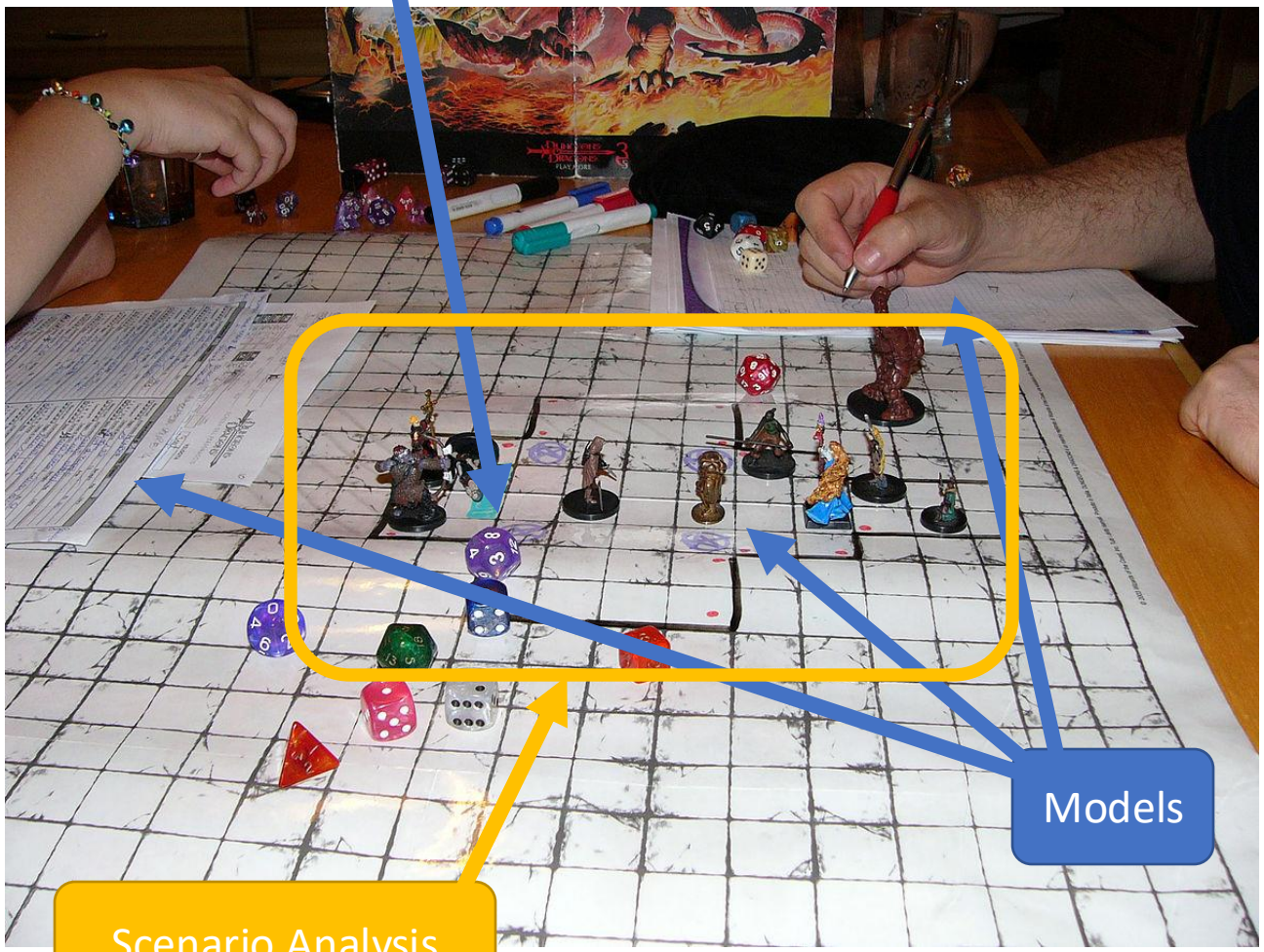

1st loop – result of immediate artefact manipulation
2nd loop – through computational model
Tangible Representation = control & actuator parts
3rd loop – by actuation into the artefact
Physical
touch/movement
Digital
sense change
actuate physically
sense change
Intangible representation (video/audio feedback) & actuated video
Digital Information (Model)
actuate virtually

Board game



Sand Table

Tactical Table



https://en.wikipedia.org/wiki/Dungeons_%26_Dragons

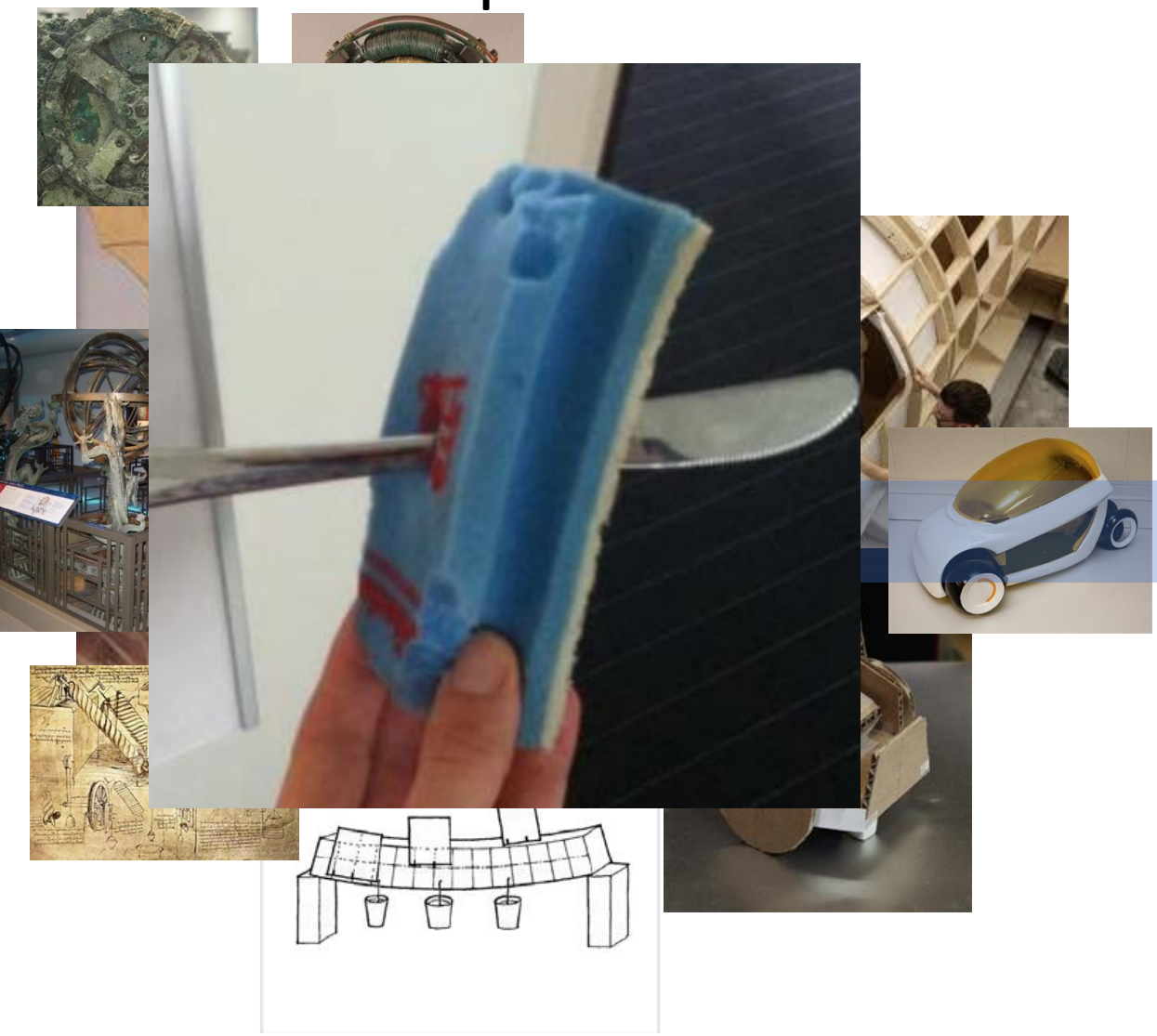
https://www.aerodefensetech.com/component/content/article/adt/features/articles/13944
http://www.projectrho.com/public_html/rocket/spacewartactic.php

