



IEA-P – DEPARTAMENTO DE PROJETOS
(PROJECT DEPARTMENT)

SIS-08 – Verification and Quality of Aerospace Systems

[2025]

Prof. Dr. Christopher S. Cerqueira



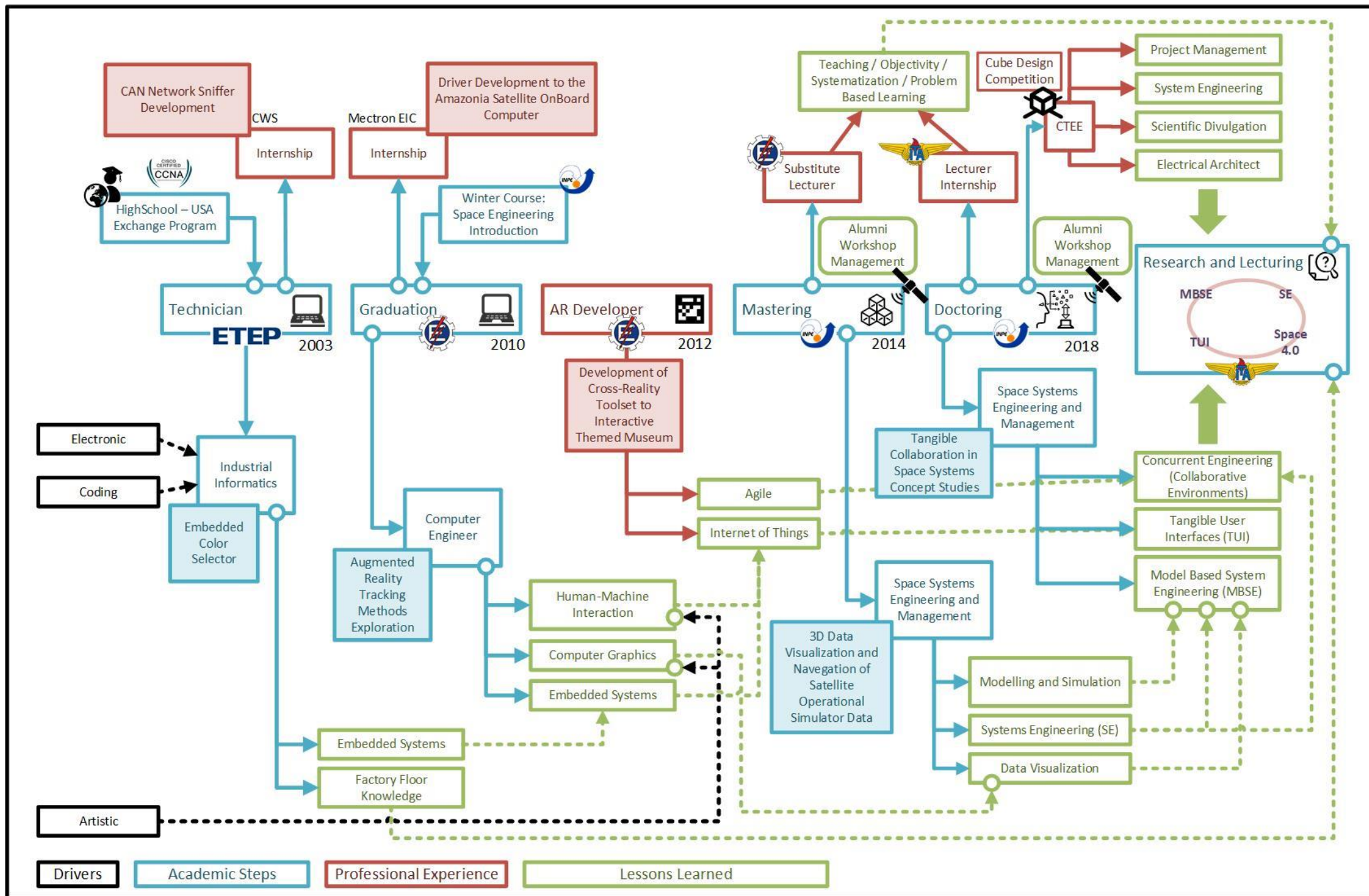
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PROJECT DEPARTMENT

