

# Milestone 2

## Search the beat

Every year, earthquakes kill an average of 63.000 people according to the US Geological Survey. When these events happen, it is not the earthquake alone that kills people; people mainly die as a result of buildings collapsing. The main issue after the earthquake strikes is locating victims inside collapsed buildings. It is crucial to get to them out as quickly as possible, because three days after the impact the chances of survival diminishes to one third.

The team was tasked to enhance the existing earthquake search & rescue system, which still is very manpower based. Moreover, the key weakness of the existing system is locating victims quickly and efficiently.

This poster concentrates on the four main steps the team went through when developing the new system and the outcome of doing it.

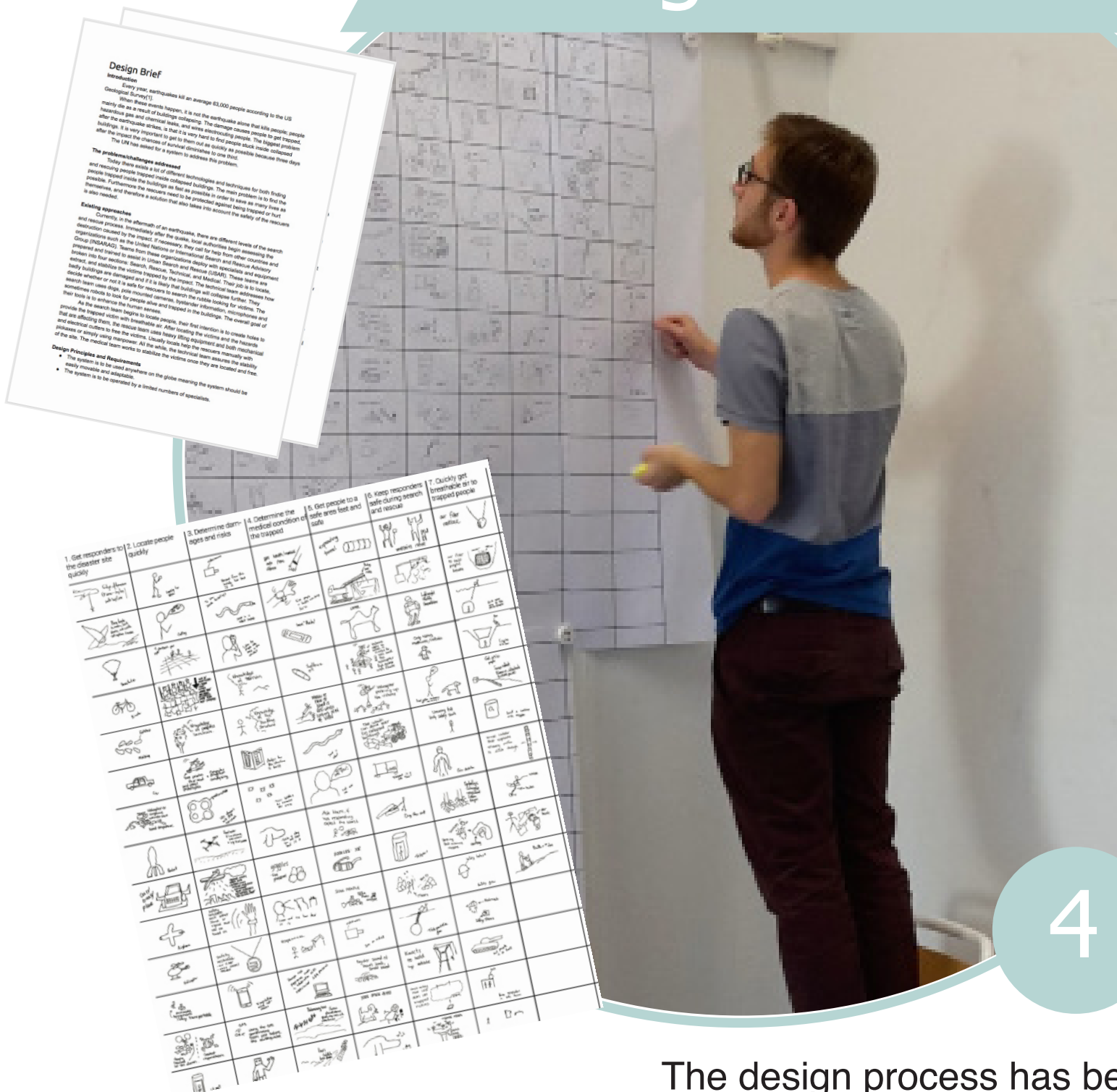


Course:  
42086 Advanced Design Methods  
DTU Management Engineering  
Due date: November 26th 2014