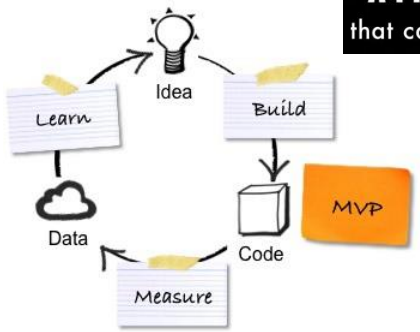
Nintendo Labo

https://www.youtube.com/channel/UC9v-Qjh8z-ey6exeadZhcHg/videos

Nintendo Labo

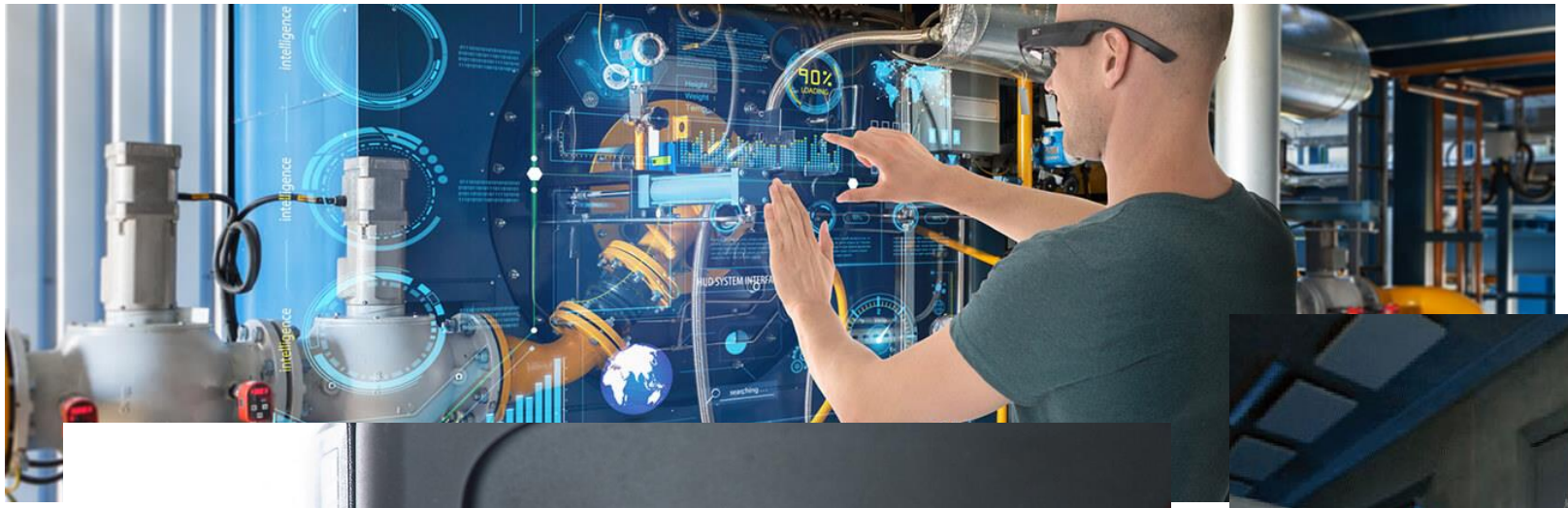
Na Engenharia sempre foram utilizados artefatos físicos para manusear um modelo

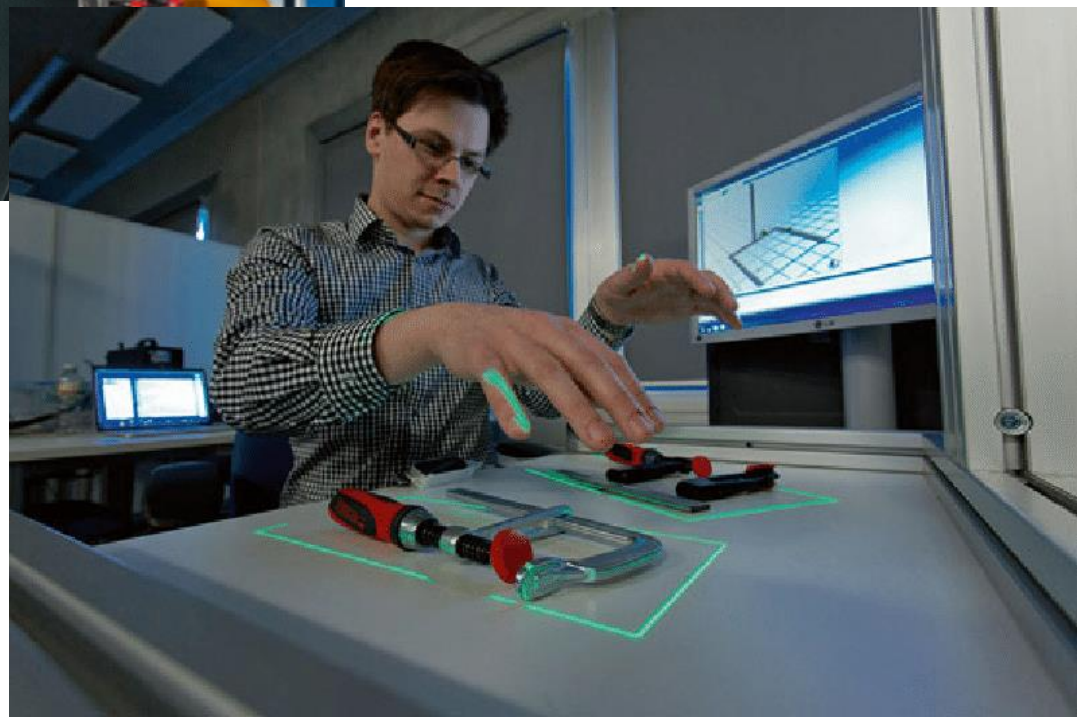




Nomes “modinha”

Com a computação estes artefatos se tornam inteligentes



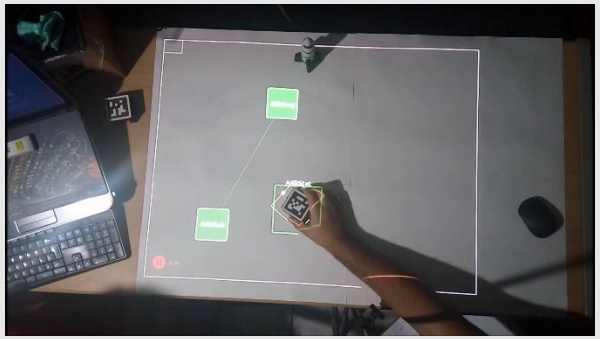


Cientistas Impressão

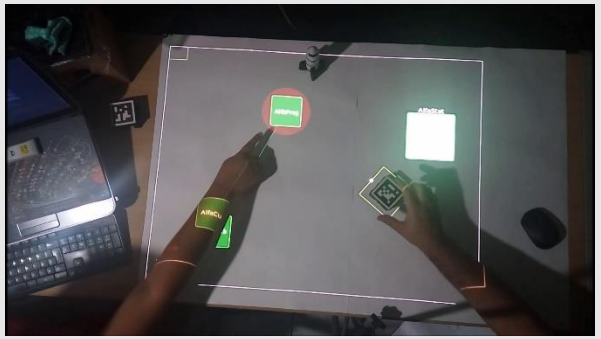
https://blog.teamviewer.com/will-augmented-reality-transform-work/
https://www.researchgate.net/publication/282817636_Ethical_Implications_Regarding_Assistive_Technology_at_Workplaces

