Translational Engineering Forum

Concluding lecture

Aalto-yliopisto
Aalto-universitetet
Aalto University

Ivan Vujaklija

01/12/2020

Agenda

- Course wrap-up
- Final technical details

Essential Questions

- What have we done?
- To what end?

Objective

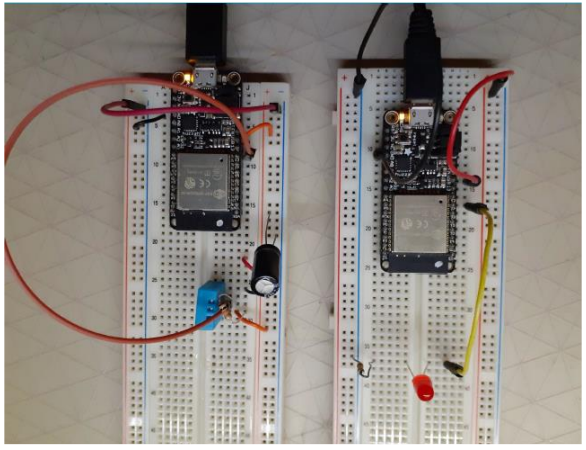
- Reflect on the course content
- Manage the future expectations
- Address any technical/content questions

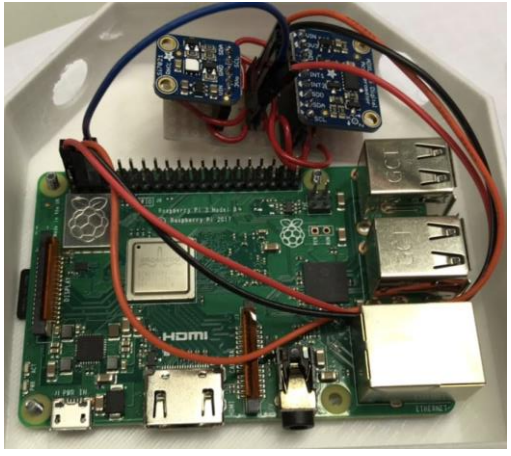
Translational Engineering Forum

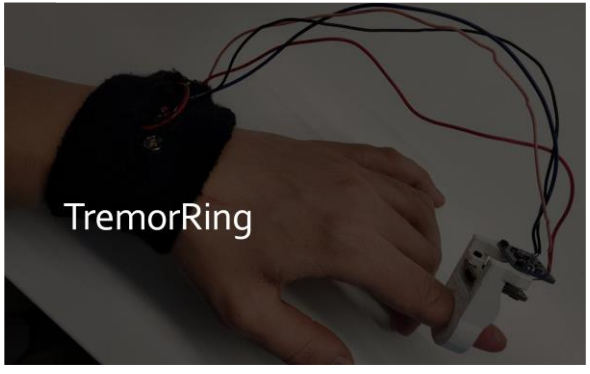
10 lectures

7 exercise sessions

4 guests in 3 forum sessions







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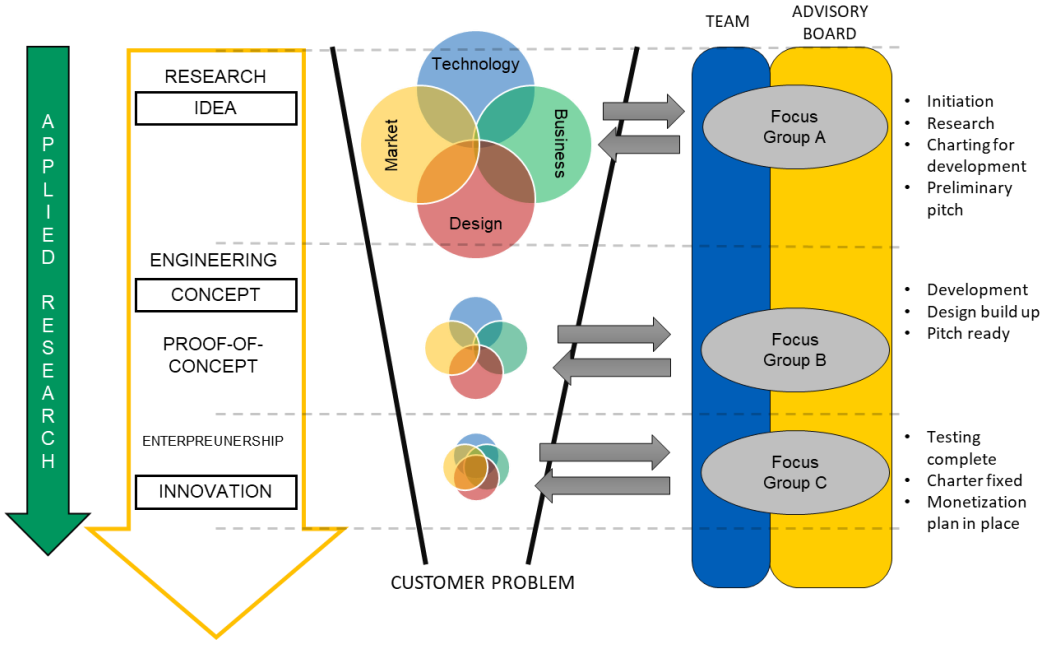
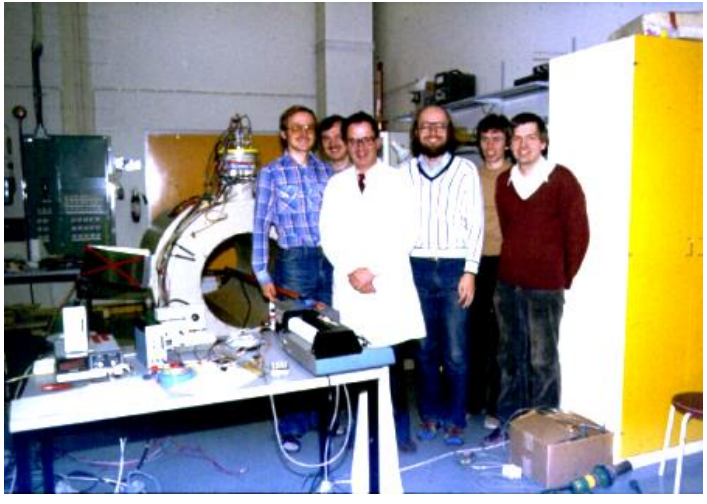
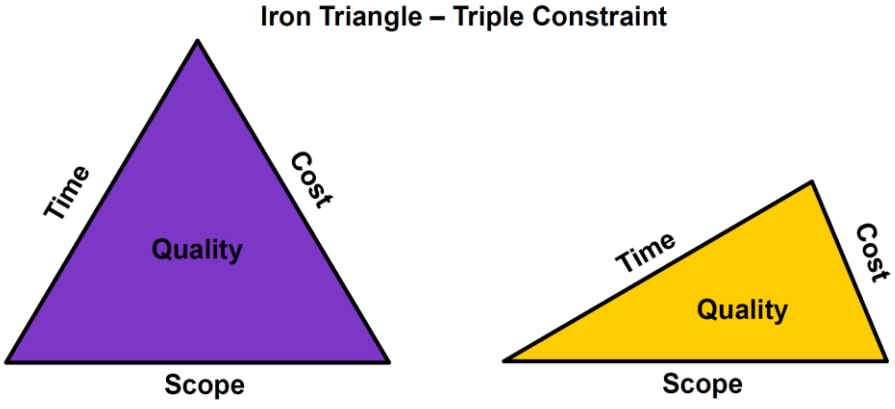
1. Introduction and local examples