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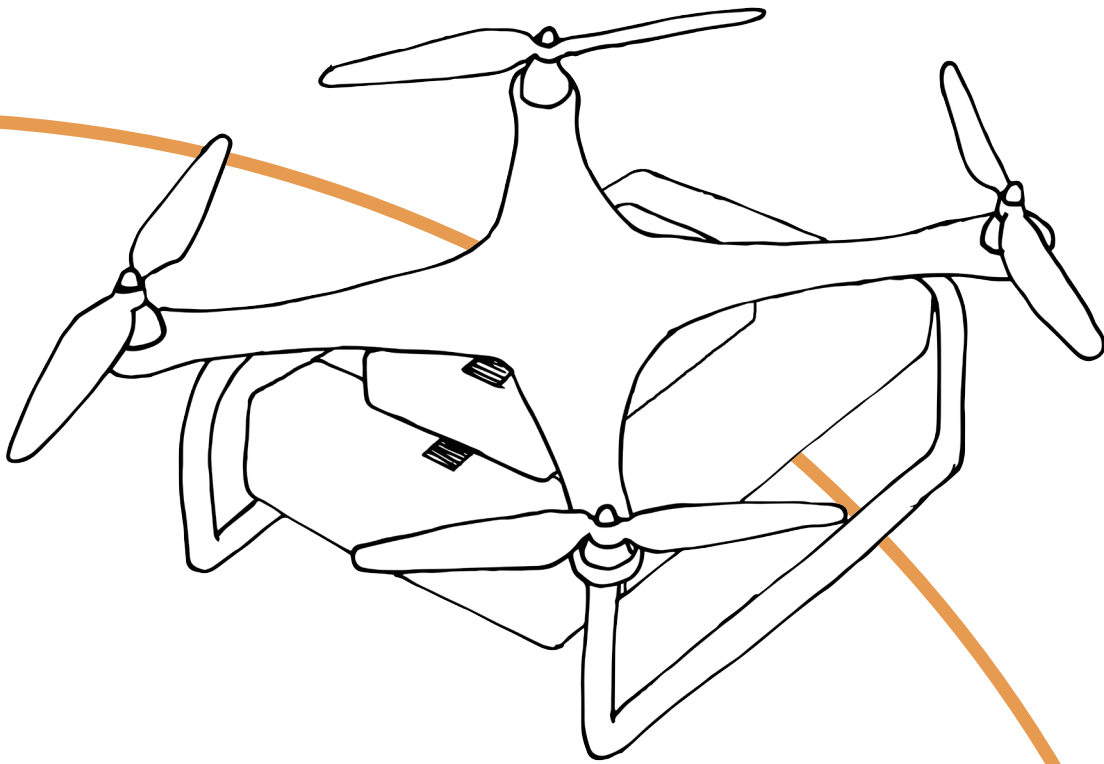


