



esade



HYSPLANT

Improving IVF

Meet the Team

ENGINEER



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ENGINEER



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DESIGNER



CAMERO
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GRAEBER

BUSINESS



CECILIA
BAUTISTA

BUSINESS



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COACH



RAMON
BRÁGOS
BARDIA

IBEC's Bioengineering in reproductive health

“Our lab aims to study human embryo implantation and provide solutions to improve in vitro fertilization (IVF)”



Key Research Areas

1. Improve Embryo Culture Conditions
2. **Diagnose Embryos with Improved implantation potential**

Team Expertise

Biology | Biophysics | Business

Key Collaborators

Hospitals
Pharma Industry
Venture Capital

Understanding embryo selection

Despite the role of implantation in human fertility, the process is still elusive to experimentation because of its inaccessibility.



- Crucial process for natural conception.
- **Only 25% of IVF embryos successfully** implant into the mother uterus' and develop to term.
- Clinics still hesitate about nowadays most advanced technology.

IBEC's proposal

Non-invasive imaging process to check implantation rate of embryos prior to transfer



Technology Overview

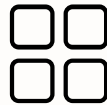
IBEC has been developing a technology to support embryologists on the diagnostic of embryo implantation.

WHAT?



**DIAGNOSE BEST
EMBRYOS IN AN
UNBIASED MANNER**

HOW?



**LABEL FREE
MOLECULAR IMAGING**

WHY?



**INCREASE EMBRYO
IMPLANTATION RATE,
REDUCE TIME TO
PREGNACY**

TECHNOLOGY DEVELOPMENT STATE: TRL 4 (VALIDATED IN LAB)

Project Statement

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SOME CHALLENGES ARISING FROM THE PROJECT STATEMENT

Should the technology be delivered as a service or a product? And if so, which product?

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Project Breakdown

To identify how the final product or service should look like, we divided the project in 5 different steps from gathering data, to defining the final product configurations

INITIAL PROJECT BREAKDOWN IN FIVE STEPS

1) MARKET RESEARCH



GENERATING KNOWLEDGE

2) DATA ANALYSIS



UNRAVELING KEY INSIGHTS

3) PRODUCT RESEARCH



IDEATING AND SELECTING

4) BUSINESS MODEL



DEFINING VALUE PROPOSITION

5) DESIGN AND TECHNOLOGY



DEFINING PRODUCT CONFIGURATIONS

Market Research Strategy

Market Research involved both quantitative and qualitative methods in order to learn more about clinics operations, industry state and embryologists' day-to-day in more than 40 countries

Quantitative Research



SURVEY

Objective: Understand operation of clinics and hospitals

Target: Embryologists / lab managers around the world

Contact methods: LinkedIn and email

Qualitative Research



INTERVIEWS

Objective: Understand industry state and necessities

Target: Embryologists / lab managers around the world

Contact methods: Email, LinkedIn and phone



MARKET REPORTS

Objective: Grasp the complexity and functioning of the industry

This research was mostly informative



Market Research Results

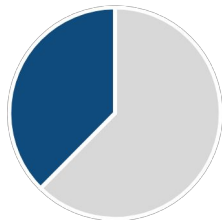
Even though the COVID pandemic had an impact on clinics and on our project, overall results were positive and sufficient to generate actionable knowledge from which to develop actionable insights.

Surveys

19 technical and business-oriented questions proposed by IBEC

Surveys sent: 354

Surveys answered: 137



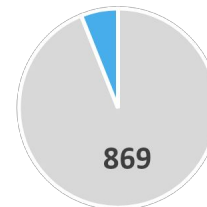
■ Surveys Answered

Interviews

15 to 45 mins interviews following a previously worked-on template

Clinics contacted: 925

Successful interviews: 56



■ Interviews Answered

Key Findings

After gathering the information an extensive study of the data had to be conducted in order to extract valuable information



Clinics are very diverse



Embryologists do not like invasive methods but do not trust prediction algorithms yet