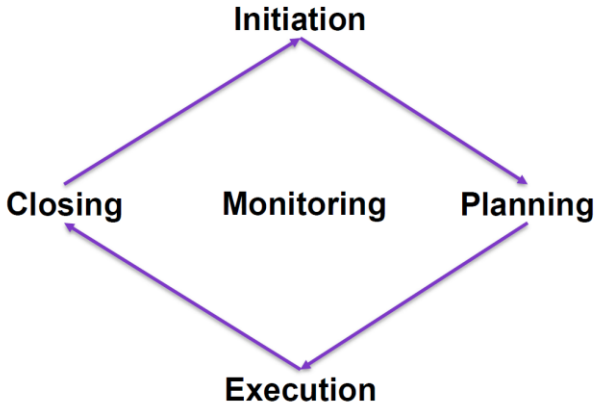




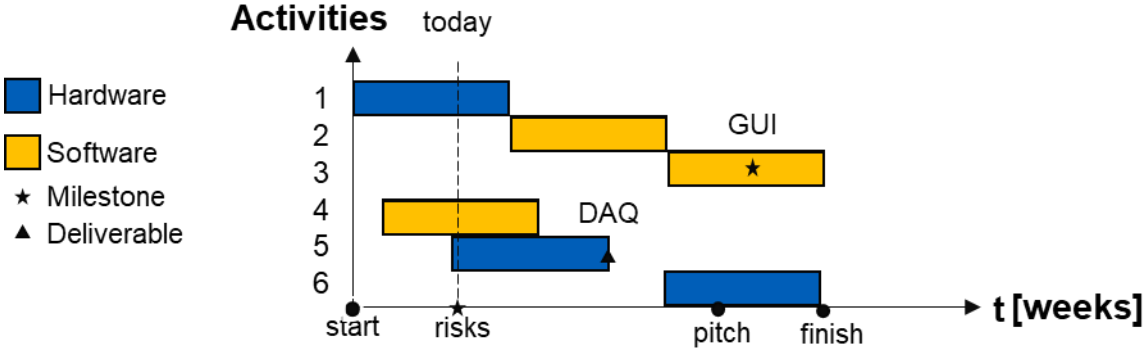
1. Introduction and local examples

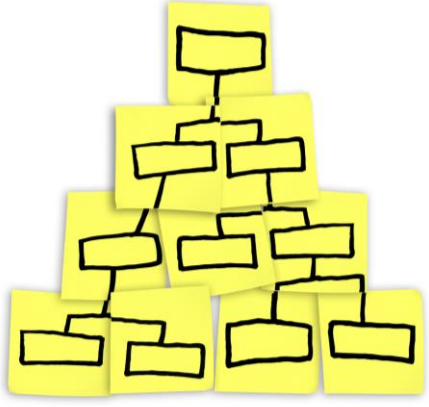
2. Engineering project management





2. Engineering project management





3. Regulations, standards and certifications

- Regulations (regulatory compliance) describe the goal that organizations aspire to achieve in their efforts to ensure that they are aware of and take steps to comply with relevant laws, policies, and regulations
- Standard is a level of quality or achievement – instructions on how to handle regulatory compliance, providing a reminder of how compliance and risk should operate together
- Certification is an action or process of providing someone or something with an official document attesting to a status or level of achievement

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3. Regulations, standards and certifications

System/Function	Failure Mode	Failure Mode Effects	Severity	Potential Causes of the Failure Mode	Current Preventative Actions	Occurrence	Current Detection Activities	Detection	Priority
Sensing/Temperature	Doesn't do	• spoiled goods • melting of the container insulation • fire	9	• sensor broken • power down	• sample testing • casing design • power control	3	• spike detection	7	7
	Measures wrong		9	• sensor broken • calibration off • reference voltage is off	• sample testing • casing design • power control • calibration (procedure and instruction)	7	• calibration log • calibration procedure	3	5
Sensing/Humidity	Doesn't do	• spoiled goods • creation of the mold • short circuiting	8	• sensor broken • power down	• sample testing • casing design • power control	4	• spike detection	7	6
	Measures wrong		7	• sensor broken • calibration off • reference voltage is off	• sample testing • casing design • power control • calibration (procedure and instruction)	7	• calibration log • calibration procedure	2	4
Actuation/Fan	Dies	• spoiled goods • melting of the container insulation • fire	9	• relay broken (voltage) • controller broken • fan broken	• sample testing • smooth start/stop • power control	4	• energy consumption monitor	5	10
	Runs too fast/slow	• spoiled goods • too dry/humid • mechanical damage	8	• relay broken (current) • controller broken	• sample testing • smooth start/stop • circuit design • power control	5	• spike detection	2	7