## Design Process

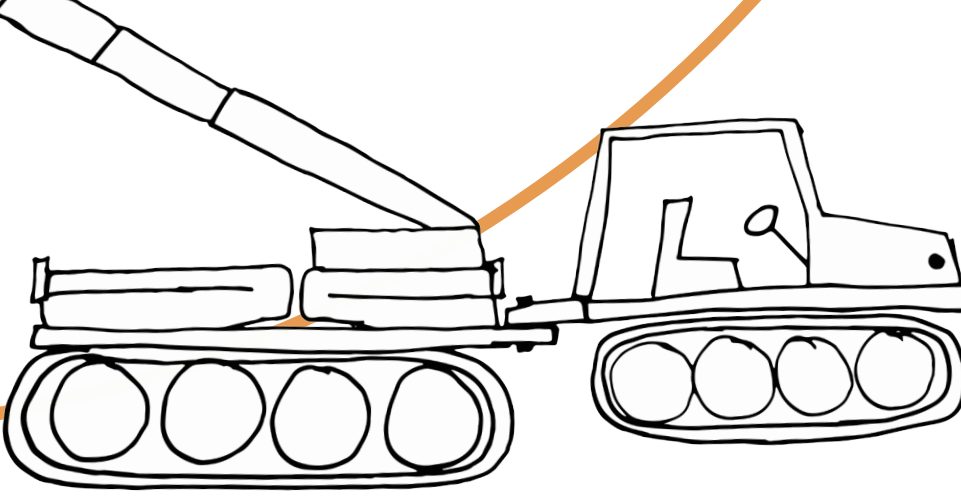
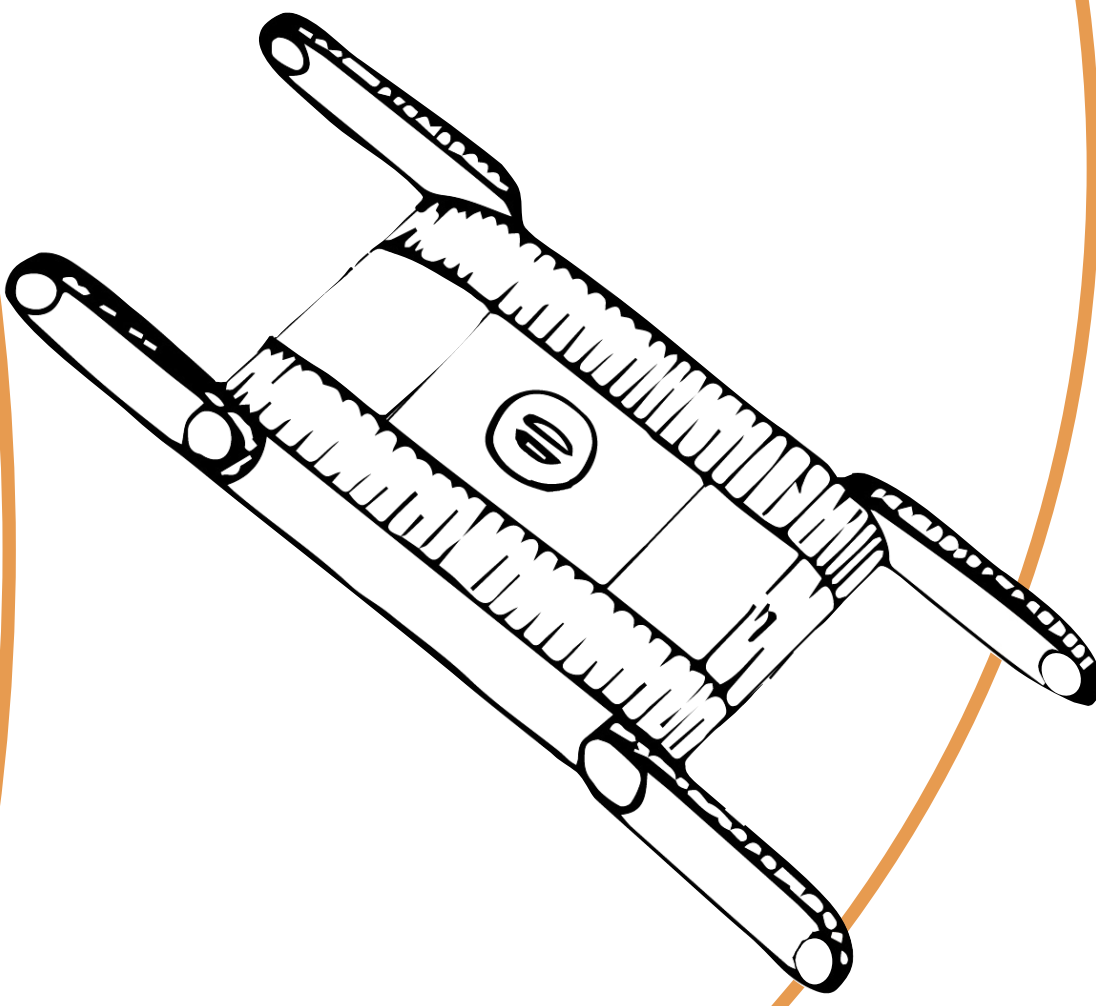


- 1 Problem definition:  
Design brief, design questions, functional diagram, QFD
- 2 Ideation:  
Brainwriting, researching on existing solutions
- 3 Concept generation:  
Morphology chart
- 4 Detailing final concept:  
Design specifications  
Design

The design process has been an iterative process. The group has throughout the process worked on specifying the problem definition. The ideation proces has been a key part of developing the concept and the group has been forced to go back to the ideation phase several times, whenever a new problem has occurred that needed to get solved. When first generating the concepts, five ideal concepts were made with different focuses. These gave the group an overview of possibilities and made a good basis for discussion and developing the final concept.