Space in the laboratory is an important issue



Embryologist prefer to check the embryos remotely instead of doing it in person



Although incubators have improved, many clinics prefer to use conventional ones

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Ideation process

Through ideation, 3 main ideas were compatible with the technology: creating a new incubator, creating an attachable camera to embryoscopes or a custom-made microscope



New incubator with technology

- Incubator would incorporate a laser and a camera which would take label-free images of embryos
- The incubator would come with a software to run a set of analysis and rate an embryo's state



Camera with software

- Would be attachable to current existing incubators
- Software would analyze images and run a set of analysis in order to rate an embryo's state






Custom-made microscope

- Complementary product to analyze embryos outside the incubator
- Microscope would allow embryologist to observe the embryo and would send images to be analyzed by the computer software




Ideation process: New incubator

From our initial research, the concept of a new incubator is completely feasible although it does not appear to be extremely desirable and viability is completely unknown

 Desirability	 Feasibility	 Viability
<ul style="list-style-type: none"> + Product would come with a clear added value — Most embryologists might stick to morphology as an indicator due to low differences — Product will be expensive, and clinics/hospitals should be willing to invest 	<ul style="list-style-type: none"> + Feasibility confirmed by IBEC. No worries on manufacturing and product engineering 	<ul style="list-style-type: none"> — High price should limit addressable market (e.g. clinics cannot afford such price, clinics don't see added value) — Cost and breakeven analysis needed to approximate minimum number of incubators to be sold
5/10	10/10	?




Ideation process: Camera with software

From our initial research, the concept of a new incubator is completely feasible although it does not appear to be extremely desirable and viability is completely unknown

 Desirability	 Feasibility	 Viability
<ul style="list-style-type: none">+ Cheap compared to other available products and convenient (e.g. space)+ Low need for training+ Democratization of algorithms even for small clinics- Certain embryologists will not see the added value	<ul style="list-style-type: none">- Feasibility unknown, it appears to be quite a challenge to design a camera attachable to different models of incubators	<ul style="list-style-type: none">+ Higher attainable market due to price, size and conformity with existing embryoscopes+ Easily scalable- Cost and breakeven analysis needed to approximate minimum number of cameras to be sold
7/10	0/10	6/10
















Ideation process: Custom-made microscope

From our initial research, the concept of a new incubator is completely feasible although it does not appear to be extremely desirable and viability is completely unknown

 Desirability	 Feasibility	 Viability
<ul style="list-style-type: none">+ Provides a clear added value in terms of prediction+ Cheap compared to other solutions+ Small space requirement- Need to move the embryos which might pose quality issues	<ul style="list-style-type: none">- Option has not been explored in detail but feasibility unsure due to the laser technology	<ul style="list-style-type: none">+ Easily scalable and less costs involved+ High attainable market with an easier to sell product
8/10	?	8/10

Summary and Idea choice

The incubator and the microscope seemed to be the best options. IBEC is exploring the feasibility of the microscope and is interested in exploring the incubator option. Thus, the rest of our project was based on that idea.

	 New incubator with technology	 Custom-made microscope	 Camera with software
			
			
			