AERONAUTICS AND AEROSPACE DIVISION

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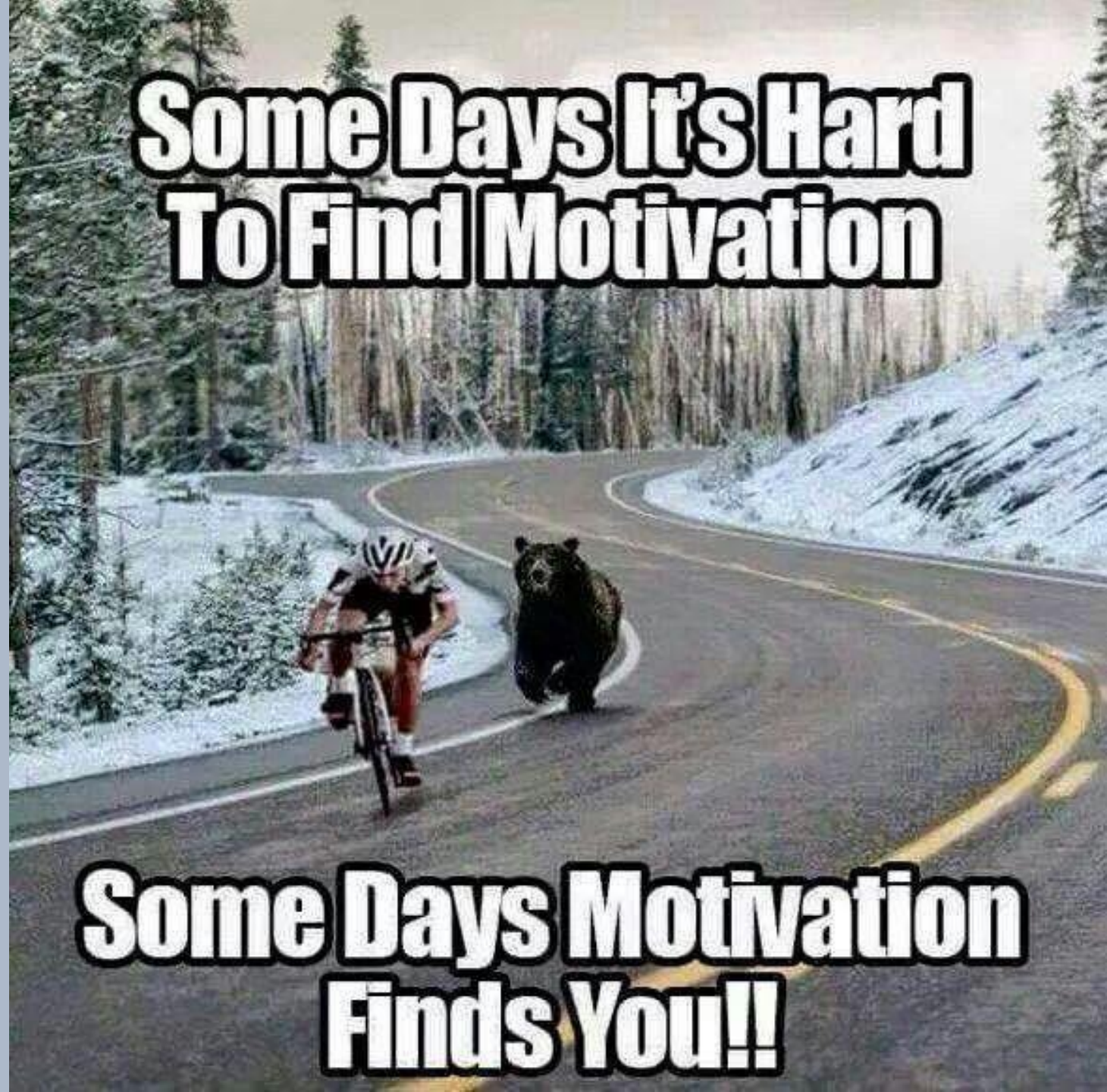


*“A goal of education is to **assist growth toward greater complexity and integration** and to assist in the process of **self-organization** – to modify individuals' capacity to modify themselves”*

Reuven Feuerstein



MOTIVATION



**Some Days It's Hard
To Find Motivation**

**Some Days Motivation
Finds You!!**



How do we ensure the quality of an
Aerospace Engineering Product?