Parameters/Machines	Rover	Crane + ATV	Quadcopter
Max Speed	7.2km/h	30km/h (50km/h)	54km/h
Units needed/km²	3	1	1
Climbing angle	80º	45º	60º
Battery life	6h	[None]	1h
Cost [Euro]	2.000	80.000	12.000



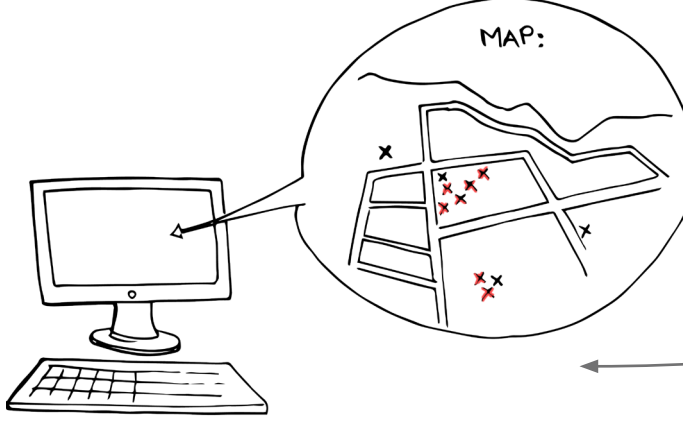
## Next Step

The next step includes two main focus areas. Specifying the different parts of the system on an engineering level and proof-of-concept. Specifying the different parts includes the actual product development, where the parts are fully specified so they can get ready for production. The other step, proof-of-concept, includes testing of flight- and driving times, the accuracy of the heartbeat detector and so on. Furthermore, precise cost estimates are needed for all of the parts of the S&R system.