For each **Failure effect** rate its **user impact**:

- *Minimal* system effect – user is unaware
- *Slight* reduction in performance – user notices
- *Noticeable* drop in performance – user is disappointed
- *Part* of the system is *inoperable* – user is annoyed
- Failure *compromises user* safety or regulations

List **how you will prevent** each failure cause:

- Planned analysis
- Preliminary testing

Rate how likely it is for this cause to occur:

- (1) *Remote* – not really anticipated (1:1.000.000)
- (2) *Very low* – only under extreme circumstances (1:100.000)
- (3-4) *Low* – isolated cases (1:30.000 or 1:1000)
- (5-6) *Moderate* – occasionally (0,5%-2%)
- (7-8) *High* – often (12-15%)
- (9-10) *Very high* – it is bound to happen (>33%)

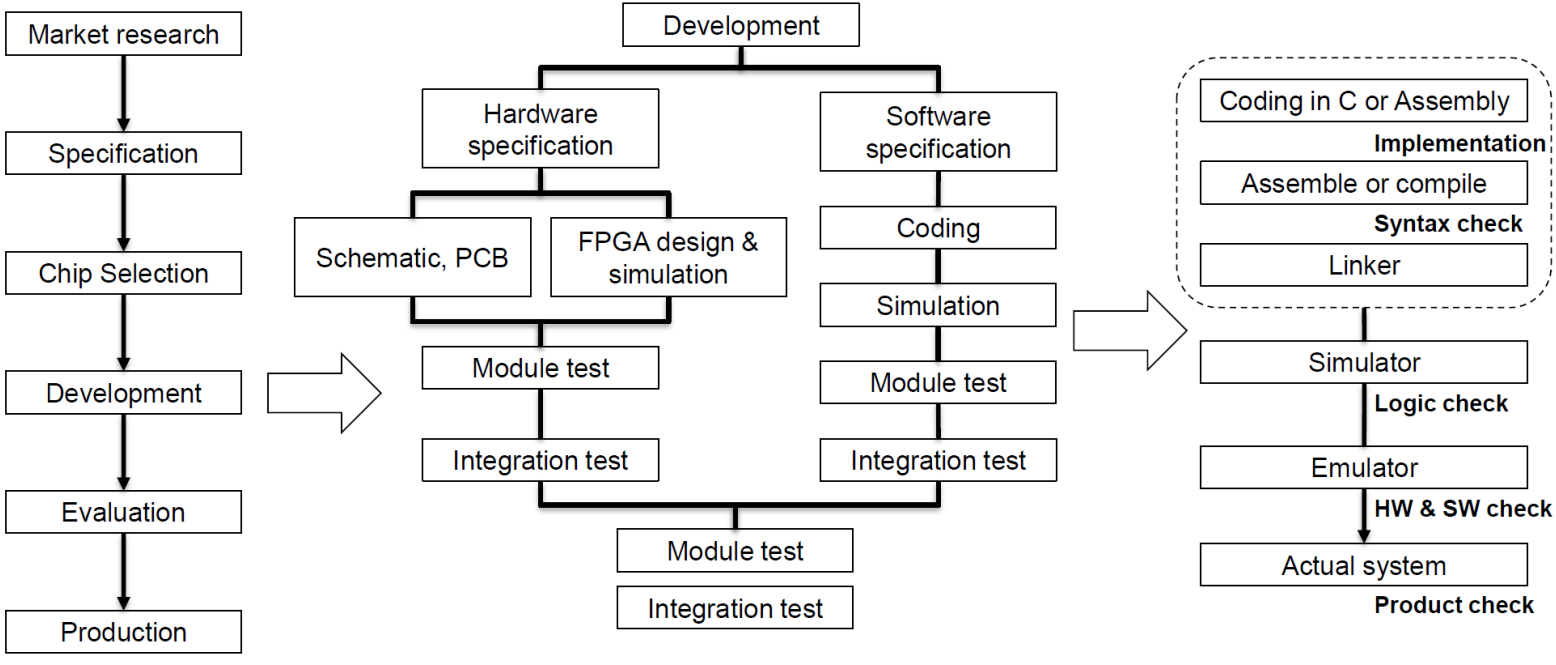
List how you **plan to detect** each failure cause:

- Customer reviews
- Final testing

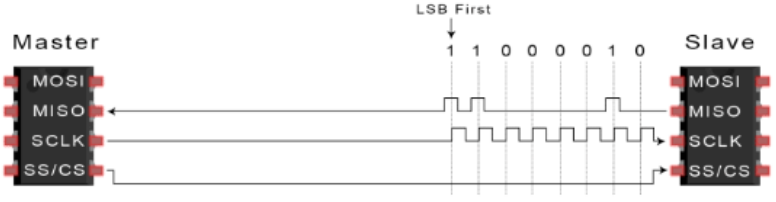
Rate how likely it is to detect this cause :

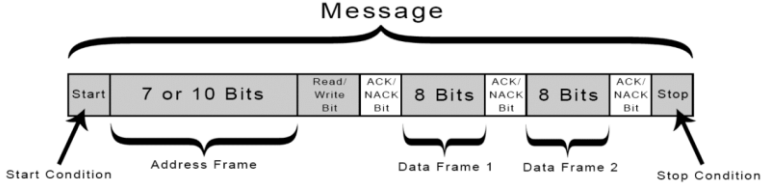
- (1-2) *Very low* – Unlikely
- (3-4) *Low* – Poor chance of detection
- (5-6) *Moderate* – Might detect it
- (7-8) *High* – Good chance of detection
- (9-10) *Very high* – Almost certain detection