Developer



Functional Expert



Requester/User





I can Verify
this is a
house



I can Validate that
this house was
installed properly





Course ID



IDENTIFICATION

- Lecturer: Prof Dr. **Christopher S. Cerqueira**
 - Other professionals/professors might assist during the course.
- ITA Course Number: SIS-08
- As taught in 2024.
- Material language: English (given the CAPES PrInt)
- Teaching Language: Portuguese (English if requested)
- Level: Undergraduate / Graduated



SIS-08 – Verificação e Qualidade de Sistemas Aeroespaciais.

- *Requisitos: SIS-04. Horas semanais: 2-0-1-3,*
- Etapas do desenvolvimento de sistemas espaciais. Garantia do Produto e da Qualidade. O processo global da Verificação. Plano de Verificação: as estratégias da Verificação para cada categoria de requisito. A filosofia de modelos. As ferramentas para o processo de Verificação. A documentação, o controle e a organização do processo de Verificação. O planejamento dos testes, das revisões de projeto, das análises e das inspeções. Sequência das atividades de Montagem, Integração e Teste de Satélites (AIT). Testes ambientais. Métodos e equipamentos de suporte ao AIT. Plano de AIT. O planejamento das atividades de AIT. As instalações de testes. Testes para Campanha de Lançamento. Manutenção de Sistemas Aeroespaciais. Estudo de Casos.
- **Bibliografia:** NASA. *Systems engineering handbook*. rev2. Washington, DC: NASA, 2017. ECSS. *ECSS-E-ST-10-02C Rev.1*: space Engineering: verification. [S.l.]: ESA-ESTEC, 2018. UNITED STATES. Department of Defense. DoD Guide for achieving reliability, availability, and maintainability. Washington, DC: DOD, 2005.



Rules of the house

14/26

ICA 37-332/2017

3 DEVERES E DIREITOS DOS ALUNOS

3.1 DEVERES

São deveres dos alunos de graduação:

- a) comparecer, pontualmente, a todas as atividades escolares;
- b) apresentar, com pontualidade, todos os trabalhos escolares exigidos;
- c) dedicar-se exclusivamente às atividades escolares prescritas nesta Norma, salvo outras que venham a ser especificamente autorizadas pela autoridade competente;
- d) observar rigorosa probidade na execução dos trabalhos escolares;
- e) obedecer a todas as regras, normas, prescrições, instruções e ordens emanadas de autoridade competente; e
- f) apresentar-se sempre de maneira digna e correta, quer no Instituto, quer fora dele, de modo a manter elevado o conceito do ITA e da Aeronáutica.

3.2 DIREITOS

Ao aluno do Curso de Graduação do ITA é assegurado:

- c) a revisão de prova, desde que solicitada no prazo estabelecido em instrução própria, por escrito e devidamente fundamentada, à autoridade competente;
- i) recorrer de punição, por escrito, à autoridade do ITA que a aplicou e em última instância ao Reitor do ITA;

