Entrepreneurship @ CERN

TERABEE

“We digitize movement”

Max Ruffo @CERN, 22.07.2019

Who are you!?

Three types with different drives and strategies:

1. Problem solver

2. Adventurer

3. Visionary / Dreamer

4. Lost in profession/life

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Agenda

- Terabee
  - The start
  - Who we are today
  - What we do
    - Technology
    - Applications
- Lessons learnt
  - Factor for success
- What else
- Now action!
  - Team exercise

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Terabee
Where did it start

The Vision: Prometheus

PLUS…. ***PASSION***:

- Programmer of video games in BASIC and FORTRAN (16 yrs old)
- Mech Engineering studies
- Airplane Model maker
- 13 years professional skydiving (World Cup Arizona 2000)
- PPL Flying Airplanes

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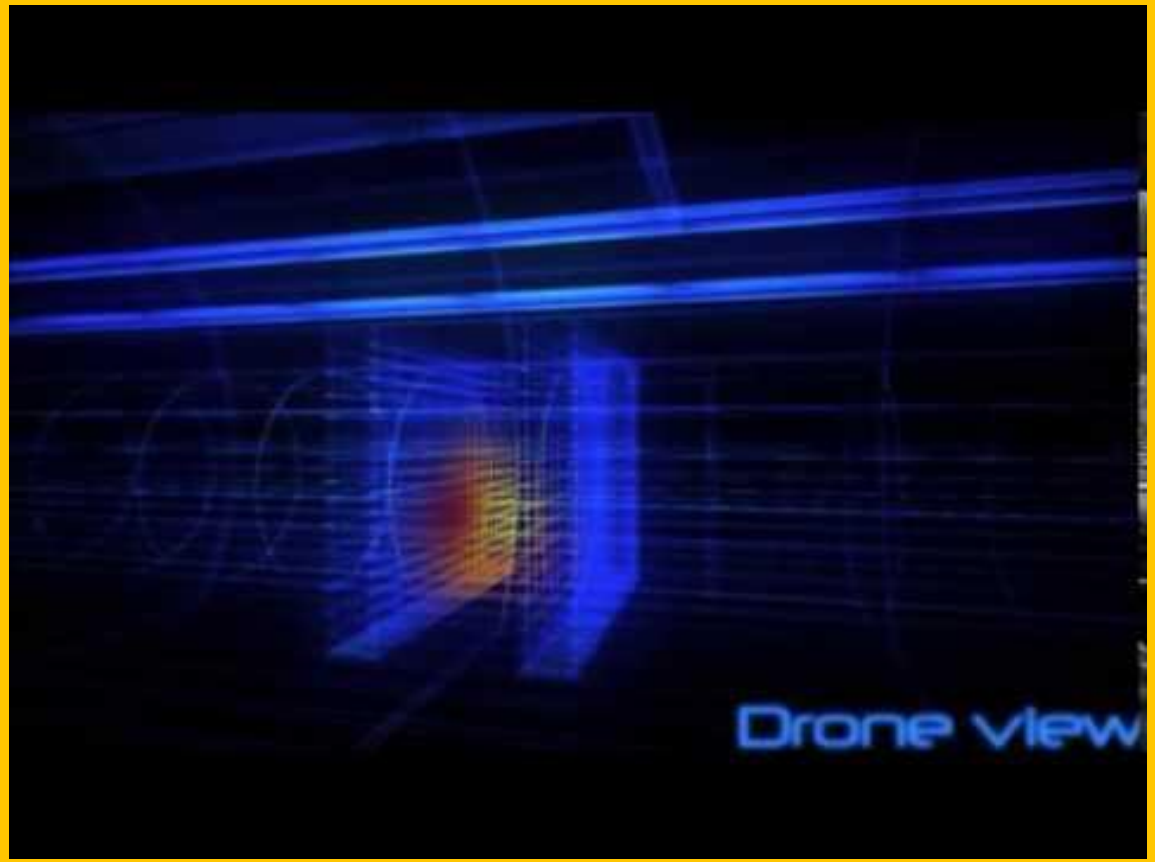
MISSION:

Achieve safe autonomous navigation for drones and fast moving robotics



Who we are today

Terabee in numbers

Founded in **2012** and constantly innovating

International team:
40 people
15 nationalities
15+ languages spoken!

AUTOMATICA
OPTIMIZE YOUR PRODUCTION
Elected N.1 Innovator in Machine Automation

INNO ROBO PARIS
MAY 24-26 2016
FRANCE
Top 6 '16

AWARD WINNER EVC
Best 25 in EU '15&'16

PIONEERS 500
Top 10 '16

web summit
Top 30 worldwide 2015

"**CERN Technology Partner**", with **40+** months of joint projects

- **½km** from CERN
- **5km** from Geneva Airport (GVA)

Multiple award-winners:
7 prizes in first **4** years

8 ***Time-of-Flight*** sensors launched to market, **2** ***Thermal***

~20'000 LiDAR sensors sold

CERN
technolog

Mission in 2012:
Inspections using drones and robots

Today:
“We digitize movement”

We make PRODUCTS

“The smallest, lightest and lowest cost 3D sensors”

Off-the-shelf sensors and 3D cameras

ToF distance sensors

Evo 60m

Evo 600Hz

Evo 3m

TR One

TR Duo

IND-TOF-1

ToF sensor arrays

Evo Hub

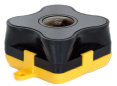
Evo Tower

Multiflex

3D ToF cameras

3Dcam 80x60

Evo 64px



IR Thermal cameras

Evo Thermal 90

Evo Thermal 33

[Learn more about sensor portfolio]

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Micro ToF 3D camera

https://youtu.be/ocwp2FYDnLI

Micro Thermal cameras

https://youtu.be/Q6coj7Ca_aM

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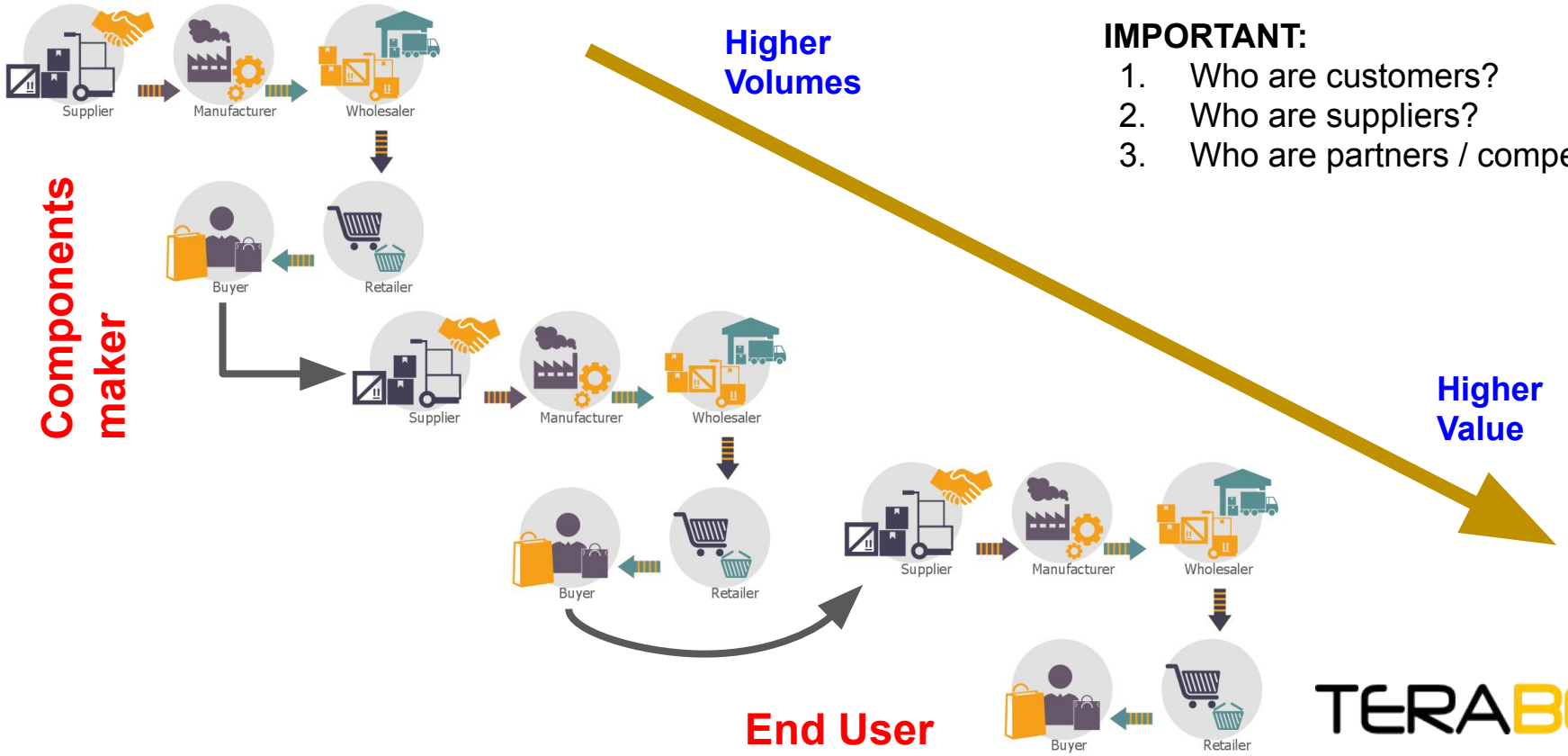
But… Where are you placed in the Value Chain?