	Selected technology	Alternative	Option Discarded

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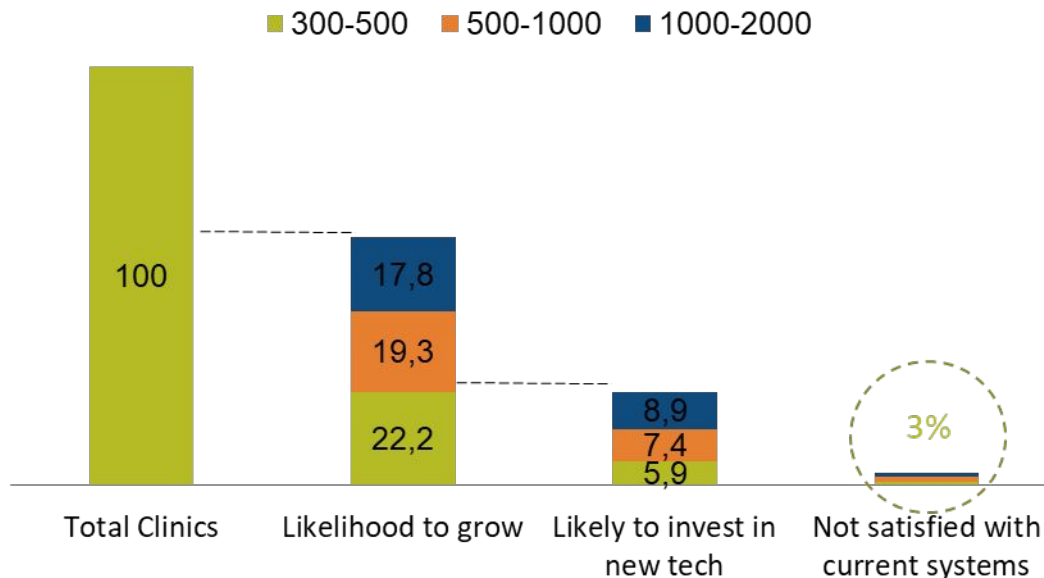
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Target Market

Clinics Firstly investing in this technology should have the need to get new incubators and willingness and resources to adopt new innovations, and not be completely satisfied with the current Incubator offering



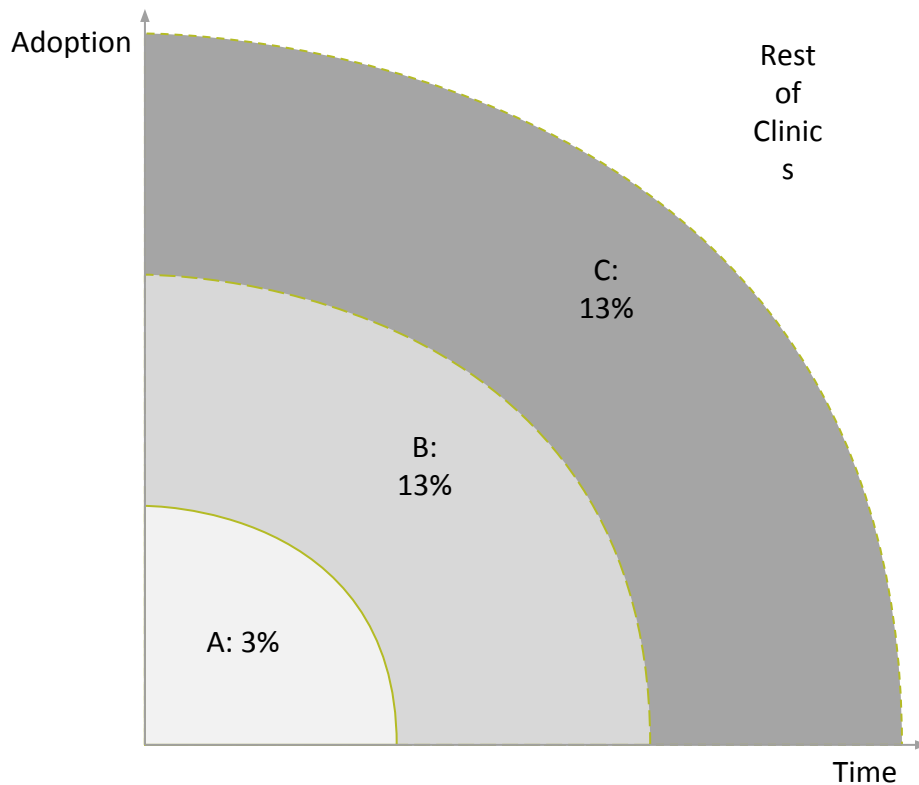
Figures in proportion (%), Source: data collection; Legend: n^o of Annual cycles

We estimate our early adopters to be up to 3% of the market.

- Assumptions:
1. Sample is representative of the population.
 2. Embryologists' answer is representative of the clinic's opinion.
 3. Clinics that initially did not invest in time-lapse are less likely to try new tech

Technology Adoption

If the Technology is adopted by the early adopters, the interest of the rest of the clinics on the technology is expected to vary per clinic.