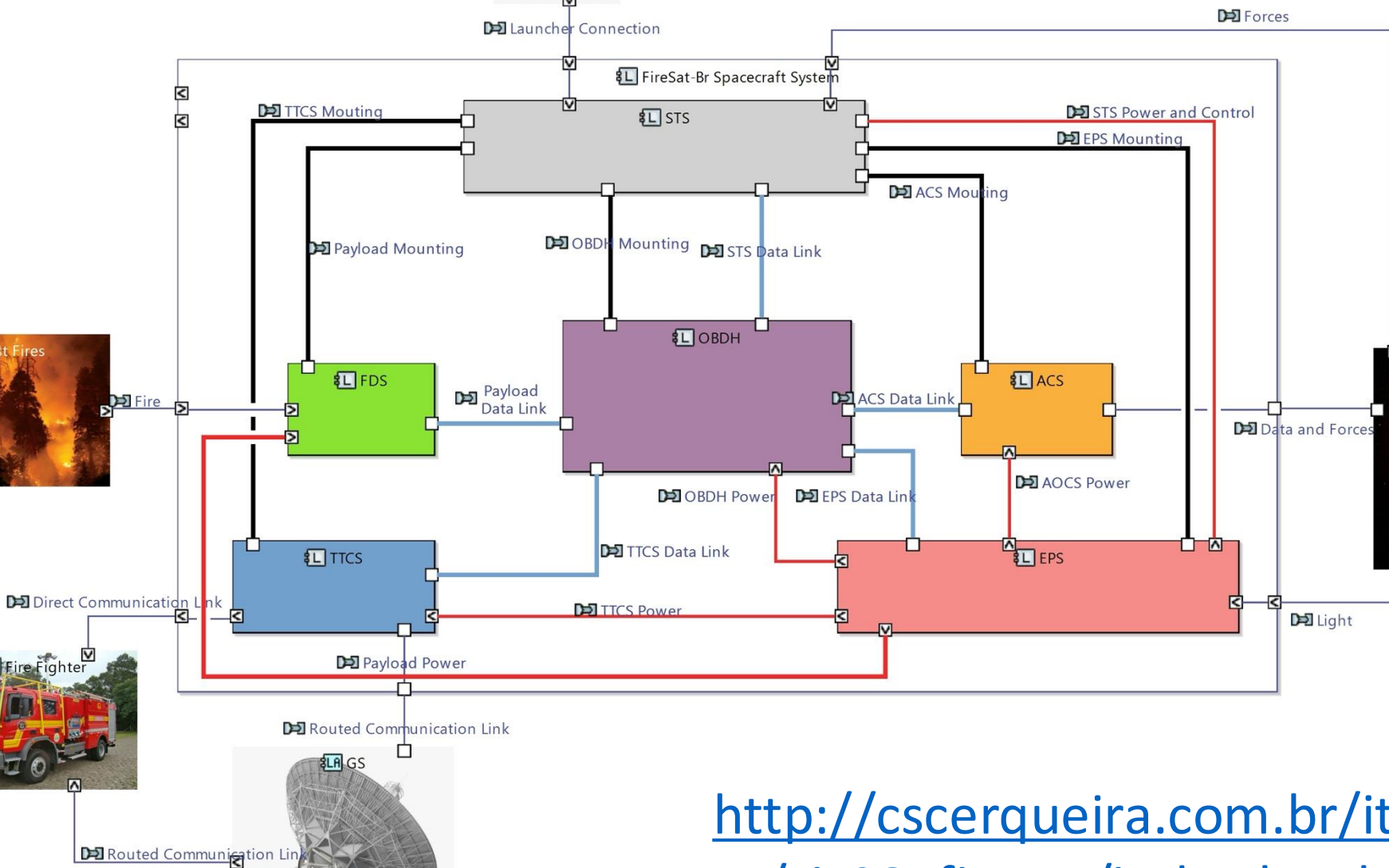
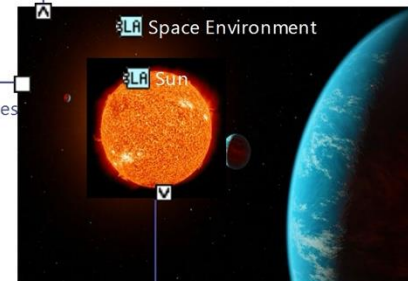


Hands-on project



Learning artifact

- Through the lectures we will use a learning artifact to practice the concepts
- A Simple FireSat Spacecraft Model (from the Space Mission Engineering Book)
- Each step may require:
 - a model use (get data/modify the model/add model parts).
 - a documentation process.



