
EPIC
CHALLENGE JNS
Halil Ibrahim Uluoglu

Problem Document

Requirement

Shall allow experts on Earth who are not physically in the same space to collaborate and develop instructions for astronauts

Author

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Description

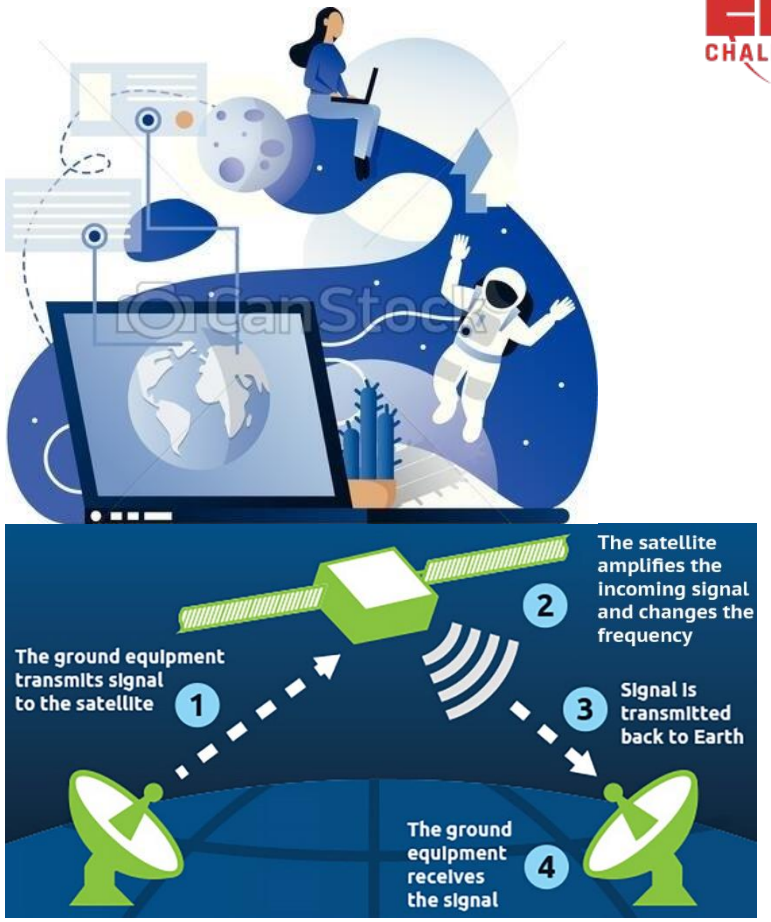
Giving instruction from Earth to astronauts is one of the most important mission during Mars exploration. It can be considered 4 steps to manage this problem.

1. Understanding what is the problem from astronauts
    - Considering that astronauts are not experts in the problem, they may not know technical details to describe for experts on Earth. So, it can cause some extra problems except just understanding the main problem
2. Solving the problem with experts on Earth
    - Even tiny problems at the Mars must always considerate as fatal problems because of Mars conditions. Experts must be gathered very quickly to save time and they must have a working single exact solution in order not to cause misunderstandings. Experts should have as the same environment as astronauts have.
3. Transferring solution to astronauts
    - Communication is a very challenging situation even two places on Earth because of weather conditions, it may disrupt. Also, antennas on Earth and satellite of astronauts must lock at the same angle during transferring messages considering that satellite and Earth spin duration and speed. Therefore, communication channels should be solid and messages should be pure.
4. Apply solution to the problem
    - Astronauts might have just one chance to apply the solution. So, the solution package should cover all significant details with basic understanding. The package also should include the purpose of that movement hence astronauts understand information about what is happening also they can interfere in an emergency

Simulation/Measurement

- Prepare same condition as astronauts have before the problem
- Simulate a communication method and test with same difficulties

Instruction with Keywords



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Problem Document

Sub-problem
Solution Instruction Developing

Author
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Description
Even tiny problems at the Mars must always considerate as fatal problems because of Mars conditions. Solutions which developed on Earth may not fit unique Mars conditions. Mars contains extreme low temperature, no breathable air, high risk radiation and changeable magnetic fields. Moreover, radiation and magnetic field is very dangerous for computers in space crafts. When radiation collides with electronic circuit, they can cause spurious currents around the craft or even burn out computer chips. Changeable magnetic field can induce the content of memory cells so, it may cause different bits in memory. It may cause even collapse.