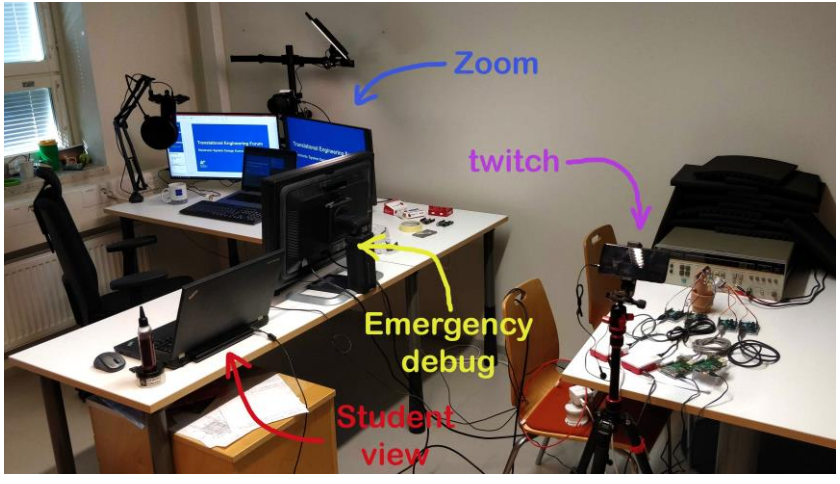
4. (Embedded) Electronic system design



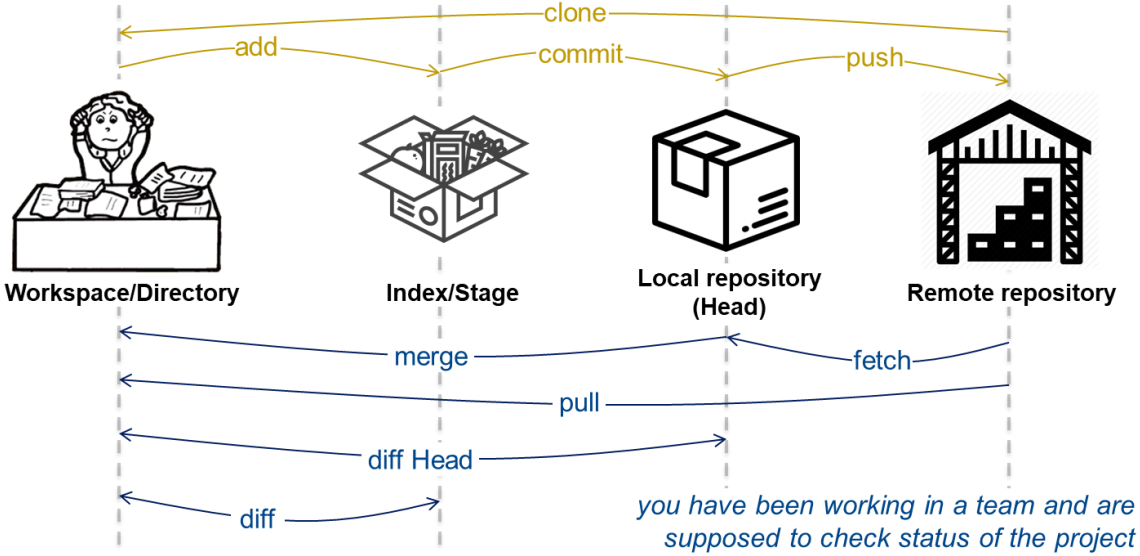
4. (Embedded) Electronic system design



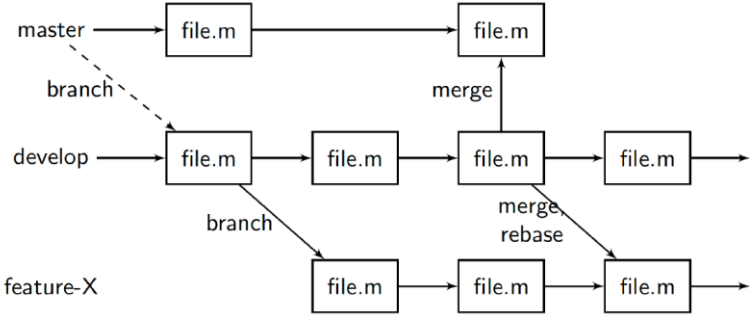




5. Software engineering



you have been working in a team and are supposed to check status of the project



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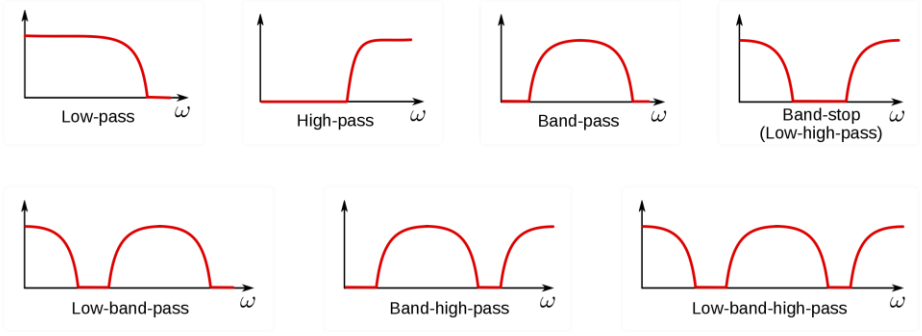
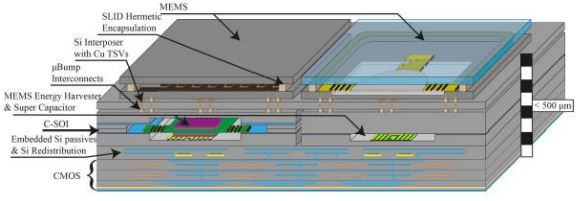
5. Software engineering & signal processing




```
L = 5; %filter length
B = ones(1,L)/L; % [0.2, 0.2, 0.2, 0.2, 0.2] numerator coefficients
A = [1]; %denominator coefficients
x = rand(1,10); %random samples for x;
y = filter(B,A,x); %filter input x and get result in y
```