Capacitando artefatos como fontes de interações “naturais” com modelos

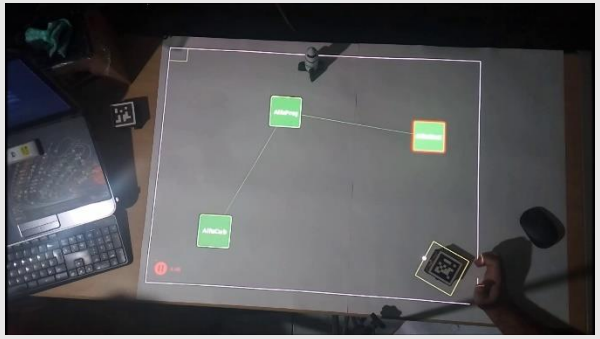
(a) Specialist placing an aura that represents a model to perform discussion



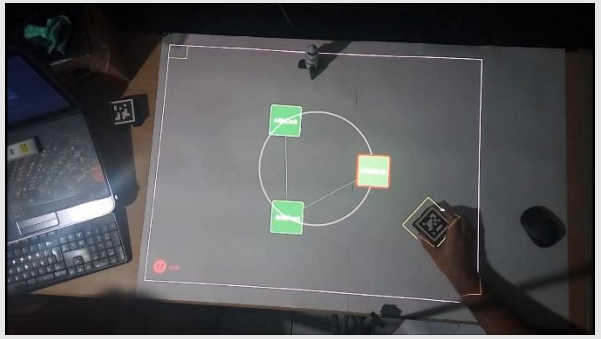
(b) Two specialists discuss the models to decide the coupling

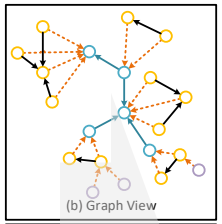


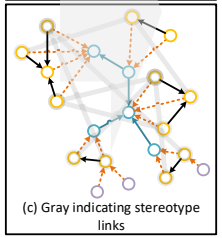
(c) View of the three models coupled.

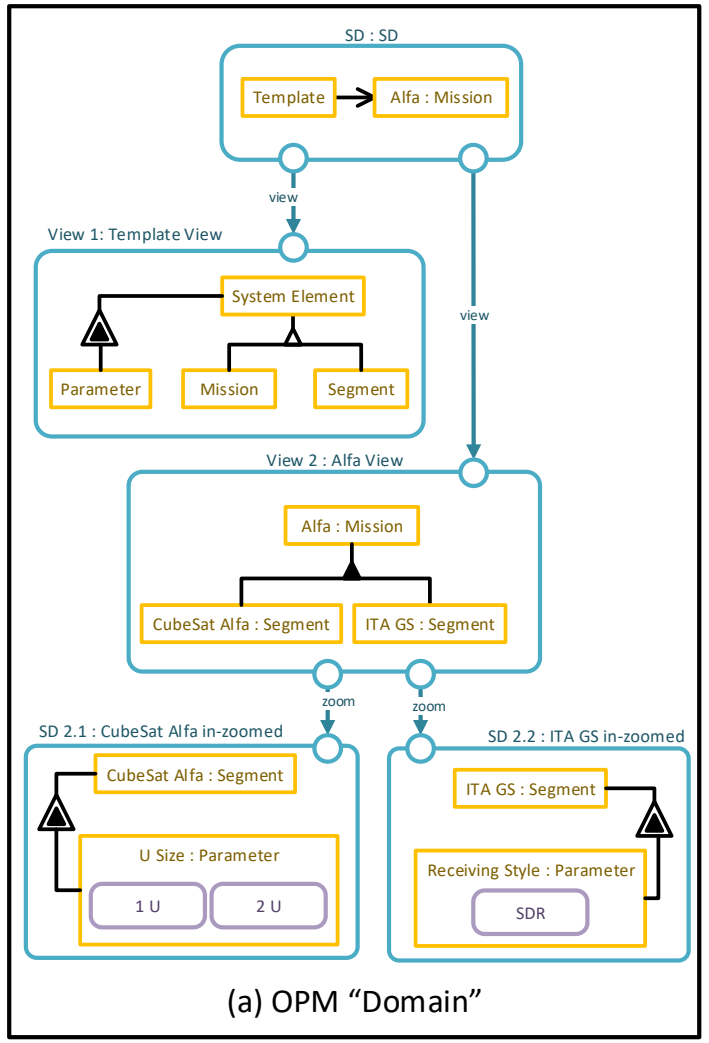


(d) A disc arrangement view to show the connected models.









(a) OPM “Domain”

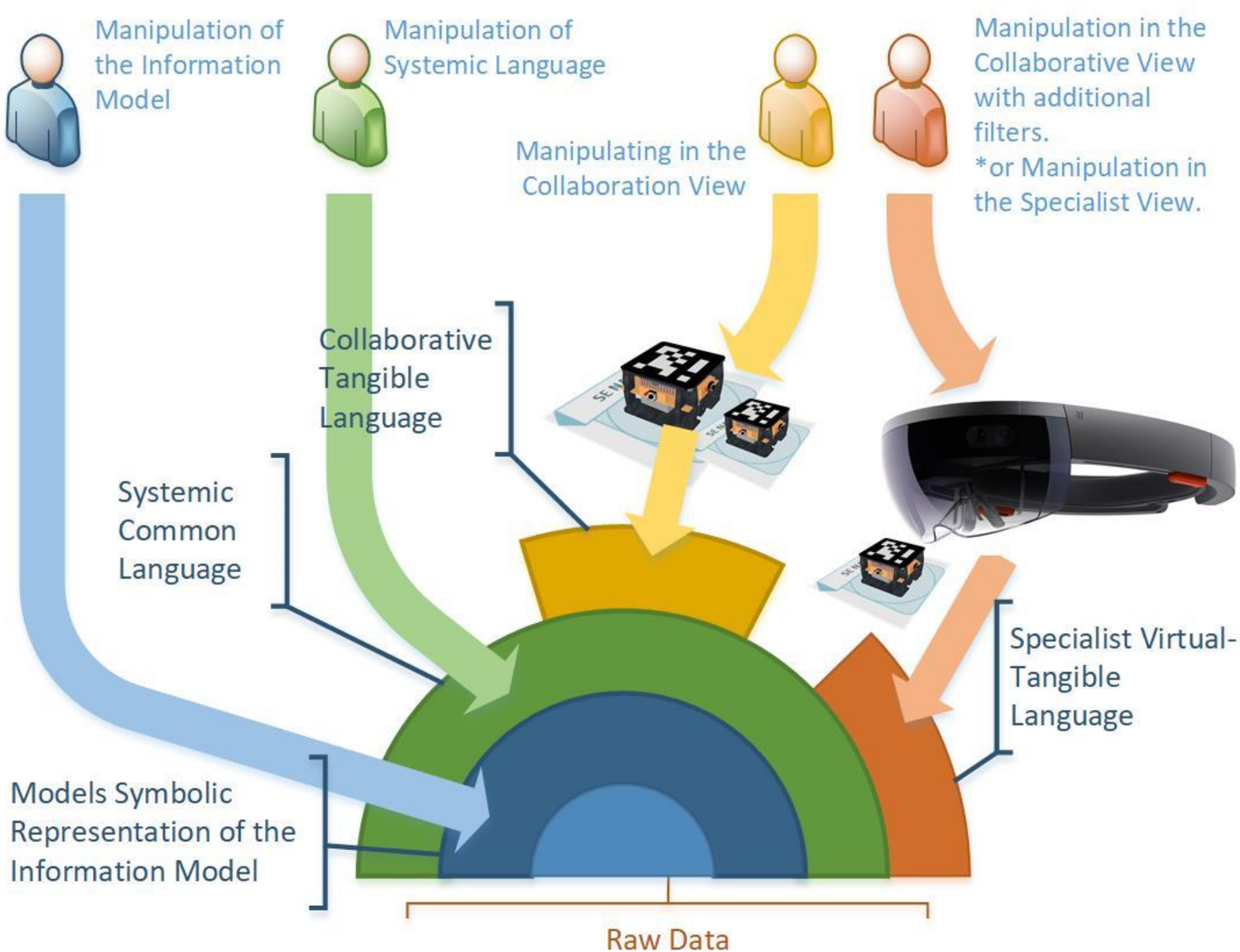
Pode-se ver “testes” de aceitação nos filmes...