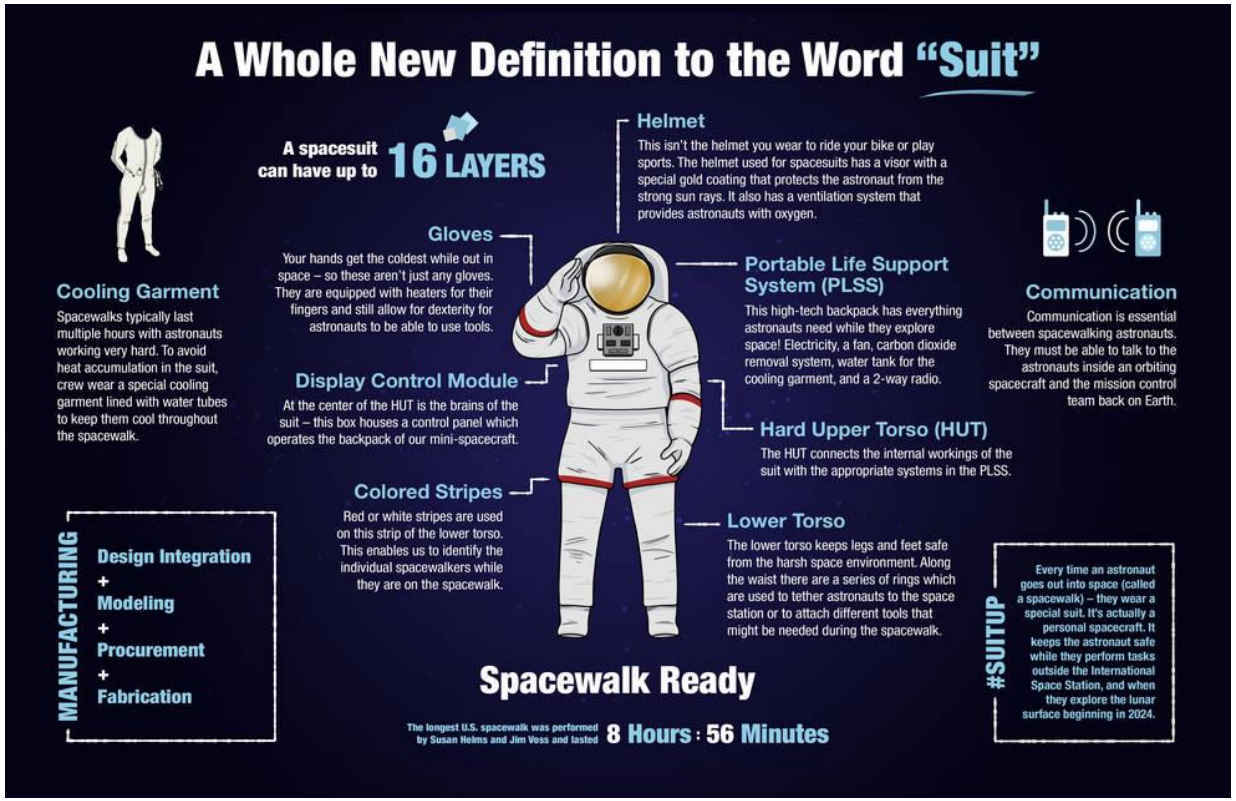
Experts must be gathered very quickly to save time and they must have a working single exact solution in order not to cause misunderstandings. So, while experts developing a solution, they should consider every possibility that may happen. Some steps may cause problems not in the moment but during the time.