IMPORTANT:

1. Who are customers?
2. Who are suppliers?
3. Who are partners / competitors?

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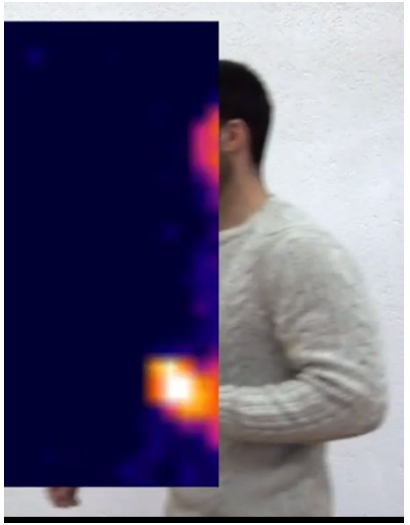
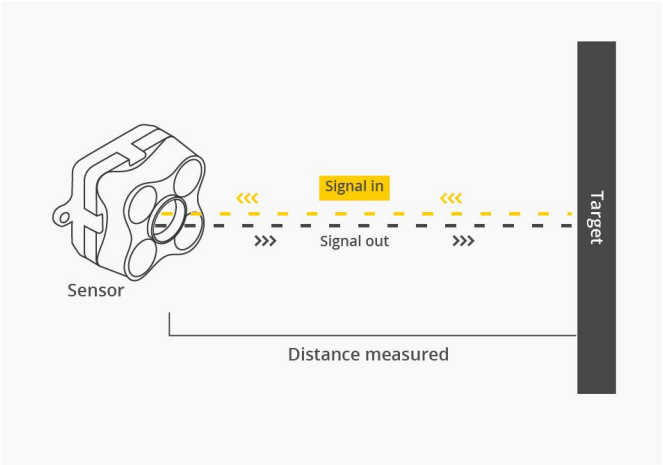
Our technology bricks

Several technologies' expertise and developments, all to *digitize movements*:

1. **LED Time-of-Flight**
   a. Rangefinders
   b. 3D-cameras
2. **Radio-Frequency**
   a. Indoor GPS (2-9GHz)
   b. Radar (20-120GHz!)
3. Vision Intelligence
4. **Thermal cameras**
5. Inertial Measurement Units





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All basic technology....

But what do you do with it? Any problem to solve?

Technology is nothing without *APPLICATION* !!

And if you can differentiate yourself, what better than a *PHILOSOPHY* ??

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Lean Sensing

(The alternative to AI)

Definition

Find the ***best physical detection method for given applications***, resulting in computationally light control units, and obtaining faster and safer data processing and decision making

We call it "***LEAN SENSING***"

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The “Lean Sensing” philosophy

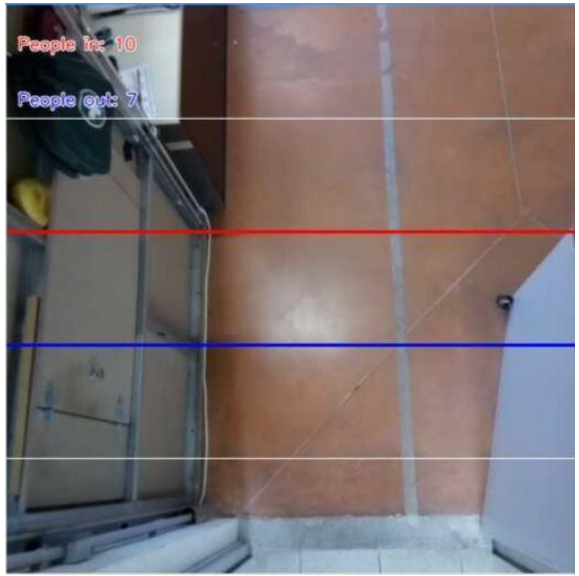
Less data, but more meaningful

=

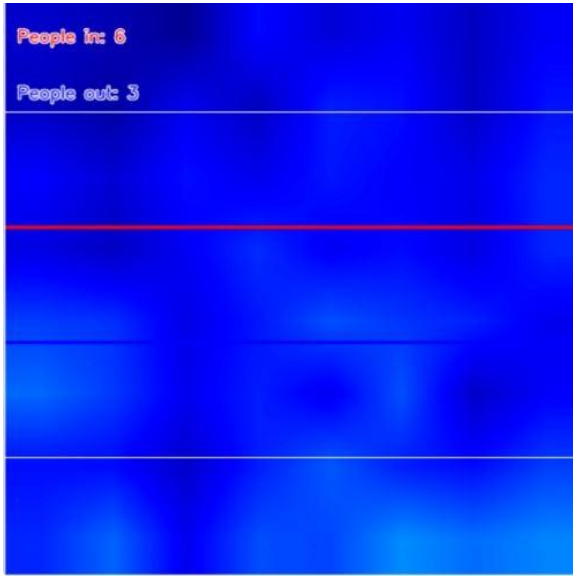
Robust and Efficient

Example application: people counting

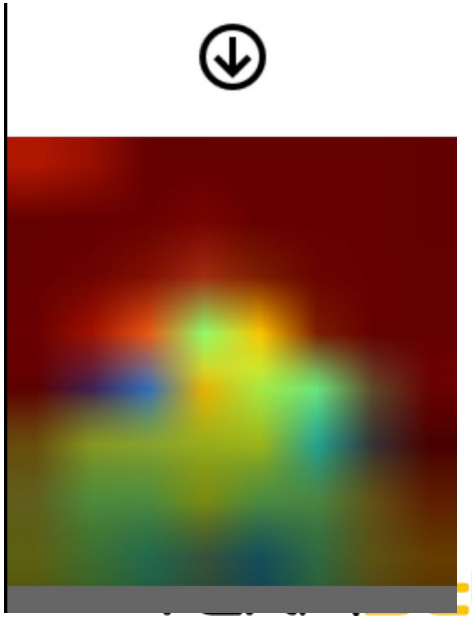
Vision



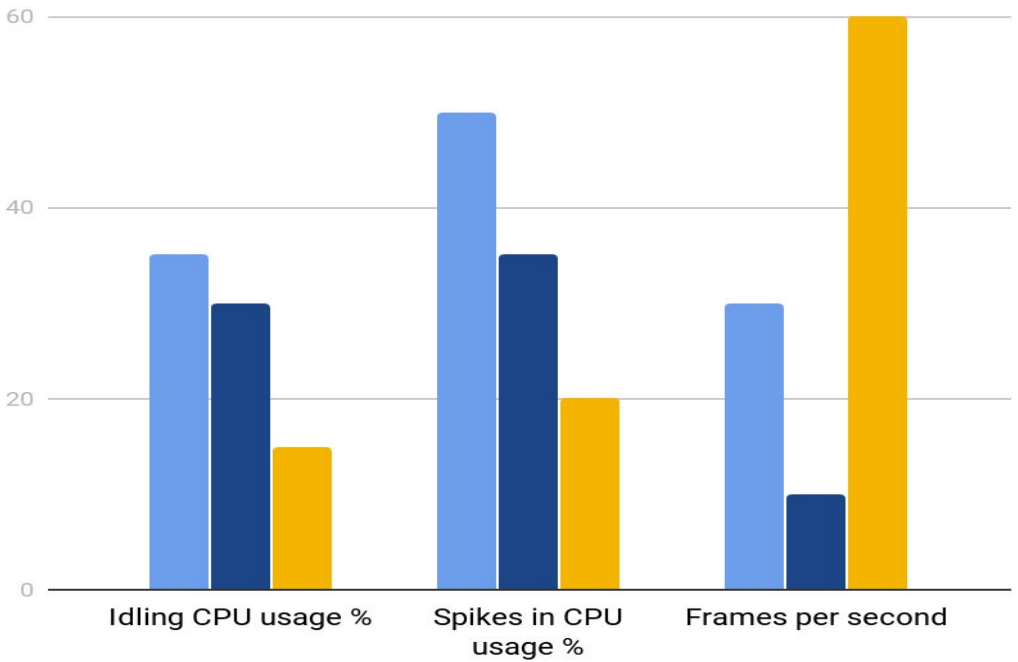
Thermal



ToF Evo-64



Example application: people counting



Evo-64 (ToF) Advantages

- Adults/kids discrimination
- Non-intrusive / privacy ok
- Accurate
- Easily scalable
- Sleek design
- Easy to install
- High refresh rate