Minha Pesquisa:

- Artificial Intelligence → Machine learning, Data Analysis
- Modelling and Simulation → MBSE, EMF
- Internet of Things → Connectivity HW/SW
- Physicality → Carboards, Lego, 3D Printing

Desenvolvimento de novos vocabulários de interação para buscar alternativas para tornar **mais natural** a **linguagem** da **Engenharia de Sistemas**

MBSE 4.0


Manipulation of the Information Model
Manipulation of Systemic Language
Manipulating in the Collaboration View
Manipulation in the Collaborative View with additional filters.
*or Manipulation in the Specialist View.
Collaborative Tangible Language
Systemic Common Language
Specialist Virtual-Tangible Language
Models Symbolic Representation of the Information Model
Raw Data

VIRTUAL REALITY FOCUS

Systems engineers as XR pioneers

By Alessandro Migliaccio - 7 June 2023

Crédits photos : DALL·E

XR, or Extended Reality, is expected to become the fourth computing platform revolution after PCs, the Internet, and mobile phones. Enabling the implementation of disruptive use cases that other technologies simply cannot, it is already beginning to impact society across the board, changing the way people consume and interact with information. But many are wondering if XR has the potential to scale. The

Articles similaires

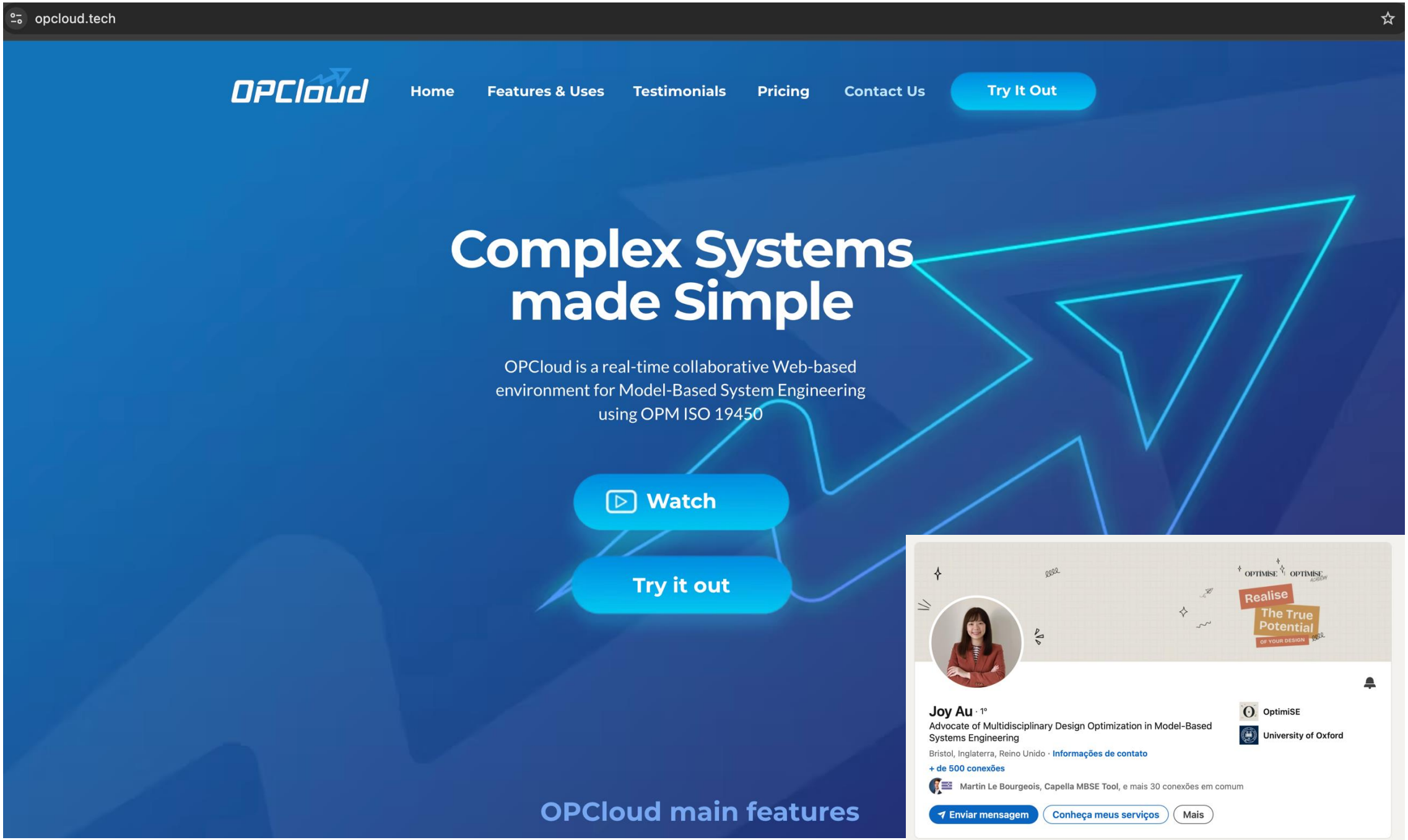
Win your booth for Europe's biggest VR/AR event

Comprehend the uses and the reach of XR at 2025 conferences

Test the latest generation of VR/AR headsets with IDEM

https://blog.laval-virtual.com/en/systems-engineering-virtual-reality-mbse/

O que ficar de olho: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Advocate of Multidisciplinary Design Optimization in Model-Based Systems Engineering
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github.com/Systems-Modeling/SysML-v2-Release

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seidewitz Added change-tracked specification documents. 8fef2b0 · 2 months ago 124 Commits

doc	Added change-tracked specification documents.	2 months ago
install	Updated for 2024-09.	2 months ago
kerml	Updated for 2024-07.	4 months ago
sysml.library.xmi	Updated for 2024-07.	4 months ago
sysml.library	Updated for 2024-07.	4 months ago
sysml	Updated for 2024-07.	4 months ago
.gitignore	Removed additional spurious "Icon?" files.	4 years ago
.project	Created an Eclipse project.	4 years ago
LICENSE	ST6RI-259 Added content as of 2020-09 release.	4 years ago
LICENSE-GPL	ST6RI-259 Added content as of 2020-09 release.	4 years ago
README.md	Update README.md	last year
README.pdf	Updated README.pdf.	last year

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About

The latest incremental release of SysML v2. Start here.

sysml systems-engineering mbse

Readme
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Activity
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466 stars
80 watching
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Releases 41