Experts and astronauts can not make a video conference every time due to communication difficulties. In order to come up with a solution, they should have to access all specific, tiny details. So, they should have the same environment as astronauts have.

For these reasons, they need to prepare well-designed instructions that both experts and non-experts can understand/apply without any difficulties. Instruction should contain visual content for better understanding, some technical details for future perspective, flow charts for algorithmic solutions and also the purpose of that movement hence astronauts understand information about what is happening also they can interfere in an emergency.

Simulation/Measurement
- Prepare same condition as astronauts have before the problem
- Simulate a communication method and test with same difficulties

Instruction with Keywords



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Existing Reference Idea Document

Problem and Idea Title

Solution Instruction Developing - Simulations

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Description

Mars has very rough conditions for human beings. It is very fatal compare to our planet Earth. As human-beings , we increase our knowledge about Mars and its unique conditions. However, It is still hard to predict all problems can happen. Fortunately, we can provide a solution with some techniques to fix immediately unpredictable problems. One of the solution developing method is simulations. Within simulations, we can create -at least with our knowledge- as same as conditions that Mars has. Nasa has unique simulations environments for solution instruction developing.

Bigelow Expandable Activity Module: Expandable habitat technology for astronauts.

Space Launch System/Orion Crewed Spacecraft/Space Launch Complex: Ensuring transportation capability for Mars missions and other challenging missions.

Asteroid Redirect Mission: Improving solar energy systems for the journey to the Mars.

Deep Space Network/Near Earth Network/Space Network: Significant communication tools for humans and robotic participants.

Rovers: Nasa sends vehicles to discover and develop instructions for can cause problems. Mars Exploration Rover, Perseverance, Curiosity, Insight Lander, Mars 2020, etc.

SimLabs: Developing new space shuttle vehicles.

Hi-Seas(Hawaii Space Exploration Analog and Simulation): Analog habitat for our journey to the Mars in Hawaii.

Instruction with Keywords

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https://mars.nasa.gov/mer/
https://www.nasa.gov/simlabs/simulate-future-space
https://en.wikipedia.org/wiki/HI-SEAS

Idea Document

Sub-problem
Solution Instruction Developing

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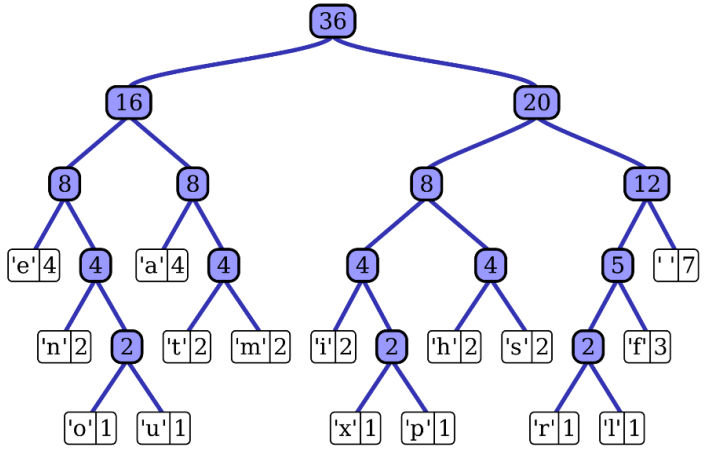
Description
The Communication method is highly important for sending solutions from Earth to the astronauts on Mars. All communication between Mars and Earth can happen with satellite. The minimum distance from the Earth to Mars is about 54.6 million kilometers(not often). Because of this enormous distance between Earth and Mars, a considerable delay signal happens between two planets even signal has the speed of light. It can take 3 to 22 minutes to reach a signal. Also considering the reply of the signal it can take a while for communicate.