Proportion of the market IBEC should target. Source: Survey

A) Clinics having the best technology in the market and not satisfied with the current one.

B) Clinics missing features on incubators, that are slightly satisfied with current technology.

Rest of clinics:

This should be determined in the future, depending on how the market develops

C) Clinics that have been disappointed by previous technologies.

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Business options

We identified two business models: the leasing model which would allow faster adoption, and the selling model which would mitigate certain risks although being less flexible

Leasing: renting with buy option after contract

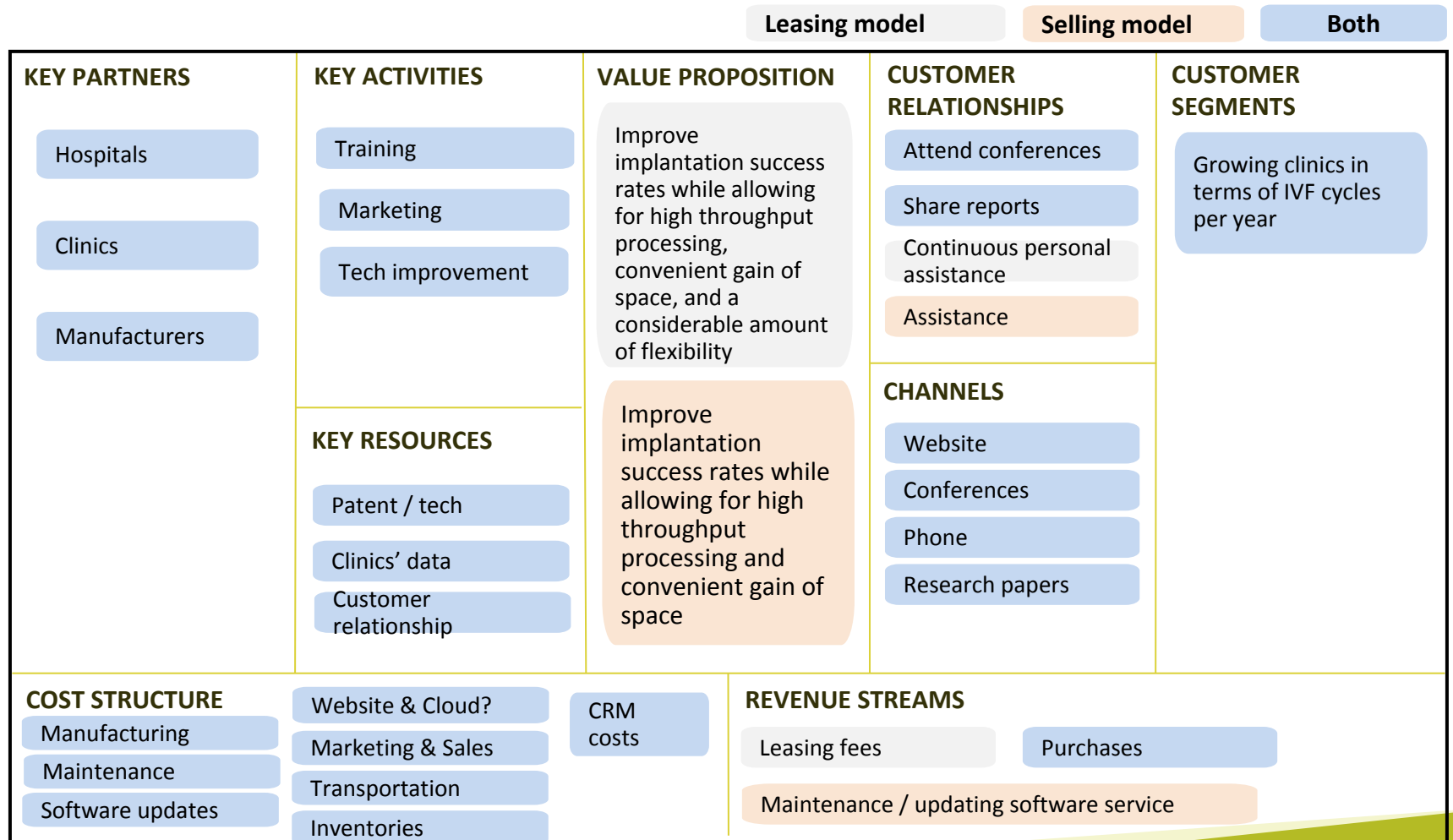
- ✓ Enhanced adoption as product can be tried prior committing
- ✓ Higher interaction and knowledge with the client opening opportunities
- ✓ Easier to perform technological updates
- ✗ Incur maintenance costs
- ✗ Complicated repeated transportation of machine
- ✗ Inventory risks (Low)