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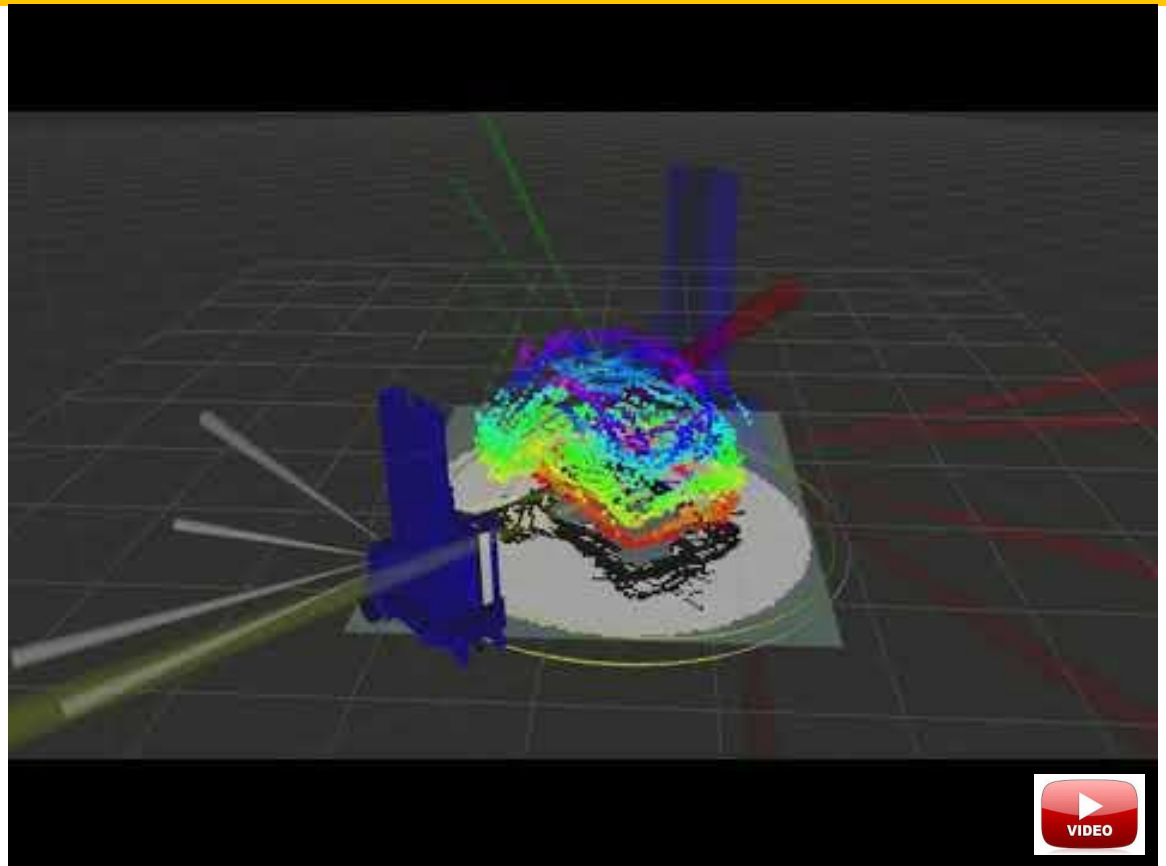
Good Example of “*Lean sensing*”



Re-made guidance and control system of industrial robot:

- Hybrid 2D SLAM and 3D mapping
- 200kg robot from a customer
- Rotation at 1.3m/s
- Pallet shape detection
- Trajectory optimization for best wrapping
- Contactless navigation
- N. of sensors: 8-16

=> Control based on <20 variables

Simple, Safe and Robust!

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Includes Relocalization!

Relative positioning at its best,
Thanks to Lean Sensing!

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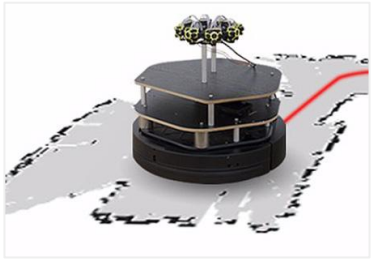
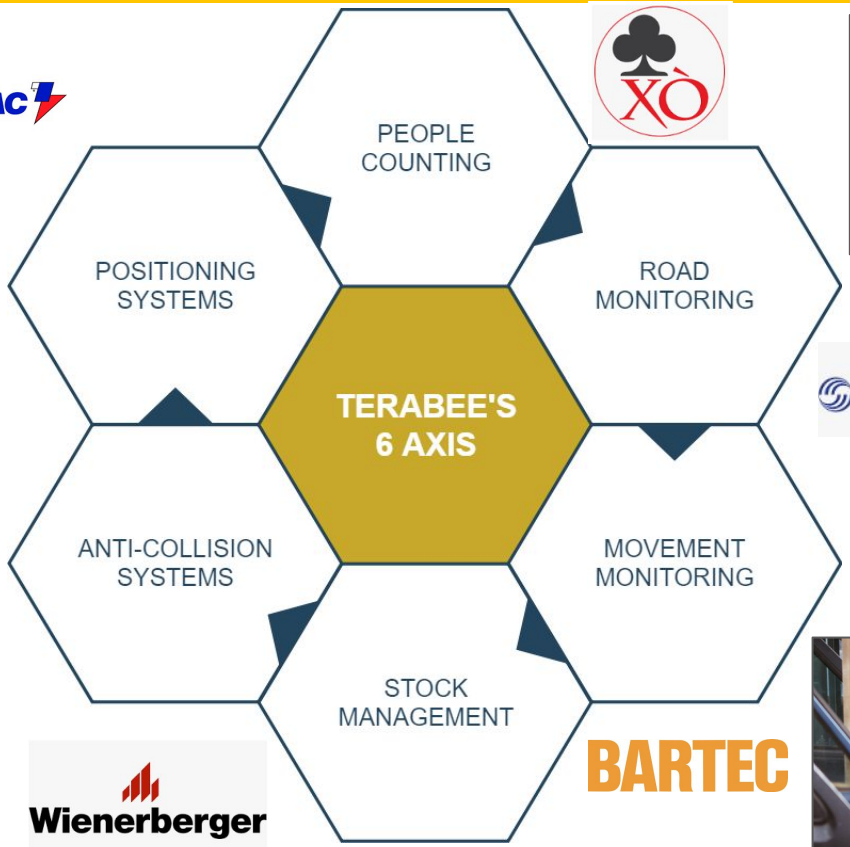
Lean Sensing projects with:

Markets and Applications axes

ROBOPAC

Mobile Robotics





XÒ

IoT / Smart Cities

AIRBUS

ABB

Wienerberger

BARTEC

Industrial Automation

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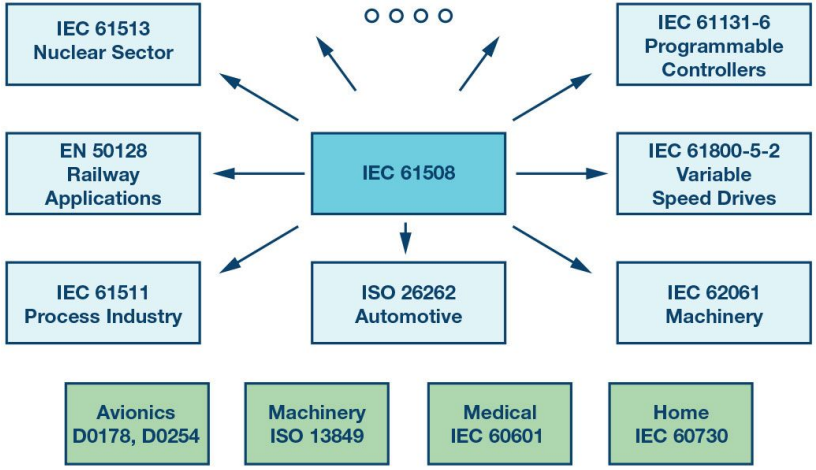
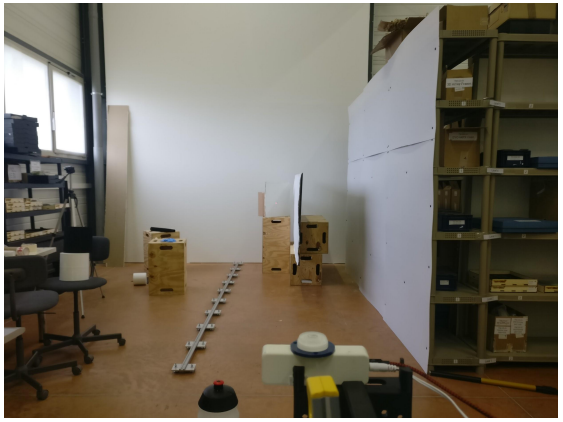
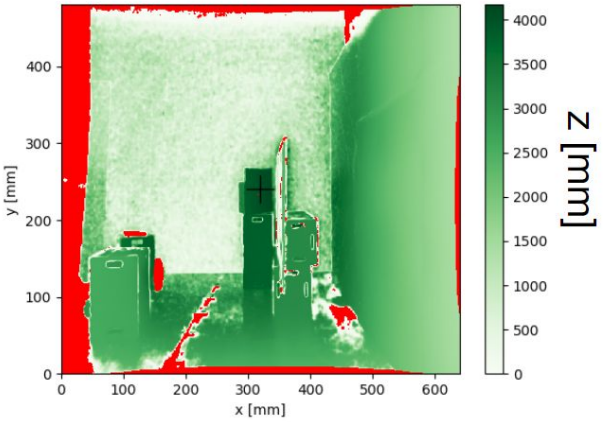
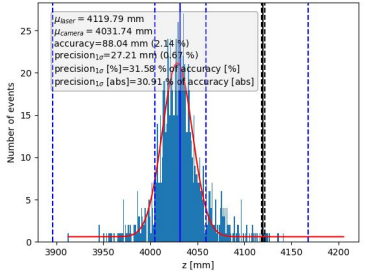
From Lean Sensing to Functional Safety

Committed to be **first with a <u>safety certified 3D camera</u> for industrial use**









Examples of Lean Sensing projects

Anti-collision for drones

Only 8 sensors made possible to fly between tree branches

- 2 degrees field of view
  1 m → 3X3 cm
  5 m → 17X17 cm
  10 m → 35X35 cm

- No need of extensive heavy point cloud analysis.

Simple, fast and Robust!