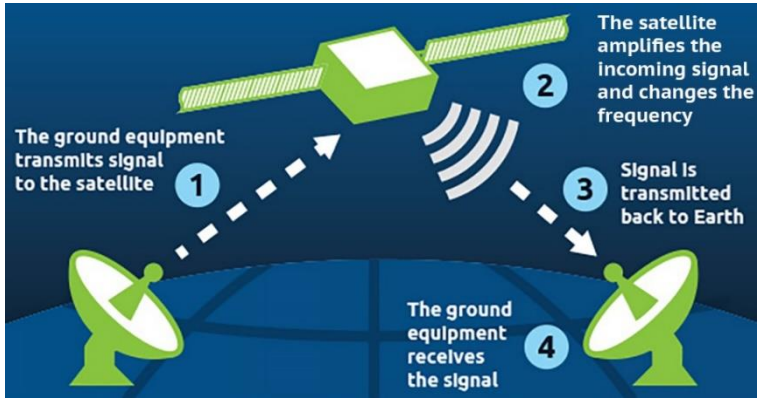
Such this case, the information /solution instructions which you send is highly significant. At this point, my idea is to use compression algorithms to send voice messages to the astronauts. There are methods for compression the file such as Huffman Coding, Elias Code, Unary Coding, SimHash, Parity Check Matrix, etc. The most well-known and efficient algorithm is Huffman Coding.

Huffman Coding: The Huffman Algorithm is a compression algorithm that represents the most used characters with shorter bits and the least used characters with longer bits. For instance, let's accept a word like "aaaaaaaccs". Structure of computer we represent 1 letter with 1 byte. So this word is 10 bytes long in computer memory. Instead of using, 10 byte long word we can represent (most used)a -> 0, s -> 10 c -> 11 . So, to represent our word we just need 7a*1bit + 2c*2bit + 1c*2bit = 12 bit which it is just 2 bytes long in the memory. So we applied a %80 reduction to our speech.

For solution instructions, we can record voice and apply this algorithm to our voice and reduce to file size. Then, we can send this file via satellite to the astronauts. The astronauts can use a special program which installed before their computers can convert to compressed file into a regular voice message. So, The time for instruction can efficiently reduce.

Instruction with Keywords





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High redundancy: Taking only robot crane tool vs 3d printing parts and tools

Question (uncertainty)

Is communication with the Huffman Coding algorithm as good as from being in the same simulation room at Mars for instruction solution developing?

Author

Halil Ibrahim Uluoglu, UEF

Method

Firstly, I will search which simulation environment has been using for space missions. Also, I will use a 3d model that I created for our concept idea. Then, I will create a Huffman Coding algorithm for messaging using Java programming language. I will output the result of the algorithm.

Prediction

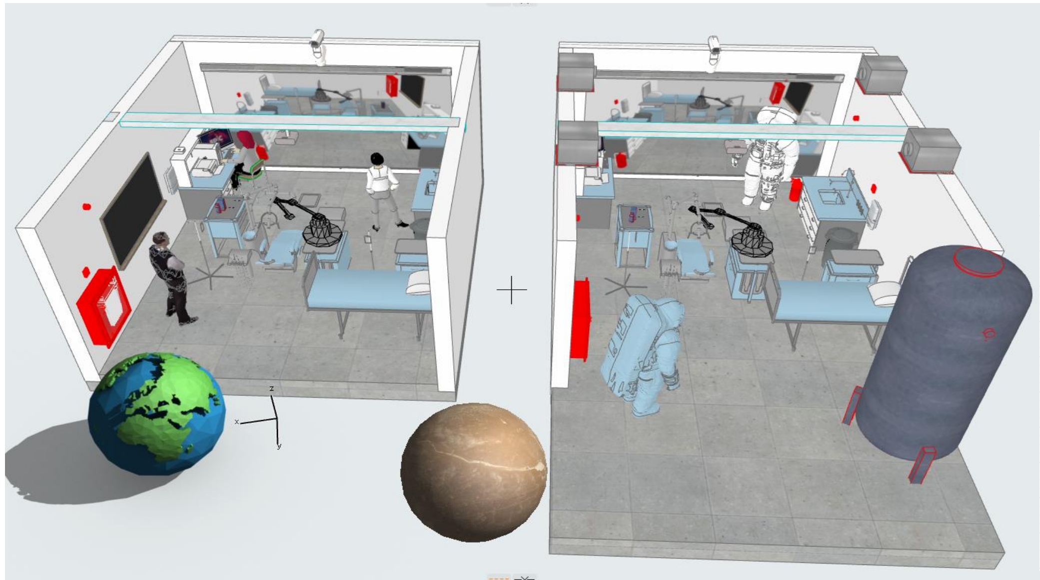
- Based on [test data compression](), using Huffman algorithm makes transmission as fast as with the reference idea.
- Simulation room can have multiple angles to see the problem and develop a solution for the problem.
- Huffman Coding can make quite fast communication for solution instruction developing.