Selling: sell the product directly to the client

- ✓ No inventory risk
- ✓ Maintenance can be a revenue stream
- ✗ Discouragement of clinics to buy the product due to high price
- ✗ Low flexibility offered to clinics and hospital

Leasing: Business Model Definition

The Leasing Model revolves around close CRM and customer flexibility while the Selling model revolves around building a strong product brand.



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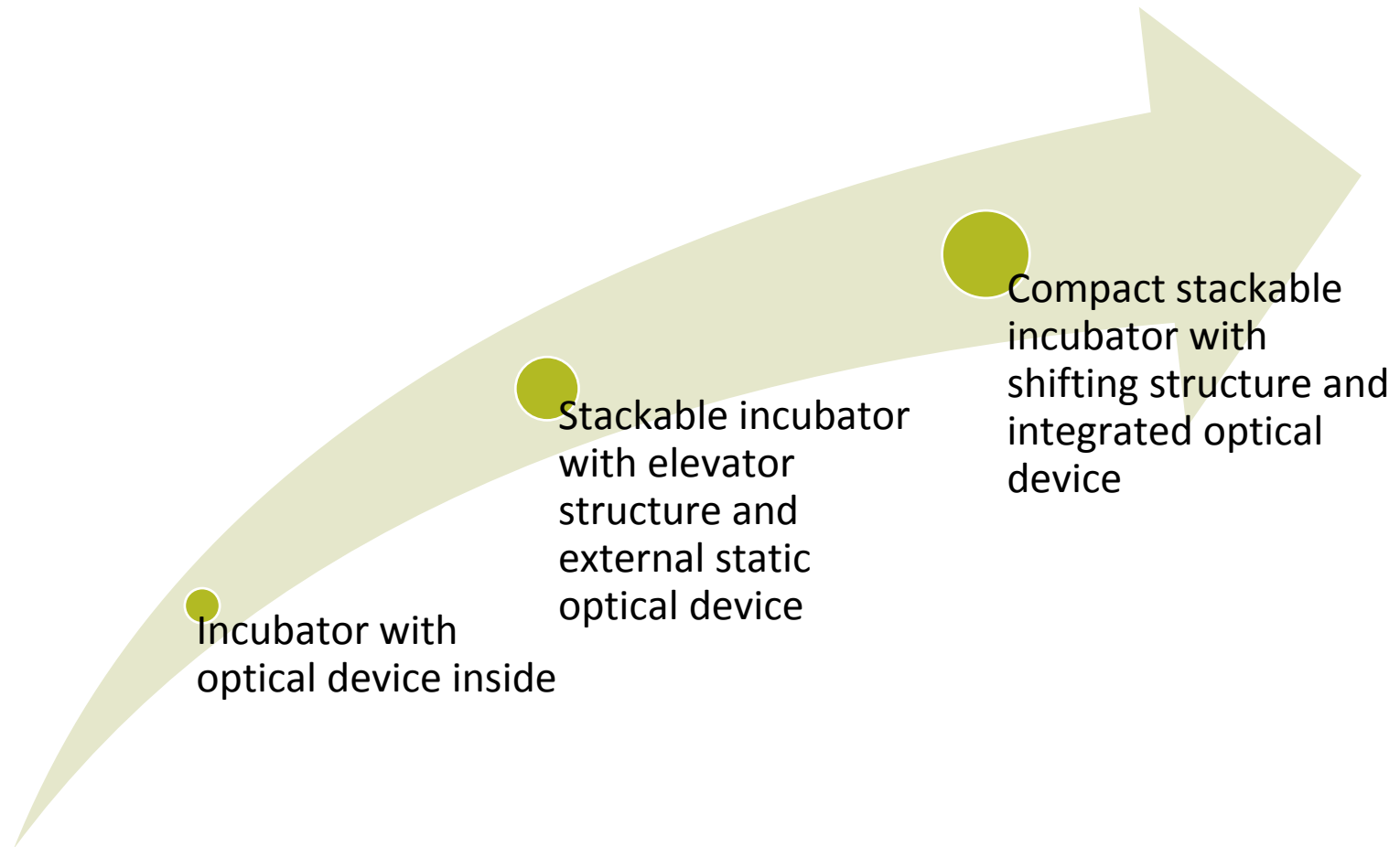
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Product approach