6. MEMS and electronics integration

Prof. Mervi Paulasto-Kröckel

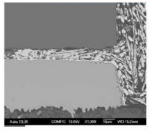


Concept for standalone sensor system

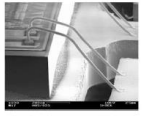
Other assembly processes

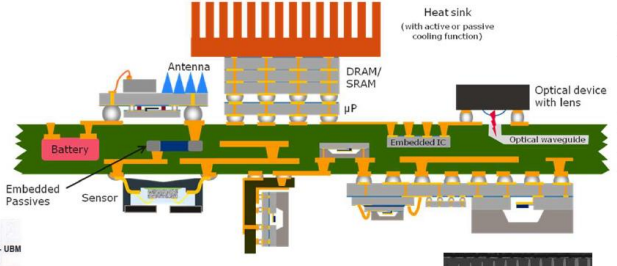
Die attach to substrate/leadframe:

Integrated circuit	Silicon, GaAs,...
Adhesion layer	Ti,TiW,Cr,...
Barrier layer	Ni, NiV,Ni(P), Co, Co(P), NiCo,...
Oxidation protection layer	Au, Pt,...
Die attach material	AuSn20, PbSn10, Ag-epoxy, Ag-glass,...
Substrate metallization	ENIG, ENEPIG, Cu|OSP, Cu|Sn, CuAg,...

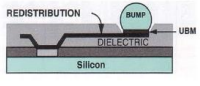


Die electrical interconnections:
- Wire bonding; Al, Cu, Au
- Flip chip; SnAgCu (SAC), SnAg including UBM adhesive (e.g. TiW) / barrier (e.g. Ni) / inertness (e.g. Au)
- µbump; Cu pillar + SnAg/SAC



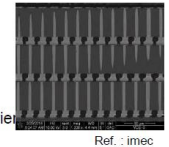


Substrate integration:
- PCB laminates, glass epoxy FR4 core – Cu (+HDI)
- Chip embedding
- Flex PCB, polyimide – Cu
- Printed electronics
- Ceramic substrates, Al2O3, AlN, Direct-Copper-Bonded (DCB)



Encapsulation/protection:
- Mold compounds; SiO2-filled epoxies
- Underfills
- Redistribution of electrical I/Os; BCB, PI
- Conformal coatings, silicone

Die-to-die interconnections:
- Through silicon via (TSV)
- Cu or poly-Si
- Insulation (e.g. SiO2)/ barrier (e.g. TaN) / metallization layers (Ru, Cu)