Model/Rationale

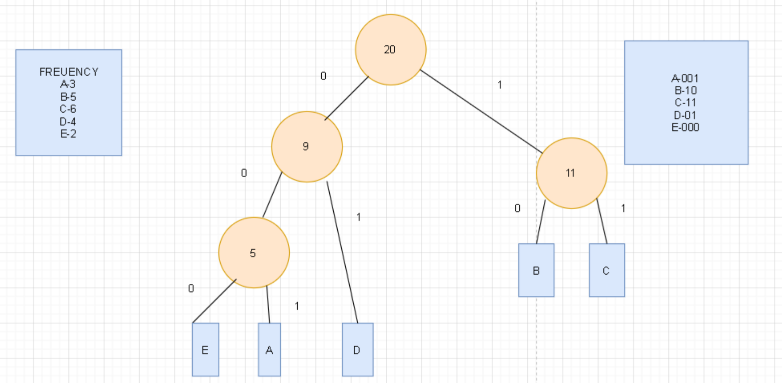
We believe that solution instruction developing is a very significant task for experts on Earth. Because It can be fatal every movement for astronauts on Mars. The experts must think every steps very cautiously. In this model, the simulation room needs to be created early from the Mars exploration. Also, experts need to learn basic computer program skills for the program with the algorithm in it.