## Final Concept

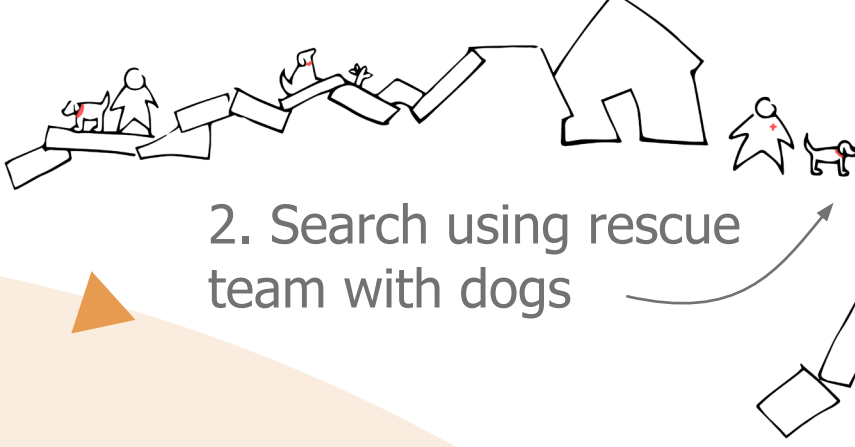
### Search

- 1. Triangulation locating mobile phones



- 4. Program giving overview of victims located and their medical condition

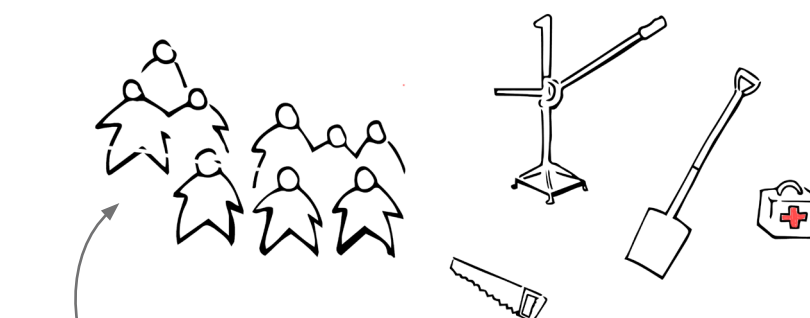
- 2. Search using rescue team with dogs



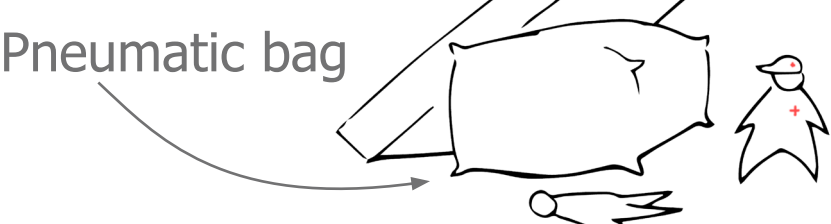
- 3. Drones with heartbeat detectors

### Rescue

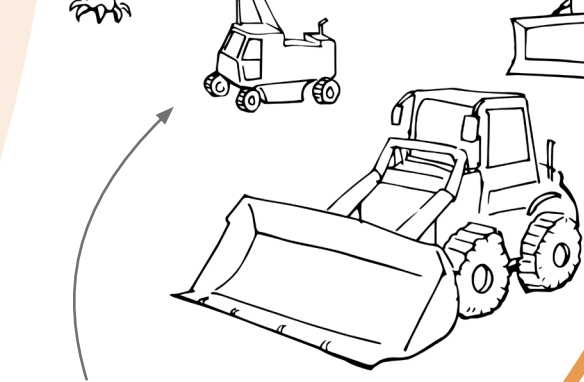
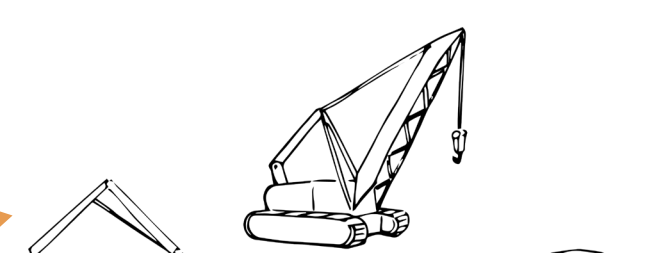
- App helping rescuers finding victims



- 5. Volunteers equipped with mobile equipment



- 7. Small crane



- 8. Using local cranes and bulldozers

The idea with the concept is to make a system that is agile, safe for the rescue workers, make use of existing technologies and make use of what is already on the site. For both the search and rescue phase there are different components which supports each other.

### Search

- 1. Triangulation: This will be carried out using existing antennas (no/low cost). It helps to get an overview of how many victims are inside the collapsed buildings and allows search teams to get a rough location of them (i.e. if the victims phones are on, it is possible to estimate their location using GSM signals).
- 2. People and dogs: There will be manual searches for victims with rescue teams, volunteers and dogs.
- 3. Drones: In order to locate people drones are used. Both quadcopters and rovers are sent over and into the rubble. They are equipped with a heartbeat detector to enable them to locate people in the collapsed buildings. The heartbeat detector is a device that can sense the heartbeats and the breath of people underneath rubble using low frequency microwaves.
- 4. Gathering and analyzing data: To process all the information gathered on the search stage, all the information from all the devices (e.g. drones, heartbeat detector, rovers, searchers etc.) will be gathered and analyzed using a computer system. This data is used in the rescue part to determine the position and medical condition of the people trapped, so they can be rescued in a fast and efficient way.

### Rescue

- 5. Rescue team and volunteers: To save people from the rubble and/or removing rubble from the surface, the rescue team will have tools, e.g. jacks, shovels, first-aid kits, GPS, steel grinders and saws.
- 6. Stabilizing and lifting: To allow rescuers to go into the rubble safely, they will have pneumatic bags to stabilize the rubble. This will form some sort of safe house and tunnel.
- 7. Small crane: This is used to lift/remove rubble/objects that humans cannot lift. It is not as powerful as heavy machinery, but it is powerful enough that it can carry some of the more demanding lifting assignments before the more powerful machinery can be brought in. It is fast, mobile and agile.
- 8. Heavy lifting: This will be done using local cranes and other heavy machinery to move the heaviest rubble.