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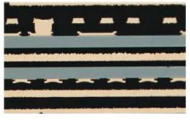
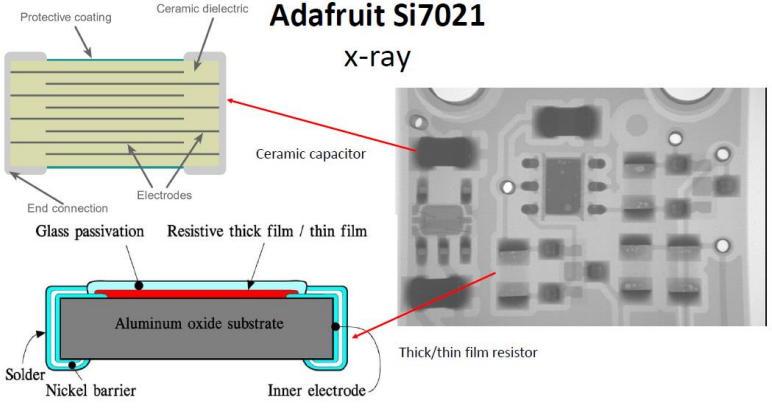
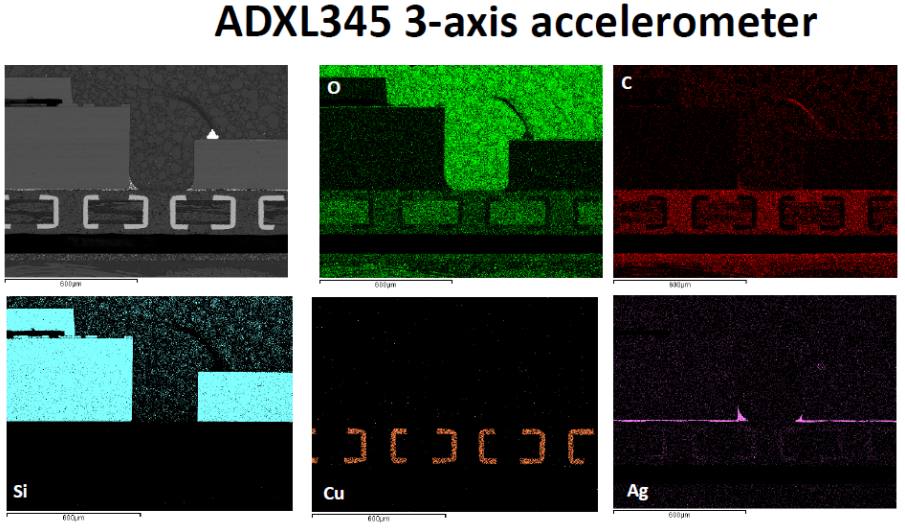


6. MEMS and electronics integration

Dr. Vesa Vuorinen





Forum

7. Forum 1


Aalto University
School of Electrical
Engineering
Jose Gonzales-Vargas
Research & Innovation Manager at Ottobock Healthcare
Translational Engineering Forum
10/11/2020

8. Forum 2


Aalto University
School of Electrical
Engineering
Irene Mendez Guerra
& Ben Lakey
CTO and CEO at Naviga
Translational Engineering Forum
17/11/2020

9. Forum 3


Aalto University
School of Electrical
Engineering
Milan Pešić
Manager Device and Technology Development
at Applied Materials
Translational Engineering Forum
24/11/2020

To what end?

Now you hopefully:

- Understand the process and requirements to convert basic research into innovative products and technologies
- Apply the process of demand-based product development
- Define core knowledge and skills needed to design multidisciplinary technical products
- Design a concept for an electronic device and anticipate main challenges in the entity including SW/HW interfaces, EMC, assembly and manufacturing
- Identify processes needed for quality assurance in product development

So you can:

- Start more comprehensive projects
- Initiate new ventures within your area of expertise and interest
- Have more complete understanding of engineering activities and their impact
- Be more competitive and have a greater understanding of your own work
- Have easier time in other courses

Final group report

Deadline **01/12** 23:59

This is an extension of your previous report. Therefore, apart from new content it should also account for provided comments.

There is no predefined format of the report as projects are highly individual, but it should still somehow convey at least the following:

> *Background research / introduction of the problem, Description of the team and individual roles, Project charter (objectives, stakeholders, timeline, communication plan, …), sensor consideration, System design, Legislative considerations (regulations, standards and certifications), Upscaling plan*

Reports will be evaluated based on their: technical content, clarity and style of writing, organization, implementation of the methods covered in the course

Short written feedback will be provided within the two weeks from each submission.

To be submitted through MyCourses (Assignments) as a PDF named:
GroupNumber_GroupReport-ReportNumber-2020.pdf

Final peer evaluation

Deadline **06/12** 23:59

Send score sheets via email directly to ivan.vujaklija@aalto.fi

Students should evaluate (0-5) their own efforts as well as their group peers by filling in the following table on two occasions.

The peer evaluation will be **fully anonymous**, and each student will communicate these directly with the instructor.

One week following each submission students will receive the average of all grades.

Do not submit uncontested grading!

	Self	Peer 1	Peer 2	…	Peer N
Reaching goals					
Meeting deadlines					
Participation in group work					
Commitment					
Quality					
Proactivity					
Learning					

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Thank you!

Online Course Feedback