2024-09 - SysML v2 Pilot Im... Latest
on Oct 15

+ 40 releases

Packages

No packages published

Contributors 2

seidewitz Ed Seidewitz

mbse-syson.org

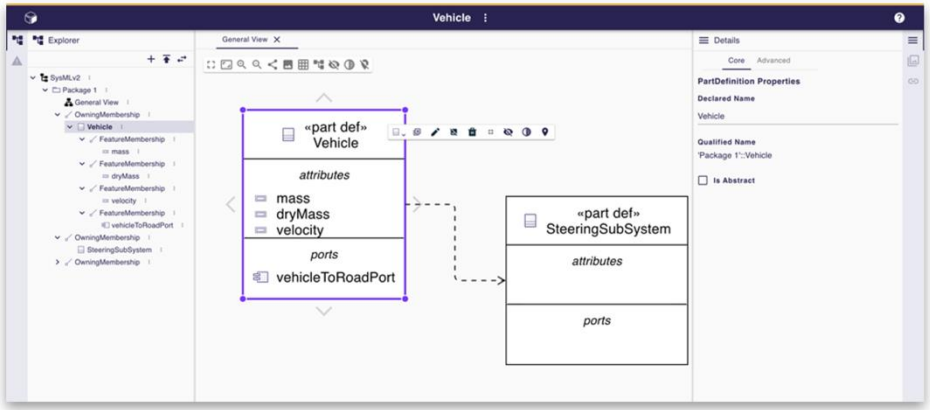
SysON

FEATURES RESOURCES ROADMAP COMMUNITY SOURCE CODE

THE NEXTGEN SYSML MODELING TOOL

Edit SysML v2 models with Eclipse SysON, an open-source and web-based MBSE modeling tool.

GET STARTED STAY TUNED



Standard Compliant

SysON aims at providing an implementation of the OMG's specification **SysML v2**: language concepts, REST API, and interoperability textual format

Web-Based

Graphical, form-based and tabular structured editors that can be used from a web browser, without any specific installation on user's desktop

Open-Source

Hosted in the Eclipse community, SysON aims to catalyze industrial collaboration, accelerate innovation, and foster the adoption of SysMLv2

marketplace.visualstudio.com/items?itemName=sensmetry.sysml-2ls

Visual Studio | Marketplace

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Visual Studio Code > Programming Languages > SysIDE CE

New to Visual Studio Code? Get it now.

SysIDE CE

Preview

Sensmetry | 1,716 installs | ★★★★★ (6) | Free

SysML v2 language support in VS Code.

Install

Trouble Installing?

Overview | Version History | Q & A | Rating & Review

SysIDE Community Edition

SysIDE

SysML v2 'as code' modeling and analysis system

SysIDE (pronounced "seaside") is a transformational SysML v2 systems-as-code modeling tool

pipeline passed | coverage 87.29% | Latest Release 0.6.2 | Download VS Code Marketplace | Download Open-VSX

SysIDE Community Edition (SysIDE CE) is a free and open source SysML v2 textual editing and analysis system, bringing rich SysML v2 language support to Visual Studio Code. *SysIDE CE* can also be integrated into other applications and automated workflows which need to interact with SysML v2 textual representations.

The main enabling components of *SysIDE CE* are a parser and a language server for SysML v2 and KerML 2024-05 release specifications.

SysIDE CE provides features such as:

Categories

Programming Languages | Linters | Formatters

Tags

KerML | SysML | SysML-v2

Works with

Universal, Web

Resources

Issues
Repository
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Changelog
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More Info

Version	0.6.2
Released on	1/26/2023, 1:46:57 PM
Last updated	7/1/2024, 9:35:38 AM
Publisher	Sensmetry
Unique Identifier	sensmetry.sysml-2ls

openmbee.org

OpenMBEE

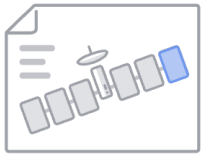
Home About Contribute Participate Projects Community Events

Connected engineering information for a connected world

OpenMBEE (Open Model Based Engineering Environment) is an open source collaborative engineering system. It enables engineers to work in the language of their choice and easily share and document their work across other tools.