http://cscerqueira.com.br/ita/sis08/output/sis08_firesat/index.html



Data



Fevereiro

	S	T	Q	Q	S	S	D
						1	2
	3	4	5	6	7	8	9
	10	11	12	13	14	15	16
	17	18	19	20	21	22	23
1	24	25	26	27	28		

Março

	S	T	Q	Q	S	S	D
1						1	2
2	3	4	5	6	7	8	9
3	10	11	12	13	14	15	16
4	17	18	19	20	21	22	23
5	24	25	26	27	28	29	30
6	31						

Abril

	S	T	Q	Q	S	S	D
6		1	2	3	4	5	6
7	7	8	9	10	11	12	13
8	14	15	16	17	18	☹️	20
s	21	22	23	24	25	26	27
1	28	29	30				

Maio

	S	T	Q	Q	S	S	D
1				1	2	☹️	4
2	5	6	7	8	9	10	11
3	12	13	14	15	16	17	18
4	19	20	21	22	23	24	25
5	26	27	28	29	30	31	

Junho

	S	T	Q	Q	S	S	D
5							1
6	2	3	4	5	6	7	8
7	9	10	11	12	13	14	15
8	16	17	18	19	20	☹️	22
Ex1	23	24	25	26	27	28	29
Ex2	30						

Julho

	S	T	Q	Q	S	S	D
Ex2		1	2	3	4	5	6
	7	8	9	10	11	12	13
	14	15	16	17	18	19	20
	21	22	23	24	25	26	27
1	28	29	30	31			



Theory

WEEK	CLASS ACTIVITY	INDIVIDUAL	W	GROUP	W
1 27-Feb 28-Feb	Course Structure and Initial Definitions Systems Engineering Review	IA-01 - Reading and Conceptual Questions (10)	5%	GA-01 - Define Groups	0%
2 06-Mar 07-Mar	Requirements Engineering Review	IA-02 - Reading and Conceptual Questions (10)	5%	GA-02 - Requirement writing and requirement validation (cross-check inter-groups).	10%
3 13-Mar 14-Mar	Risk - Hazard Analysis Review	IA-03 - Reading and Conceptual Questions (10)	5%	GA-03 - Raise overall mission risks and specific to the subsystem	0%
4 20-Mar 21-Mar	AIVV Introduction	IA-04 - Reading and Conceptual Questions (10)	5%	GA-04 -	20%
5 27-Mar 28-Mar	Means of Compliance Success Criteria	IA-05 - Reading and Conceptual Questions (10)	5%	GA-05 - Write the means of verification and the success criteria.	20%
6 03-Apr 04-Apr	Structuring the Life Cycle Technical Reviews	IA-06 - Reading and Conceptual Questions (10)	5%	GA-06 - Structure a lifecycle and the content of the reviews.	20%
7 10-Apr 11-Apr	Model Philosophy and Environmental Testings Questions?	IA-07 - Reading and Conceptual Questions (10)	10%	GA-07 - Structure the model philosophy	30%
8 17-Apr 18-Apr	P1 - Conceptual Questions and Case	IA-08 - Select 20 questions and a mini-case to build a coherent DVM (RTM)	60%	GA-08 -	
			100%		100%

Async





Async

Model Based Testing

WEEK	CLASS ACTIVITY	INDIVIDUAL	W	GROUP	W
9 01-May 02-May	Reliability	IA-09 - Reading and Conceptual Questions (10)	10%	GA-09 - With the conceptual design create the theoretical reliability.	10%
10 08-May 09-May	Suportability Quality Assurance	IA-10 - Reading and Conceptual Questions (10)	10%	GA-10 -	0%
11 15-May 16-May	GSE Project	IA-11 - Reading and Conceptual Questions (10)	10%	GA-11 - Desing of a GSE to test one of the requirements upon the Subsystem	10%
12 22-May 23-May	Model based Testing: State Machine	IA-12 - State Machine Exercises	10%	GA-12 - State machine of the system under test and of the ideal tester.	10%
13 29-May 30-May	Questions!? Mutants	IA-13 - Mutant creation exercises	10%	GA-13 - Create mutants to inject faults.	10%
14 05-Jun 06-Jun	Presentations	IA-14 -	0%	GA-14 -	0%
15 12-Jun 13-Jun	Presentations Encerramento do Curso	IA-15 -	0%	GA-15 - Apresentação dos Procedimentos	60%
16 19-Jun 20-Jun	P2 - Conceptual Questions and a MBT Case	IA-16 - Select 20 questions and a mini-case to build a Fault Injector GSE	50%	GA-16 -	
			100%		100%
EXAM 26-Jun 10-Jul	If necessary: Writing an article (min 6pgs / max 10pgs) reporting the case of their group in the SIGE standard.				100%

Async



Grading

B1 - IND (40%)	AI-01	AI-02	AI-03	AI-04	AI-05	AI-06	AI-07	AI-08(P1)	100%
	5%	5%	5%	5%	5%	5%	10%	60%	
B1 - GRU (60%)	AG-01	AG-02	AG-03	AG-04	AG-05	AG-06	AG-07	AG-08(P1)	100%
	0%	10%	0%	20%	20%	20%	30%	0%	
	0,5%	0,5%	0,5%	0,5%	0,5%	0,5%	1,0%	6,0%	10,0%
	0,0%	1,5%	0,0%	3,0%	3,0%	3,0%	4,5%	0,0%	15,0%
								1st Bimester:	25,0%