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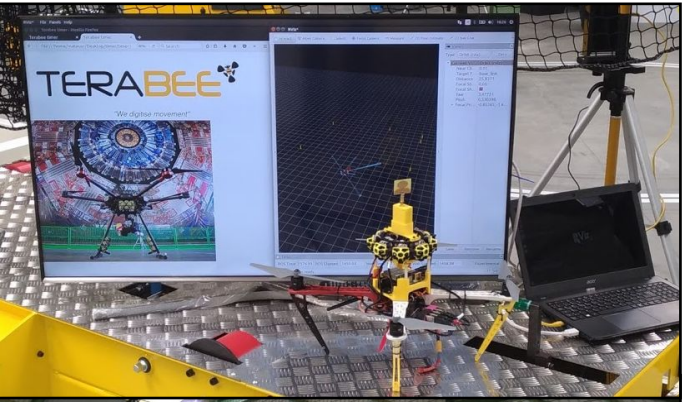
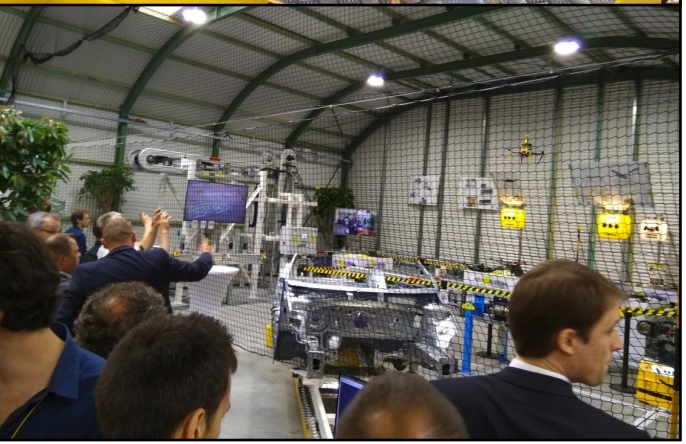
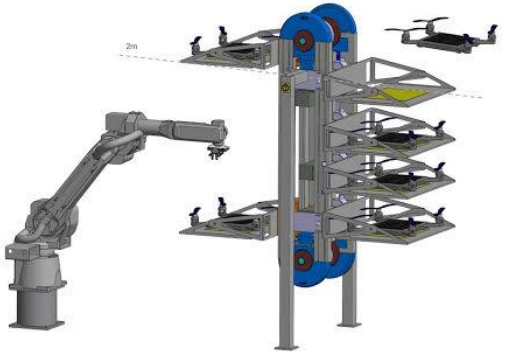
Our latest goal for drones: Revolution in production plants







TÜNKERS-NICKEL Dosiersysteme GmbH

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Anti-collision on 6 axis robot arm

26 custom sensors configuration for a 360 degrees of protection around an aerospace drilling tool.

- Collision detection and safety STOP
- No need of extensive heavy point cloud analysis.

Simple, safe and Robust!

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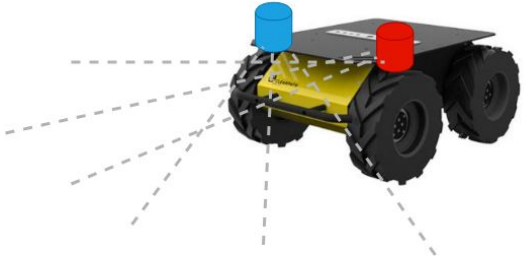
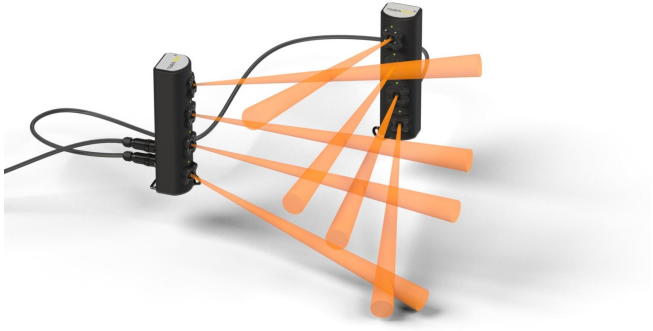
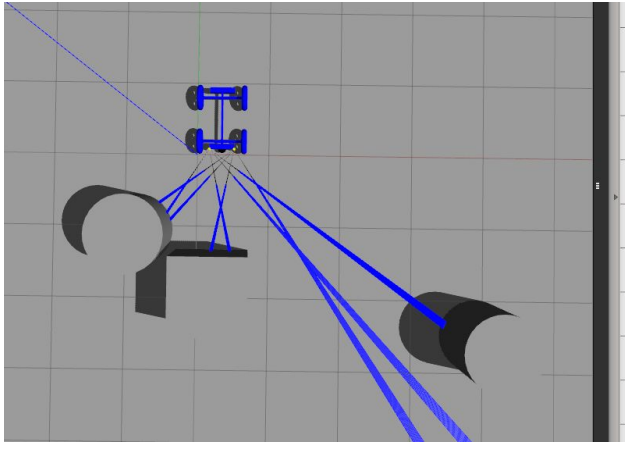
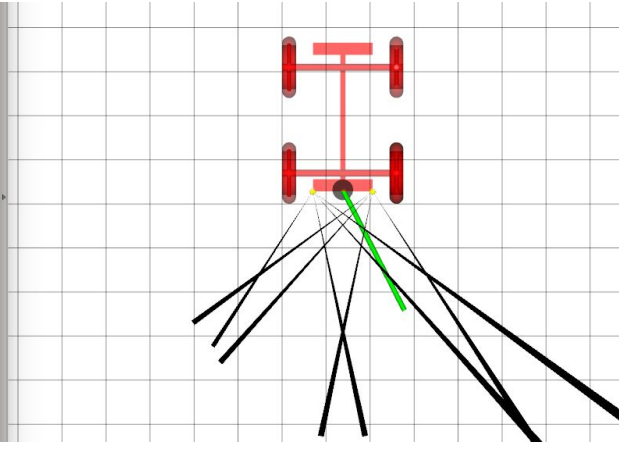
Anti-collision for AGVs









- 8 sensors crossed beams to create 2D or 3D protection area
- A stop function is implemented in case of collision emergency.
- A Guided vector is transmitted to the control of the AGV for object avoidance.

Simple, safe and Robust!

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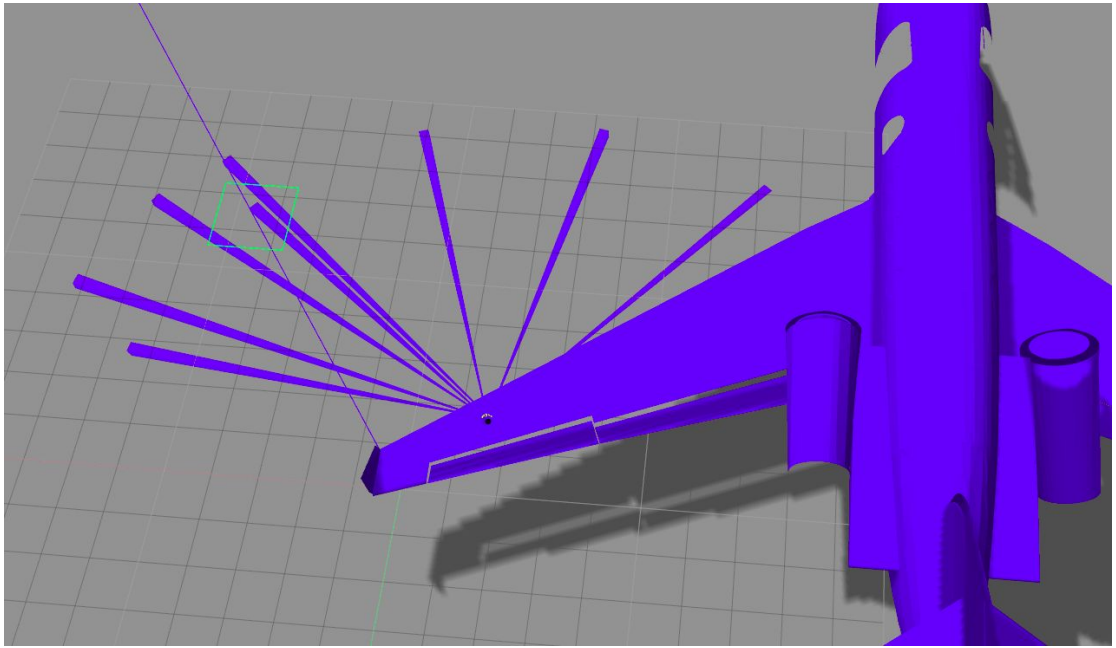
Taxi-Plane Anti-collision



8 sensors made possible to avoid crashes of the wing when handling planes during taxi operations.

- No more scratches on the wing tip due bad human maneuver.
- No need of extensive heavy point cloud analysis.

Simple, safe and Robust!