Edit once, use everywhere

OpenMBEE Components

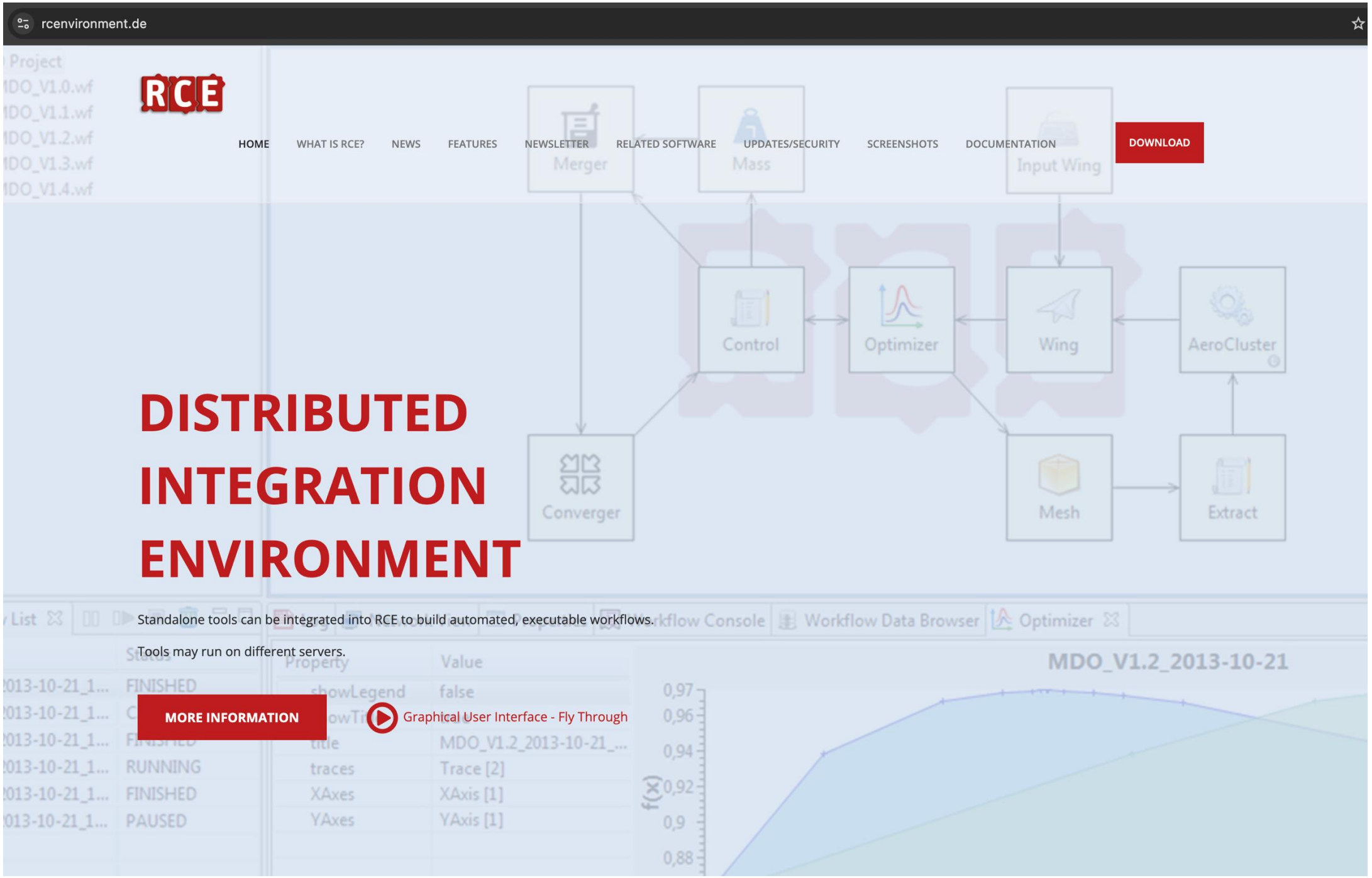


Model Development Kits

Model Management System

View Editor

OpenSE Cookbook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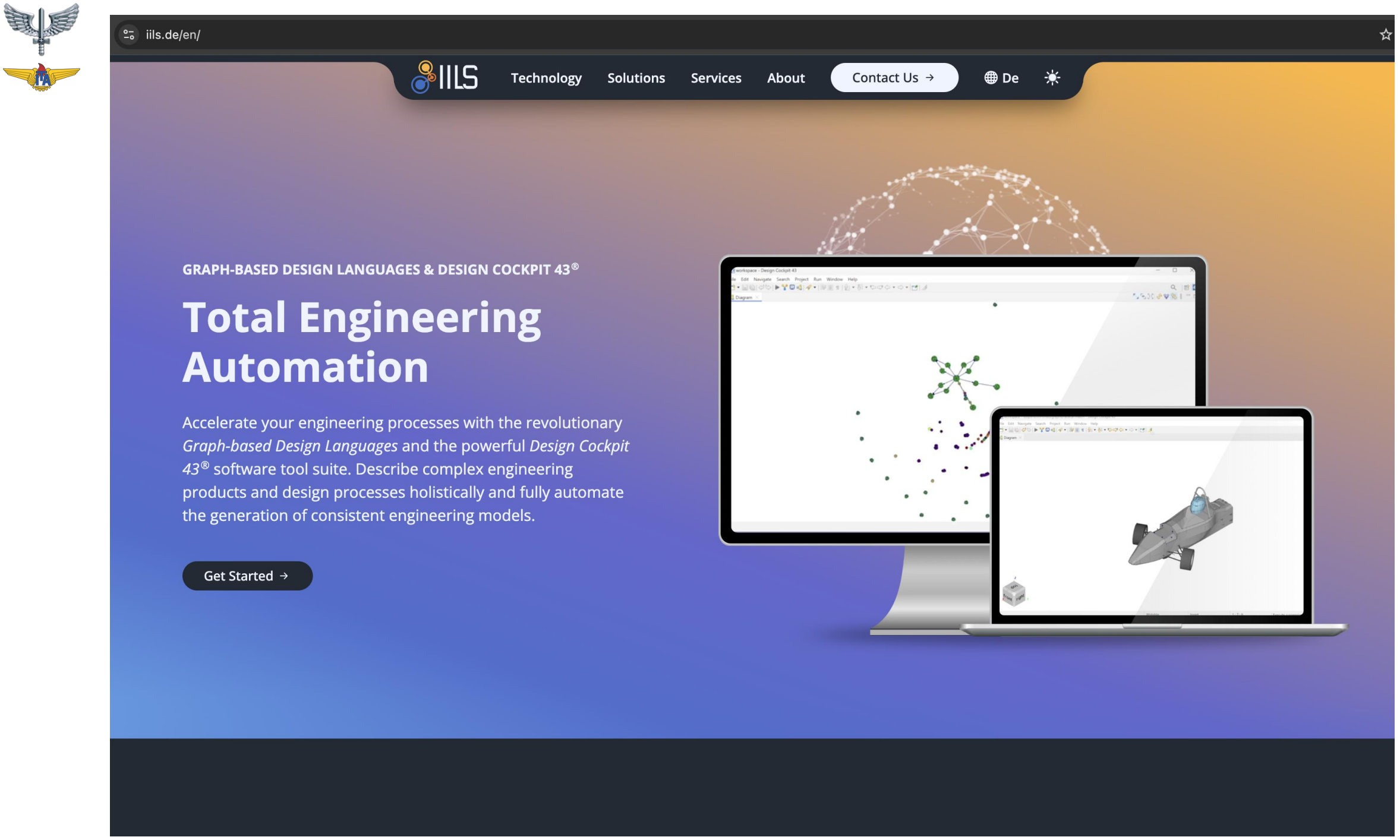
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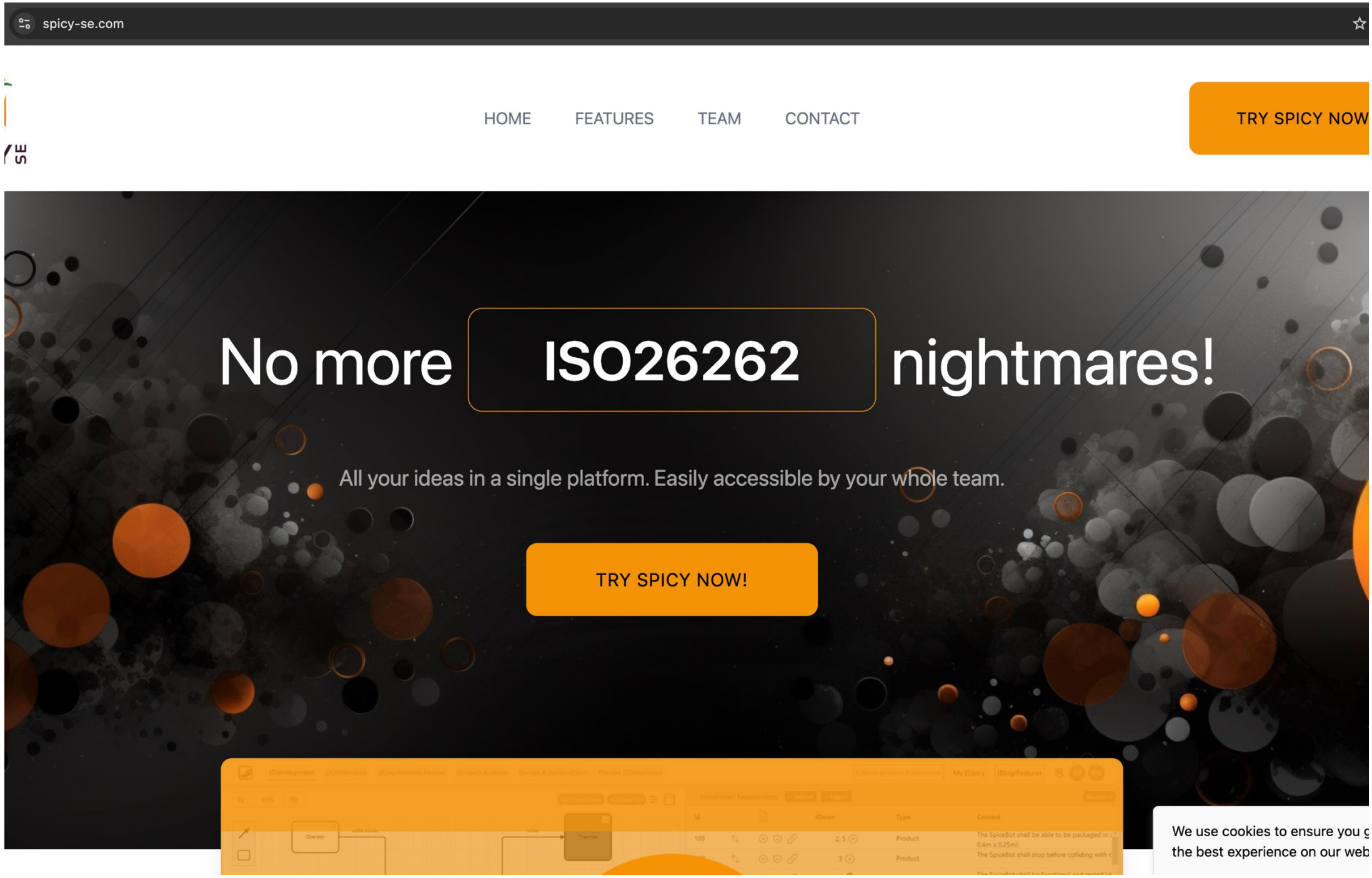