B2 - IND (40%)	AI-09	AI-10	AI-11	AI-12	AI-13	AI-14	AI-15	AI-16 (P2)	100%
	10%	10%	10%	10%	10%	0%	0%	50%	
B2 - GRU (60%)	AG-09	AG-10	AG-11	AG-12	AG-13	AG-14	AG-15	AG-16 (P2)	100%
	10%	0%	10%	10%	10%	0%	60%	0%	
	1,0%	1,0%	1,0%	1,0%	1,0%	0,0%	0,0%	5,0%	10,0%
	1,5%	0,0%	1,5%	1,5%	1,5%	0,0%	9,0%	0,0%	15,0%
								2nd Bimester:	25%
Exam (100%)	100%								
	50%							Final	100,0%



END of the
beginning



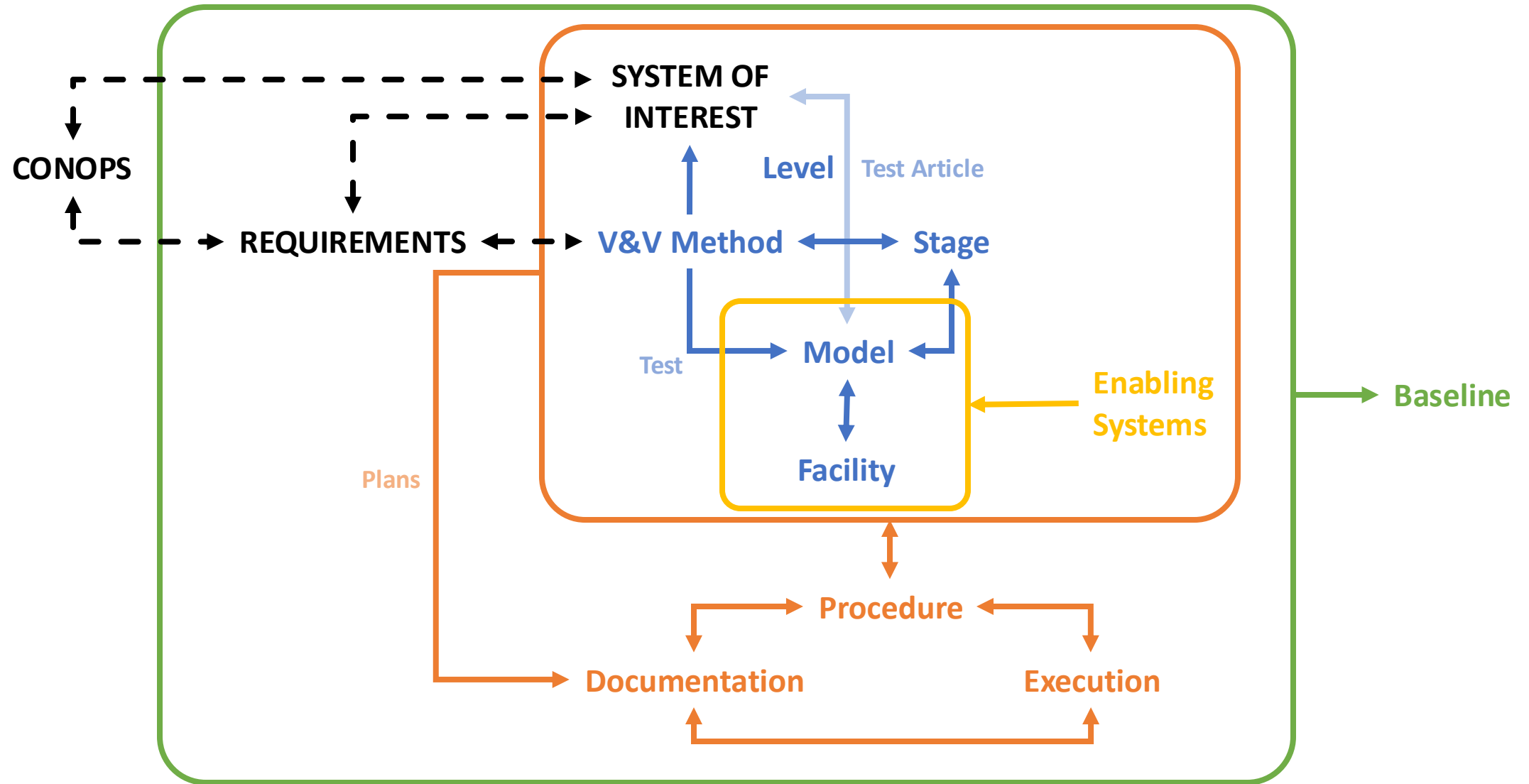
KEEP
CALM

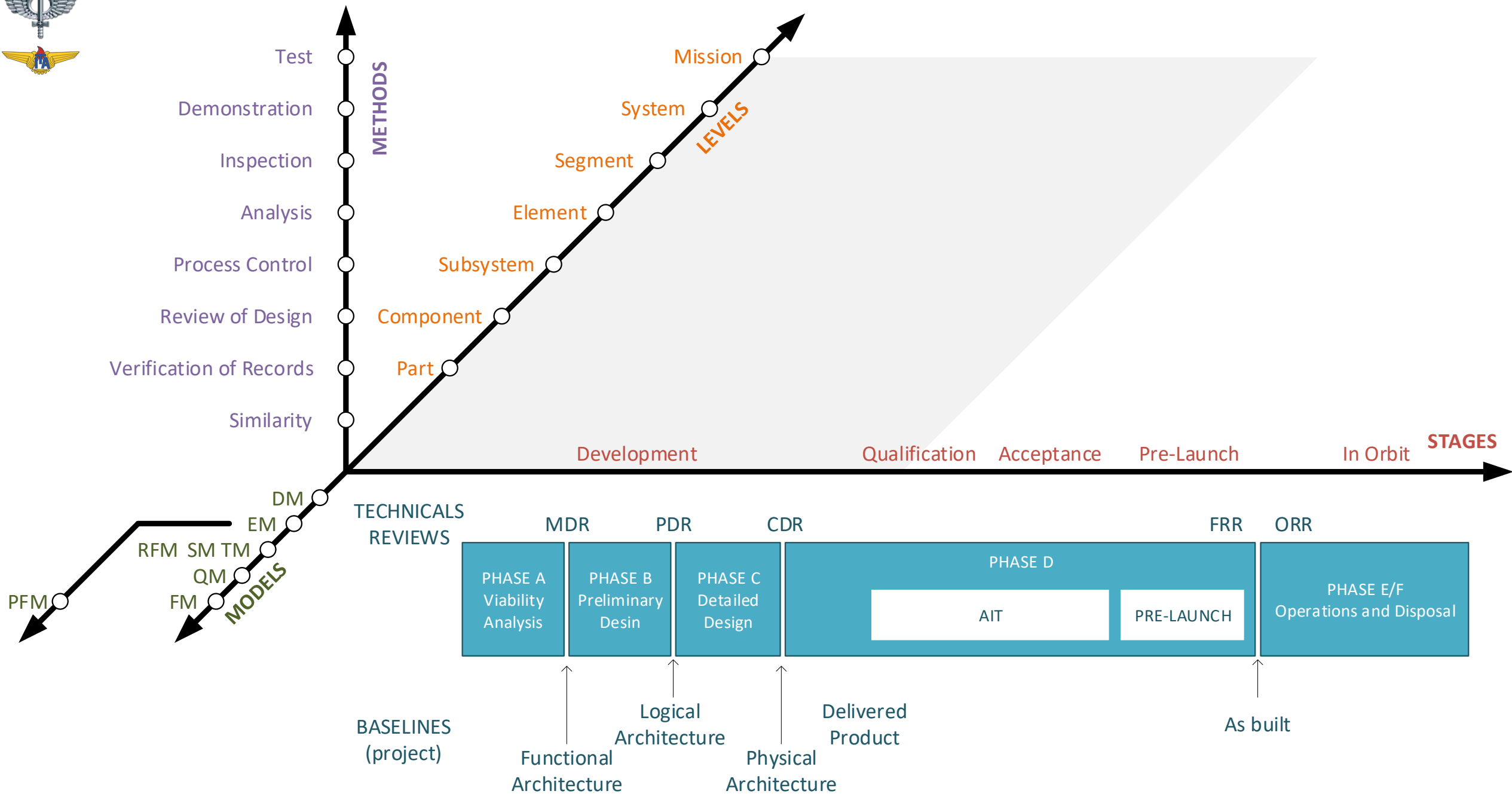
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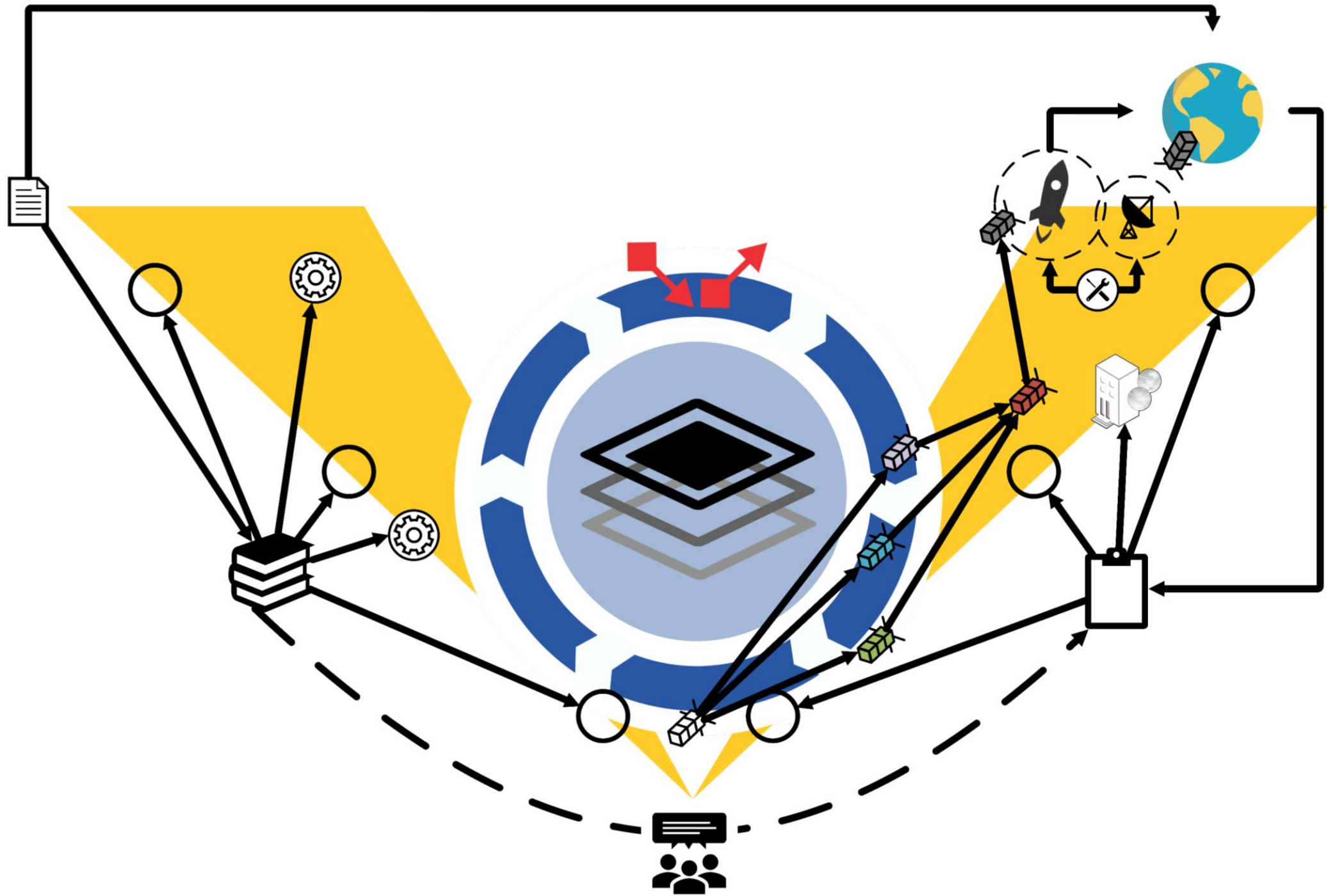
ROCKET
SCIENCE



Relationships









FINAL CONSIDERATIONS

- This course is always being “readjusted”
- **Problems** are expected.
 - *We are going to work hard to solve them.*
- *Expecting **feedbacks and lessons learned.***
- **We need** to be **patience** in this endeavor.
 - Hope you have fun learning through the course.