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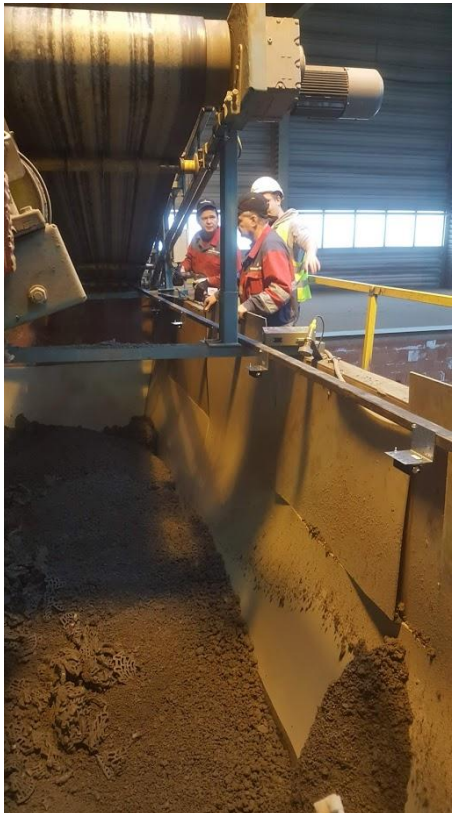
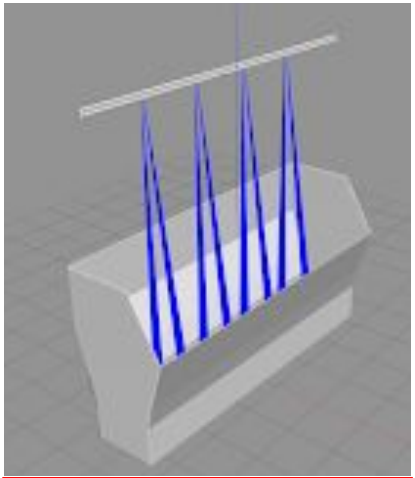
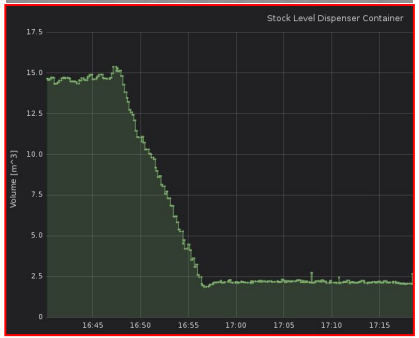
Stock level monitoring







Only 8 sensors used to measure volume of material in wide container.

- Harsh industrial environment
- No need of extensive heavy point cloud detection.

Simple, Safe and Robust!

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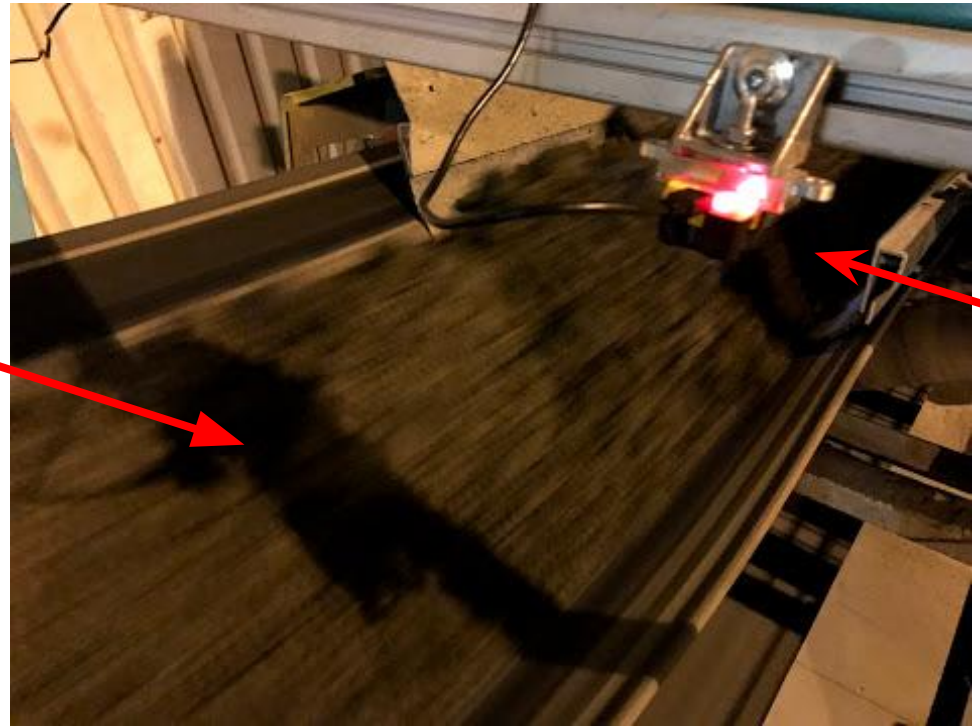
Conveyor belt position monitoring



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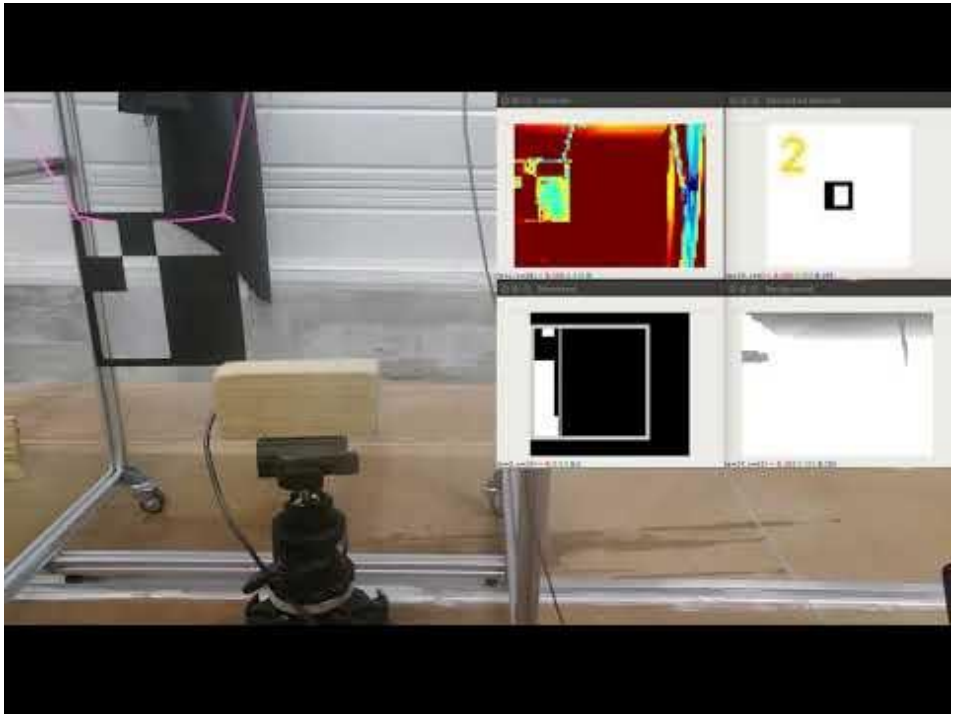
3D Metal barcode scanner



Do you want to identify objects going to ovens?

Metal barcodes are the solution!

Simple, Safe and Robust!

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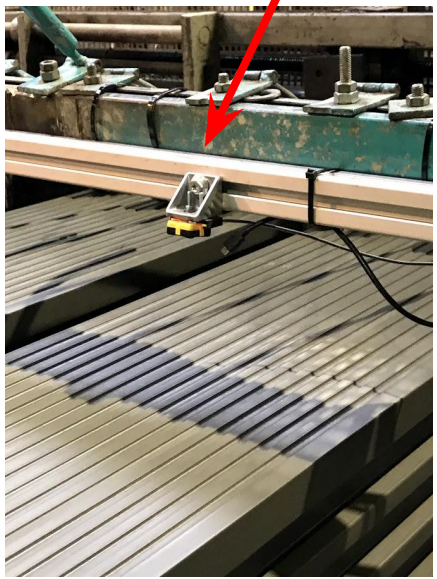
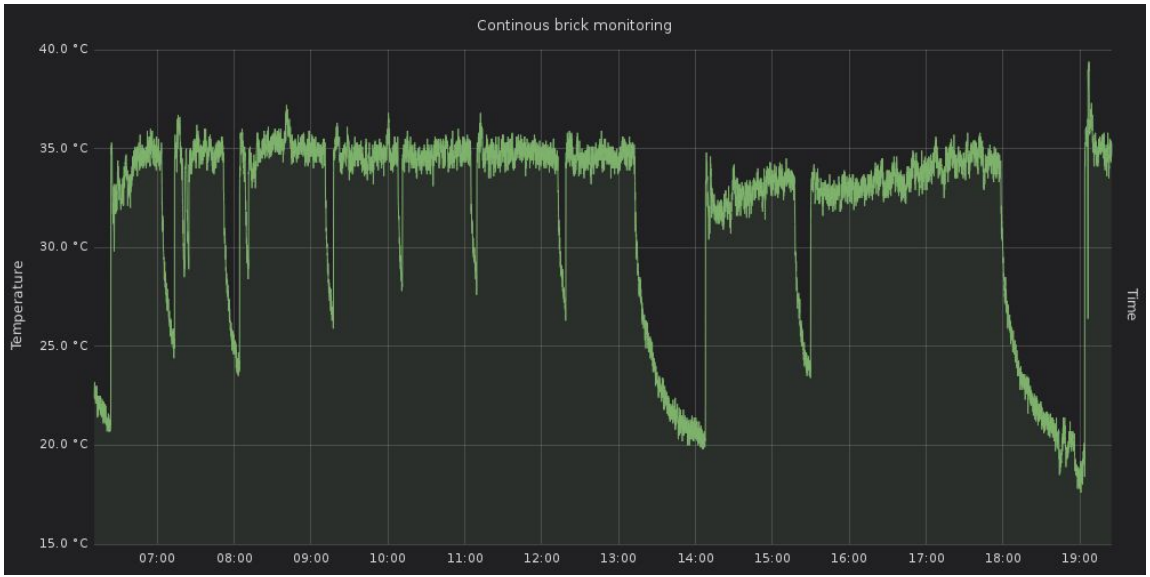
Extrusion temp monitoring

Evo Thermal



Extruded brick before cut

Temperature monitoring



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Bricks automatic cooling

Simple 32X32 pixel thermal camera.