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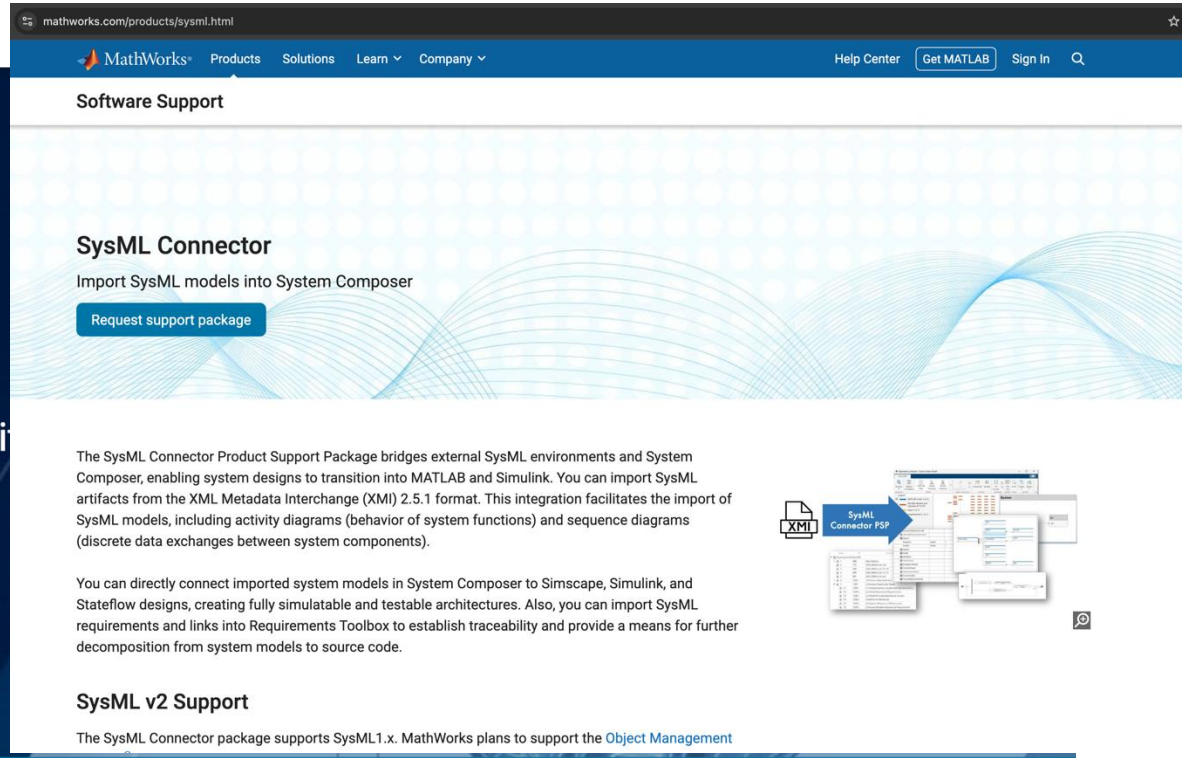
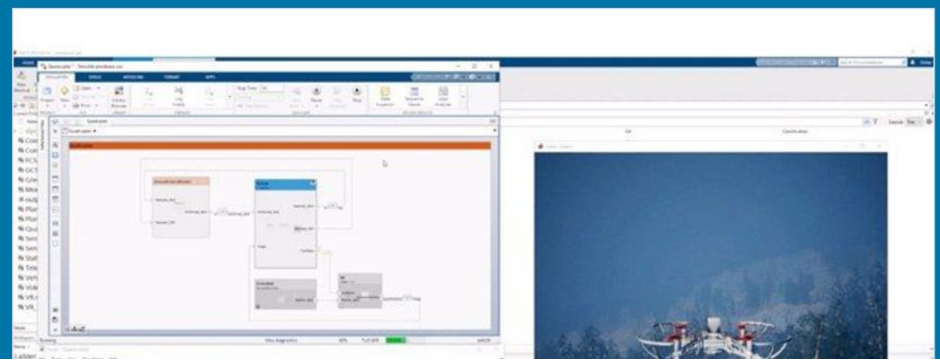
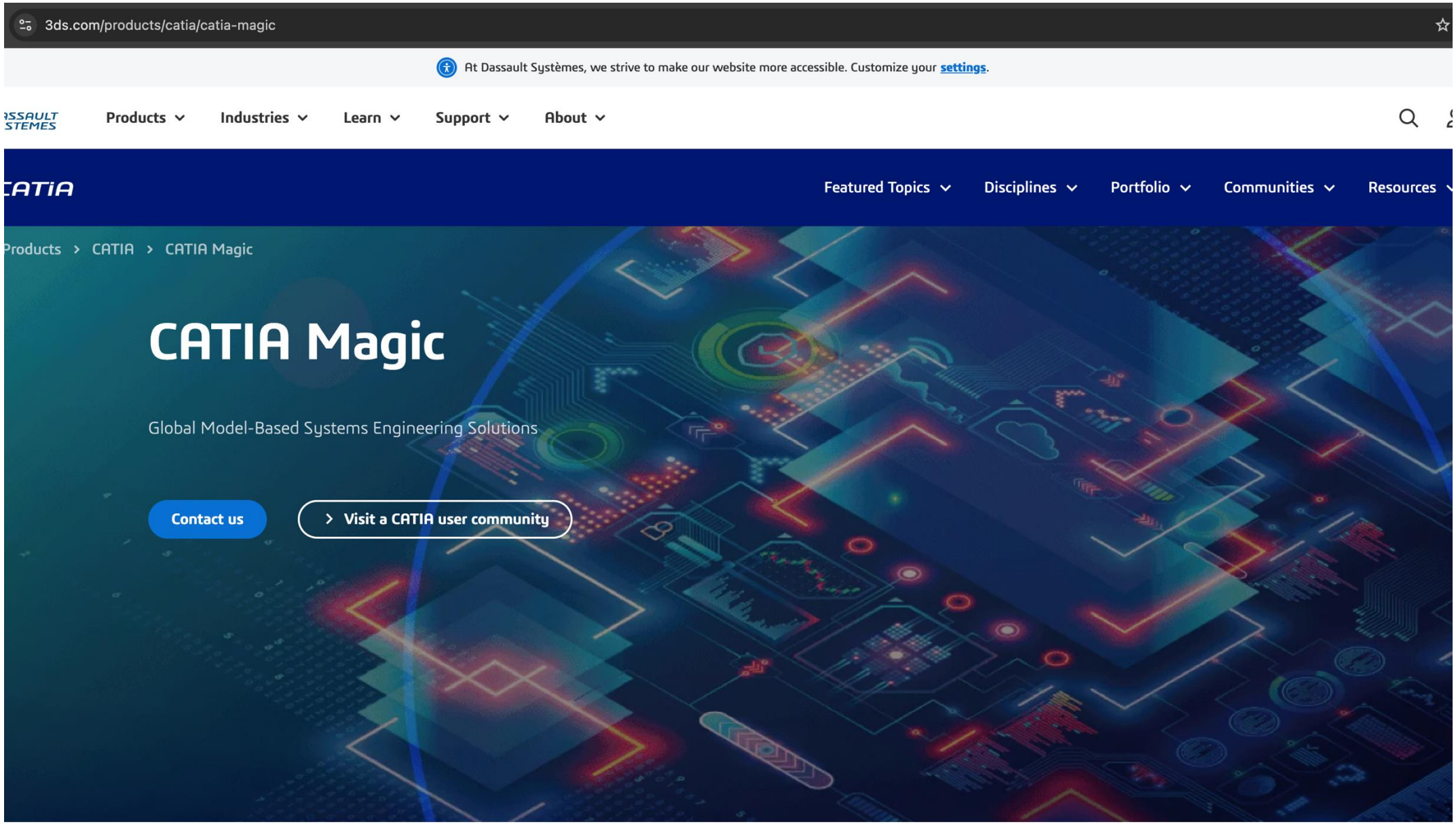


System Composer enables the specification and analysis of architectures for model-based systems engineering (MBSE) and modeling of software architectures. You can allocate requirements, refine an architecture model, and design and simulate in Simulink.