After going for the incubator idea, several brainstorming sessions with the research institute were required before getting to the final approach



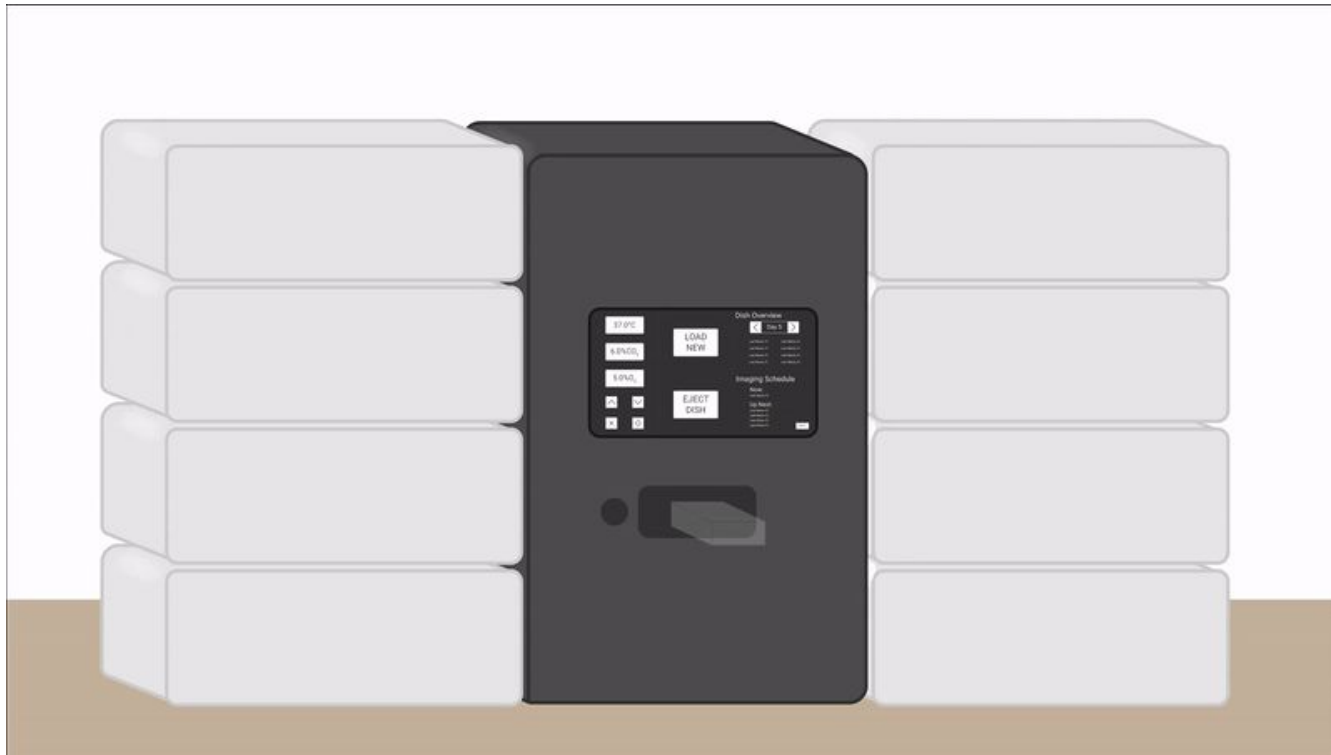
Proposed design

With all of the above, here is the proposal of our designers



Design interaction



Not only aesthetics are important, but also how the design interacts with the user, and we have not left anything out our design.



Advantages and Limitations