- Process Improvement: Bricks temperature Monitoring for increased efficiency

Simple, Safe and Robust!

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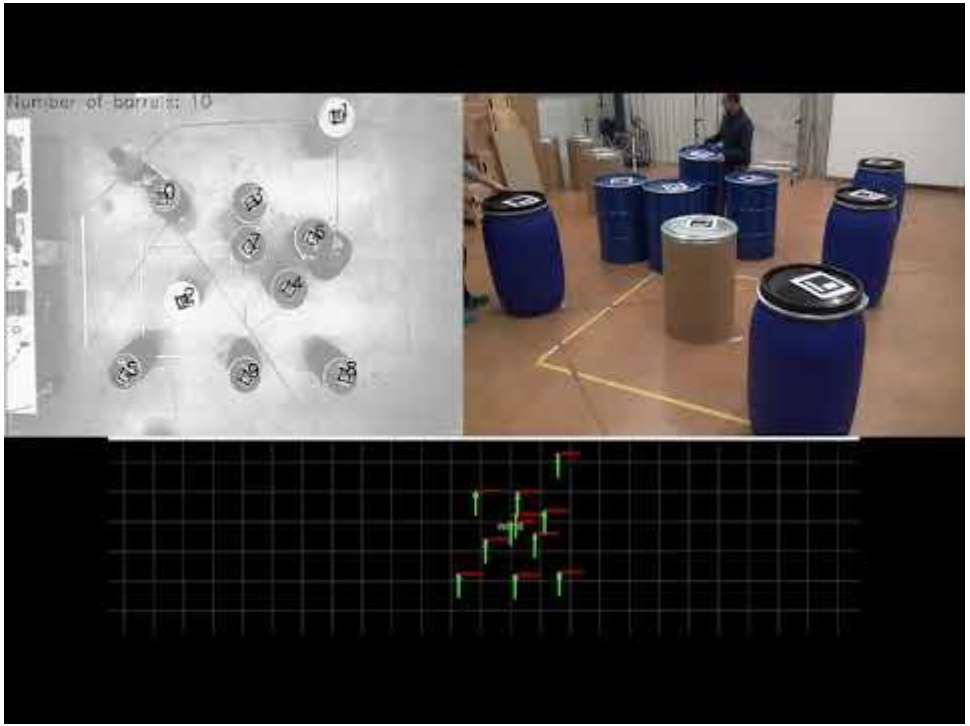
Barrel Counting & positioning



How many barrels are in stock?
And what is where?

- Efficiency increase
- Stock monitoring
- Object control and identification

Simple, Safe and Robust!

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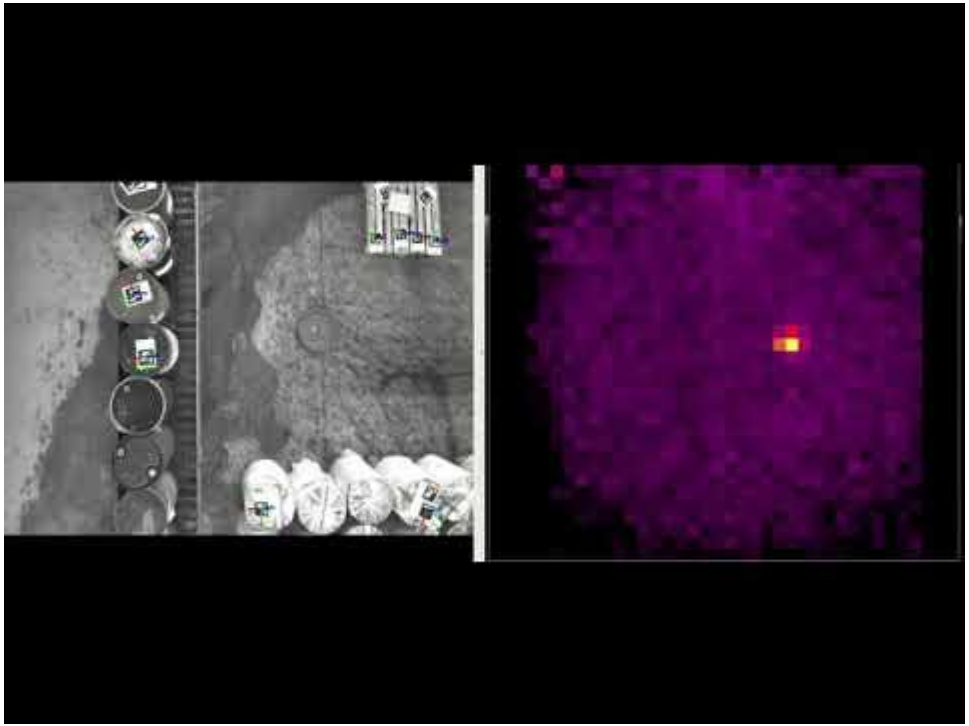
Self-Ignition prevention



Toxic material can self ignite, how to monitor temperature in wide spaces and at low cost?

- 90 deg thermal camera
- Hot spot detection
- Super LOW COST!

Simple, Safe and Robust!

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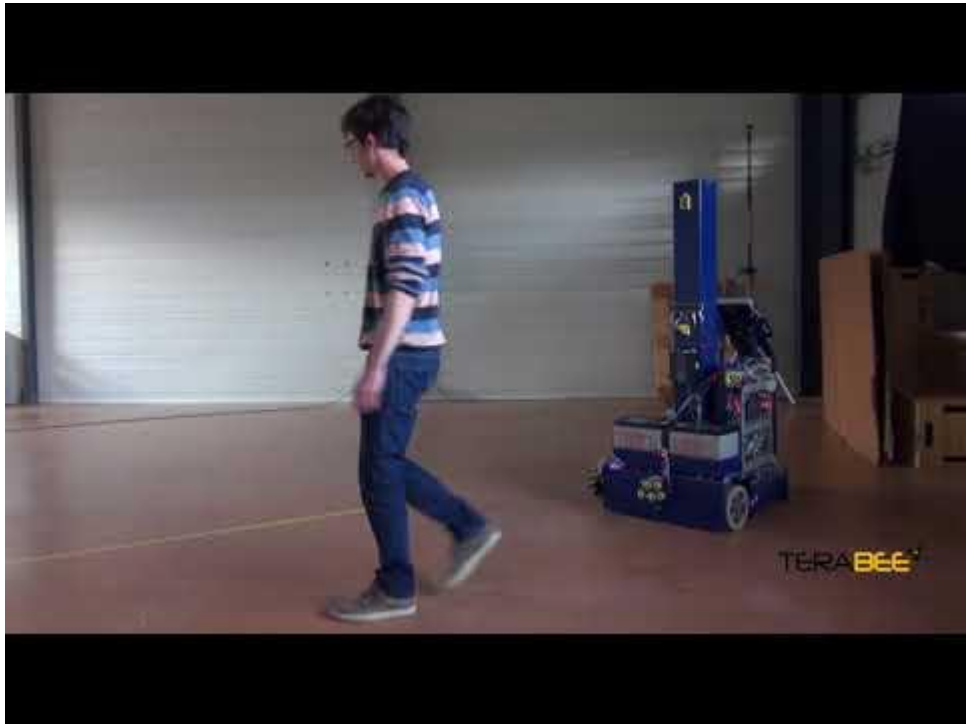
Follow-me function:
VGA depth vs 3 *“directional pixels”*

Classic 3D VGA approach



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Follow-me based on RF!

Are big machinery difficult to push around?

No more effort!

- Press a button to Start,
  Release the button to Stop
- System based only on RF
- Super simple - 100 lines of code!

Simple, Safe and Robust!

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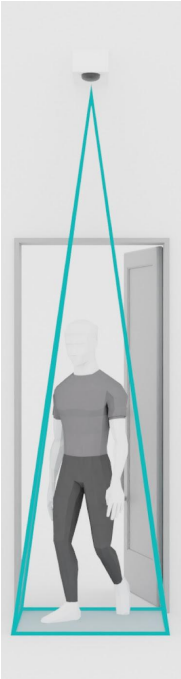
People Counting with 64 pixels



https://youtu.be/3DOQ-0ZbgLw

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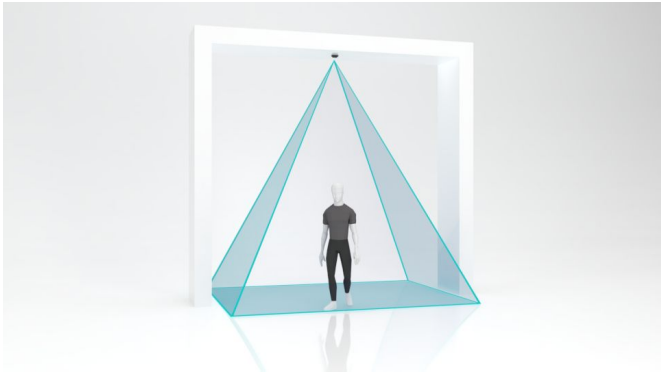
People counting with 80x60 pixels