System Composer lets you directly author architecture models consisting of components, ports, connectors, and interfaces, import them from other tools, or populate them from the architectural elements of Simulink designs. You can describe your system using multiple architecture models and establish direct





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Change My View: Model Based Systems Engineering in 2024 is at best overhyped, or is at worst actively dying

I know the title is a little controversial but I feel like this conversation needs to be had now within the community. For the past couple of years I've felt like more and more of a scam salesman trying to push this MBSE stuff onto people, and at this point it feels like it's time to let the reality of the situation have it's time in the light.

About me:

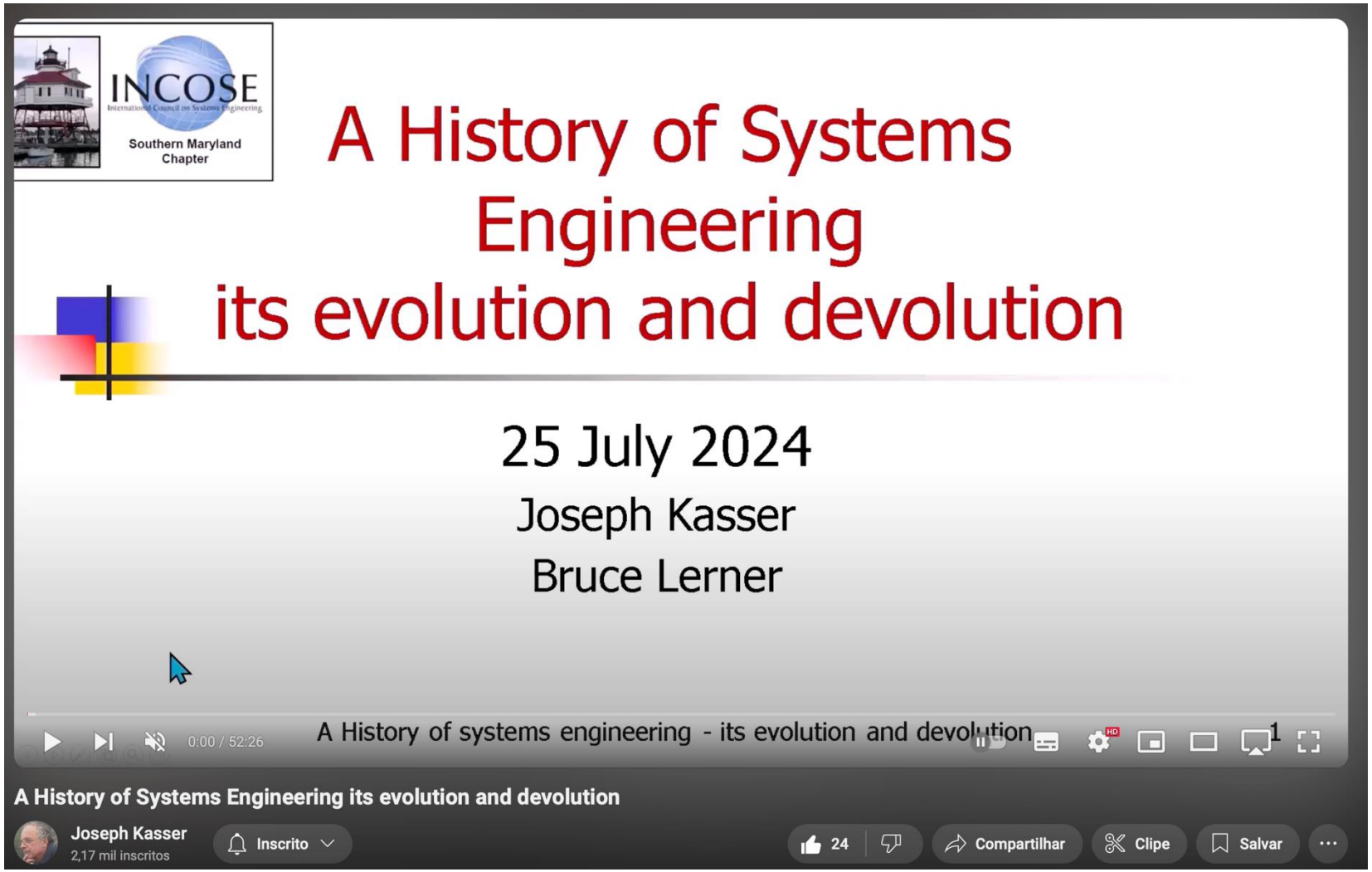
- Systems engineer for 5 years with a focus on MBSE
- Have done straight MBSE since undergrad and through my MS degree as well (BS/MS Aerospace Engineering)
- Currently holding the OCSMP-MBI certificate
- Have used Cameo almost exclusively, as well as quite a few different 3rd party integration suites (Syndeia, SBE Vision, Excel, etc.)
- Have attempted to push SysML in at least three different industries (commercial aerospace, automotive/tech, DoD aerospace)

My breaking point with letting go of MBSE has come pretty recently, and I've done my best to remain hopeful in the concept despite my doubts, but at this point I'm no longer confident in MBSE's ability to be a transformational force in system design as it's been sold.

As it sits currently, MBSE has turned into another boutique silo of information that is squirreled away in a program that looks like it's out of 1992 and is impossible for a new user to quickly pick up and start using to generate useful engineering artifacts. It requires a team of bona fide experts to even set up and begin using the tool properly, and also more trained experts to effectively use the SysML modeling language to try and derive some value out of the language and process.

What I've learned is that no actual engineers (meaning, the ones who design and build the actual product) really care about MBSE or what it's trying to do. Whereas MBSE practitioners and salespeople try to pitch it as a single source of truth methodology where all engineers can derive their SE material from the model, in practice, unless a design engineer is forced to log into teamwork cloud or cameo collaborator by upper management, they really don't care about the contents of the model since they're already effectively managing their own content in their excel sheets/visio diagrams/JIRA. Sure this is a problem, but I don't think MBSE is currently at a place where it can be solved without, effectively, data duplication.

The program I'm on currently has put its full backing into an MBSE effort all the way from upper management support to being a requirement on the statement of work. And we're STILL at the point where no engineering is being done in the model (by decree of our very well-intentioned and forward looking chief engineer) and the model is really only being used as high quality documentation so that the customer has an easier time snooping at our architecture. This



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Considerações Finais

When your boss says you can leave early if you want:

Fechamento GE

Prof. Dr. Christopher Shneider Cerqueira

IEA - Divisão de Engenharia Aeronáutica e Aeroespacial
ITA – Instituto Tecnológico de Aeronáutica

christopher@cscerqueira.com.br
http://www.cscerqueira.com.br
chris@ita.br

*"With the **passage of time**, the psychology of people **stays the same**, but the **tools and objects in the world change**. Cultures change. **Technologies change**. The principles of design still hold, but the way they get applied **needs to be modified** to account for new activities, new technologies, **new methods of communication and interaction**."*

Don Norman

"The DESIGN of EVERYDAY THINGS, Revised and Expanded 2013's Edition"

Prof. Dr. Christopher Shneider Cerqueira
christopher@cscerqueira.com.br
chris@ita.br