When designing the product, we evaluated the advantages and disadvantages of our chosen configuration



 Strengths	 Limitations
<ul style="list-style-type: none">□ Minimal movement of dish□ Reduced movement of microscope□ Modular system giving flexibility	<ul style="list-style-type: none">□ Both components move□ Requires a larger area than purely verticle stacks

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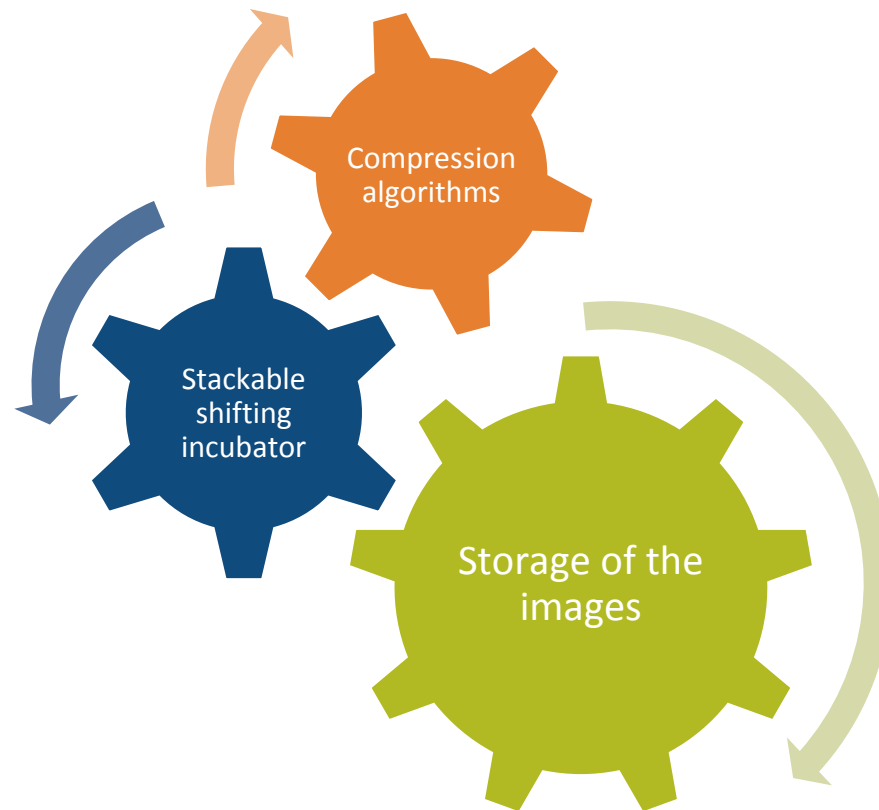
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Engineering of the prototype