GDPR compliant!
(Privacy friendly)
(Only depth information, no people recognition)

https://youtu.be/IFRVnMQXV2g

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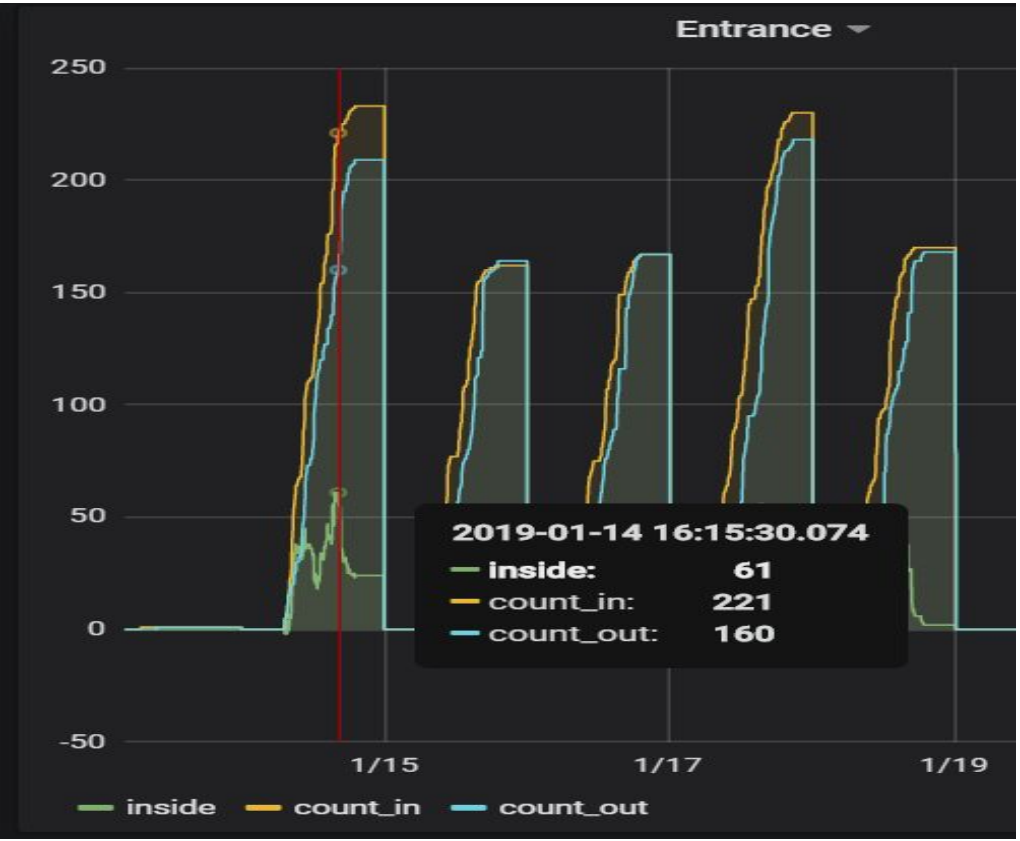
IoT backend and analytics



- Monitor people in's and out's
- Get count of people inside rooms, areas, floors, and their flow during the day

Metrics:

- Building/Room occupancy data (Daily/Weekly/Monthly/Yearly!)
- Data for staff planning decisions
- Sales conversion information
- Marketing/Event effectiveness

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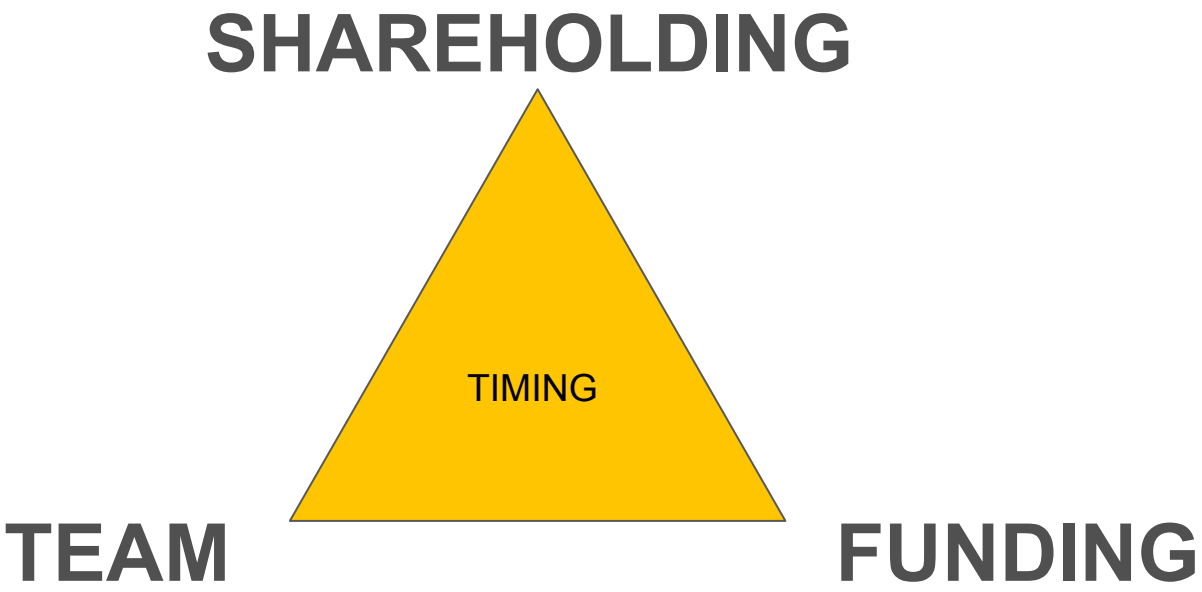
Raising a company: Lessons Learnt

Triple factor for success



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FUNDING (Importance of)

1. STOP thinking it's the main problem - **it's NOT**!!!! (Making the business work is the problem.....)
   a. No money, no investment, no chance
   b. Too much money = pressure
2. Funding is a delicate *"Beast"* and needs to be optimized in **timing**
3. It's never about *"money in"*, but about ***"money in - money out"***
   a. Keep burn rate as low as possible (almost RULE N.1 for success)

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Funding / Burning strategies

VS

SHAREHOLDING (Importance of)

1. Attention to Pressure that could come from above
2. Avoid VC if you have the luxury
3. Avoid “Consultants”
4. Avoid Groups of Business Angels & time wasters (little money lots of talking)

Remember that a **SHAREHOLDER is not “money”**, he’s a player in your game (bringing positive / negative value)

- ***Would you hire him/her/this entity if it was an employee?***

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TEAM & Hiring (Importance of)

1. Attention to Mercenaries!!! Hire people in mission, not in personal growth
2. **Gut feelings** are important
3. Always balance **Thinkers and Doers**, but remember that a company is made by Doers….
4. **Senior people** often brings practice that will slow you down
    a. Junior people can learn, even if very painful
    b. Insert senior people when you need to keep a balance (later stage)
5. Do everything possible to **keep the people that you retain key to success**
6. Above 15 people, make sure you have clear **structure and responsibilities** (it's your new job unless you have a dragon COO)

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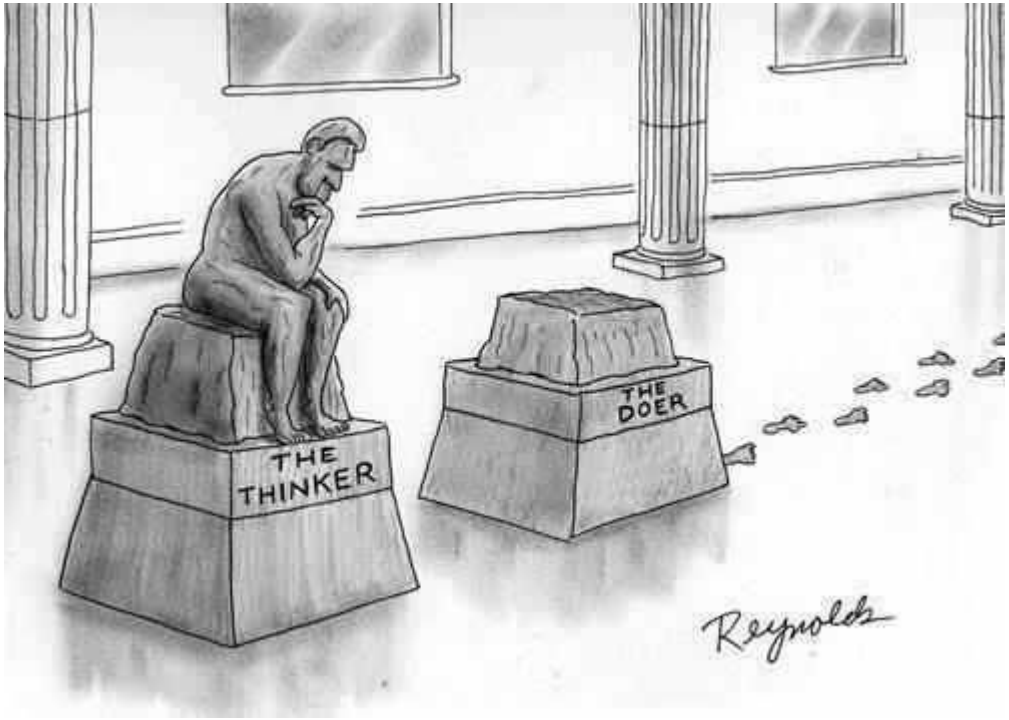
Thinker vs Doers



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Structuring (Importance of)

Always starts like this….

You pass through this….

But you'll need to manage much more ….