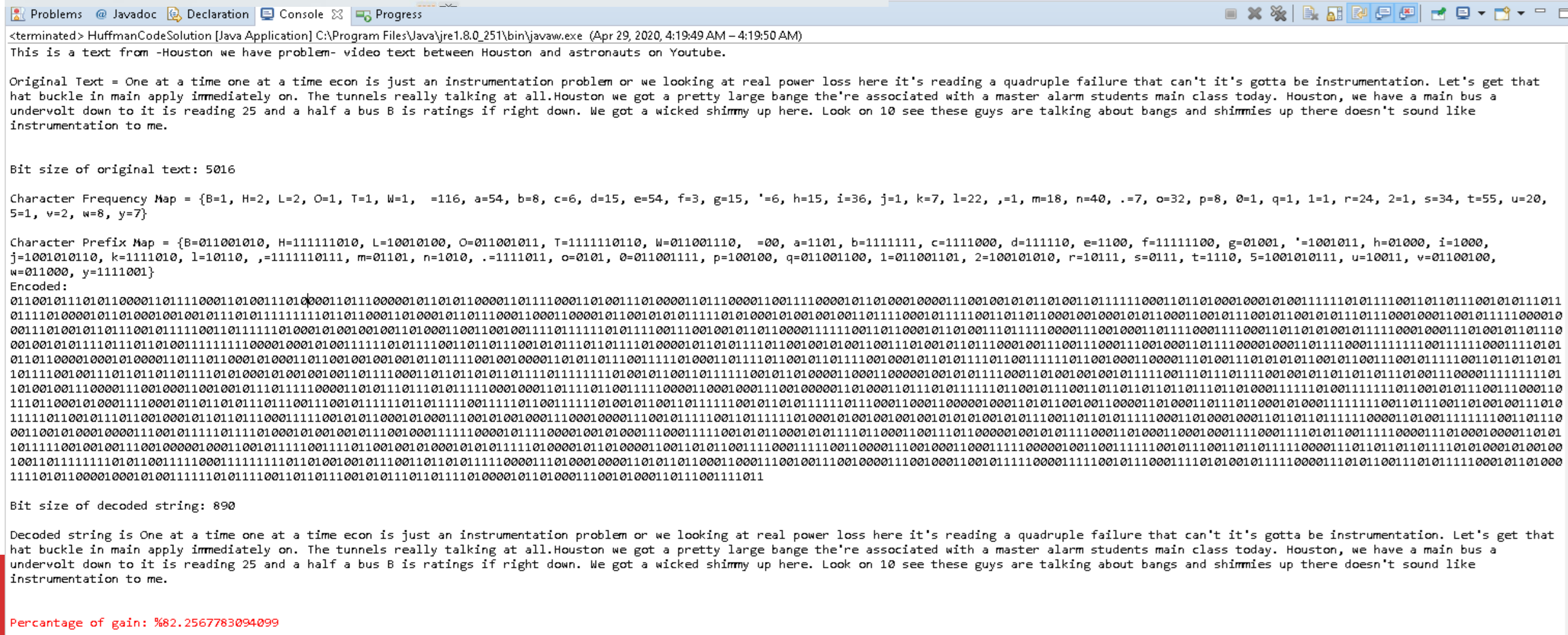
Experiment Design Document

Illustration w. Keywords



Huffman Tree





Experiment Results and Insights

High redundancy: Taking only robot crane tool vs 3d printing parts and tools

Question (uncertainty)

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Results

- Huffman Coding algorithm succeeded to increase %82 percent of gain from a template text. (Bit size of original text: 5016 – Bit size of decoded string: 890 – Percentage of gain: %82). It can understand like this: The algorithm can present 100 letters text within 18 letters.
- Huffman Coding algorithm can able to make a very fast communication environment for solution developing the algorithm for experts that apart from each other.
- Simulation environment enables every angle that astronauts have. It allows to see every detail for instruction developing.
- The experts can access and test every element in the simulation room. Also, they can feel the same environment with astronauts, so it helps to understand the inside of the problem. It produces right on spot solutions.

Insights

The findings suggest that communication with Huffman Coding algorithm and being in the same simulation room for solution instruction developing are quite good two options. They produces fast and reliable outcome for developing solutions.

Experiment Design Document

Solution Instruction Developing: Simulation on for same situation vs Using compression algorithms

Question (uncertainty)

Is taking raw material, printing 3d parts, and tools better than only taking necessary tools in Mars exploration considering redundancy perspective?

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Method

I will create a scenario and record a video from a video game simulation which is based on real physical rules and facts.

Prediction

- Based on expert estimation, It is important that to bring what you need considering about every pound is worth 10K$ even more for Mars. In this matter, It is to bring just raw material and convert to useful tools and parts. Also, It is good to recycle the tool and make another tool for its purpose. Therefore, 3D printing provides high level redundancy for Mars exploration.
- Taking raw materials more convenient than taking only some tools because you may able to convert raw materials to different tools.
- Therefore, we think printing tools will make good difference about time and cost.

Model/Rationale

We believe that if we want to understand and see the real results of the Mars atmosphere outcome and for this challenge, we need to arrange the same conditions as same as the real world. So, we use a video game simulation for this better and deeper understanding of this experiment. It based on facts and physical rules. Therefore, using this game for the experiment will help us to see millions of possible probability atmosphere and It will show quite close real results.

Illustration w. Keywords

If you can't play the video, please click here to go the video source.

Experiment Results and Insights

Solution Instruction Developing: Simulation on for same situation vs Using compression algorithms

Question (uncertainty)

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Results

- Time and cost are one the main issues, so it is important to consider wisely. Therefore, taking only some tools increases redundancy because of reusability.
- Taking raw materials and printing parts and tools method is can create different tool options.

Insights

The findings suggest that some basic changeable possibilities are fixed for general purpose such as which material type. It is assumed that the materials suit printing tools and parts for this purpose. Also, including the life of a tool is important for redundancy. If a tool runs out of its time, converting that tool is a better option comparing from throw away.