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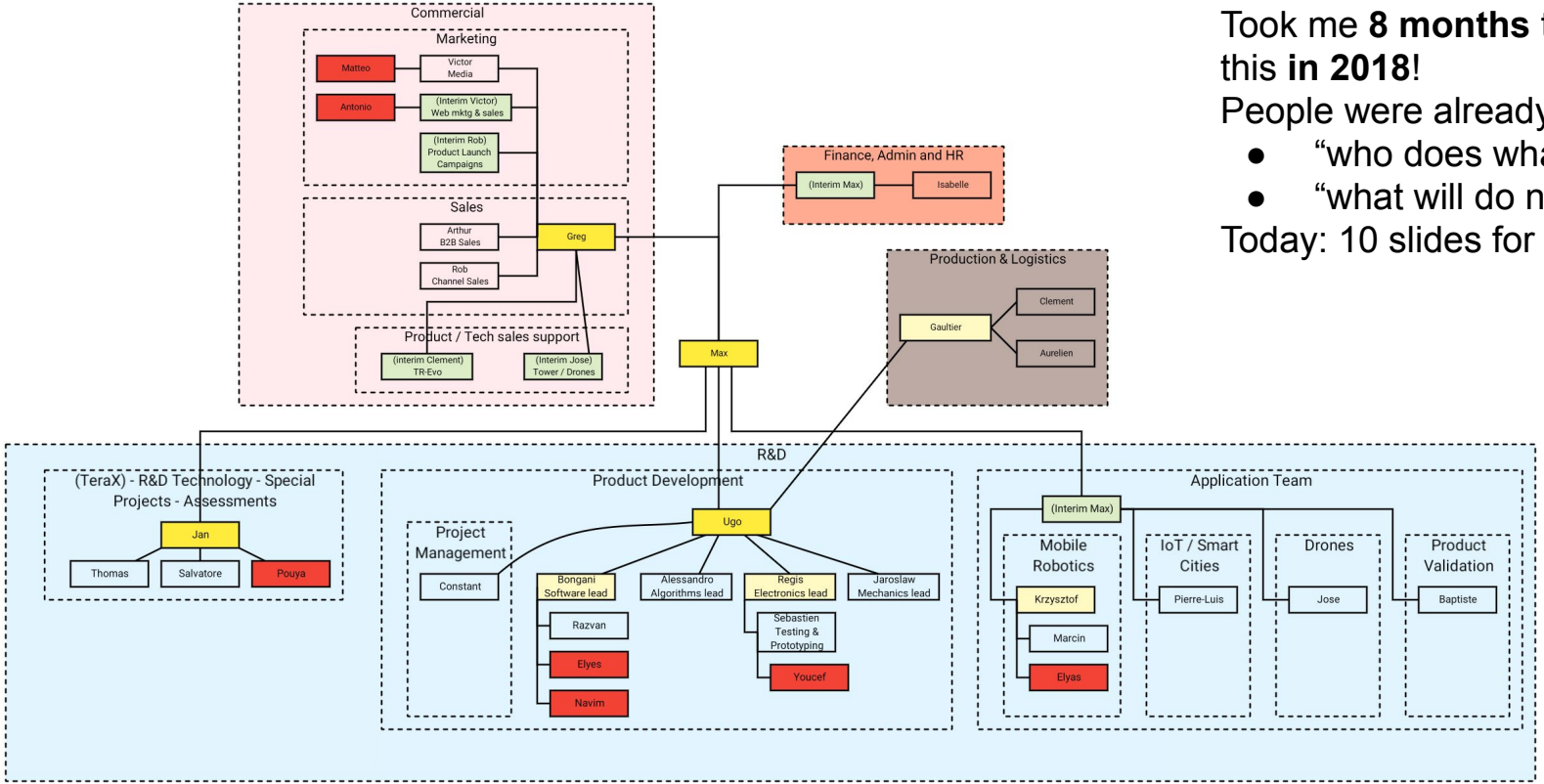
Structuring (Importance of)



Took me **8 months** to structure this **in 2018**!

People were already here, just:

- “who does what exactly”
- “what will do next”

Today: 10 slides for org-chart!

What else

Tips learnt along the way

Working with LARGE ORGANIZATIONS

1. Patience Patience Patience
2. Timing is long, but you can only poke gently
3. **Large organizations don't think small and fast**. Anything you argue or try to obtain triggers a very long time cycle to be addressed by many people on different sections / layers
4. Always assume that you do not talk to a decision maker, and this is your friend/champion in the organization (not your target for negotiations); likely he/she will need to make an **internal sale**

Handling Exceptions

Make every case a rule, extrapolate to higher level

- Exceptions and single events don't exist, they are only the start of a new series of regular events that should be frameworked into rules.
- If you treat many single cases and cannot abstract, you'll die under dealing with exceptions/cases.

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CEO? You are alone!

- Be resilient
  - Ups are ups, but downs are downs
- Be aware of people non-understanding you and your motivations
- Passion Passion Passion

Understand yourself:

- Good timing CEO?
- Bad timing CEO?

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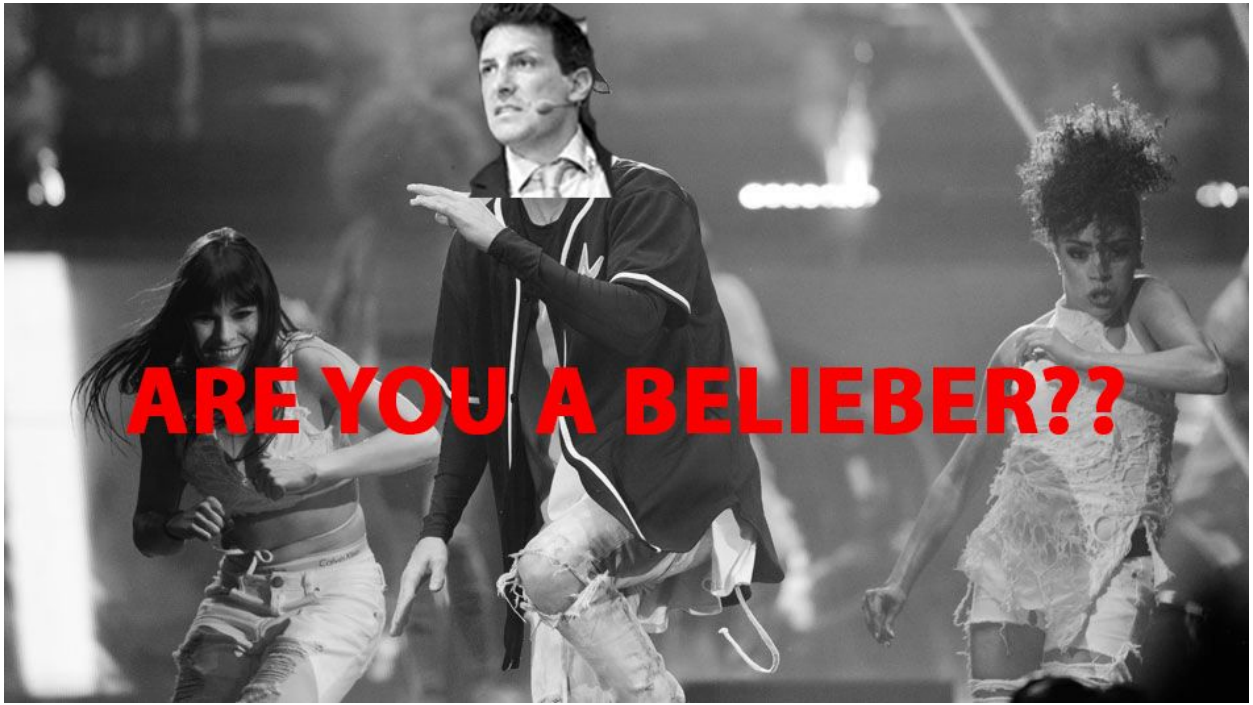
Believe in it.
And make others believe.



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Now Action!

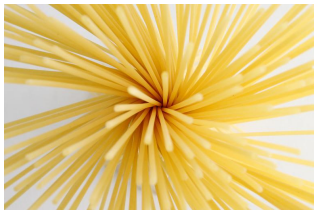
The Marshmallow challenge

www.terabee.com

The rules

18 minutes to build the tallest free-standing structure out of 20 spaghetti sticks, 1 meter of tape, 1 meter of string and one marshmallow

The marshmallow must be on top



20 spaghetti sticks

1 meter of tape

1 meter of string

One marshmallow

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Not allowed

1. To attach structure to the desk, or anything else
2. To eat, fully or partially, the marshmallow
3. To hold the structure when measuring - it will be measured after a few seconds standing

The marshmallow must be on top

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Teams

1. Jan/Ugo/Greg/Krzysztof
2. Dino/Baptiste/Jaroslaw/Regis/Andrey
3. Bongani/Victor/PLK/Salvatore
4. Arthur/Thomas/Razvan/Youcef
5. Rob/Gaultier/Sebastien/Elyes/Alessandro
6. Mateusz/Constant/Pouya/Hugo

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Timer on-line

https://www.timeanddate.com/timer/

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Give your feedback

- Experience
- Team Working
- Prototyping
- Mistakes
- Learnings

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Tom Wujec @TED

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What we can take away

- Clear and shared vision
- Prototype quick and dirty
- Iterate
- Embrace the experiment
- Teamwork and diversity
- Challenge assumptions, don’t take anything for granted!

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We help digitize movements around you