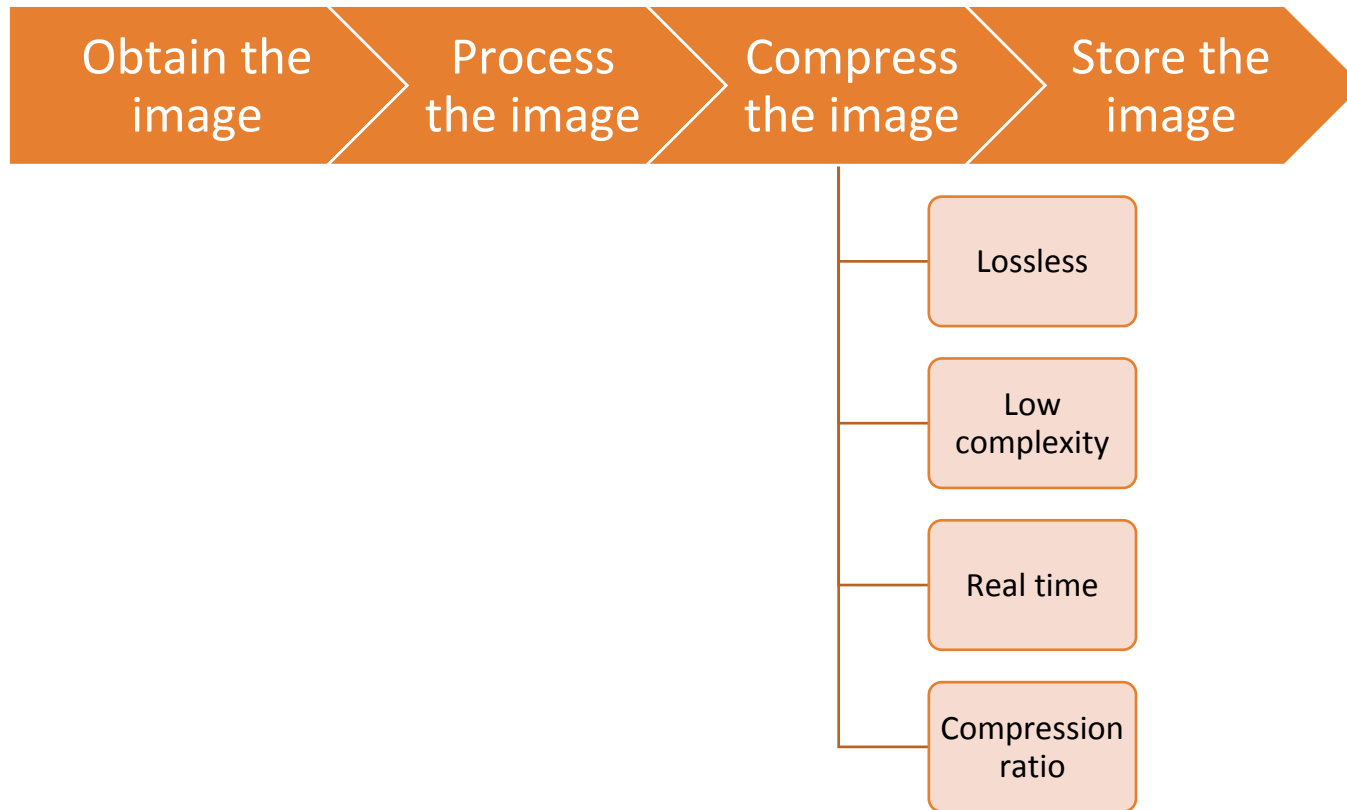
After the idea was clear, and the design done, our engineers started thinking on a way to make our high throughput incubator work. Designing is not an easy process, and neither is engineering. For our engineers to get to the a final functional design, still several points need to be considered.





Compression algorithms

The main issue for compression of the algorithm is the size of the images. That is still an open issue, so we are posing several questions that should be answered before choosing one algorithm.





Compression algorithms

After having a look at state-of-the-art compression algorithms, here we propose two valid options based on the criteria we mentioned before.



Recursive least squares (RLS) filter	Hyperspectral image compression in band-interleaved-by-line (BIL) format using lookup tables
Lossless	Lossless
Statistical based	Interband correlation based
Low complexity	Low complexity
Highly suitable for real-time compression	Real-time compression
Eliminates spatial and spectral correlation	High compression rates achieved

Source/Additional reading: K, Subash & K K, Thyagarajan. (2014). Hyperspectral Image Compression Algorithms – A Review. Advances in Intelligent Systems and Computing. 325. 127-138. 10.1007/978-81-322-2135-7_15.

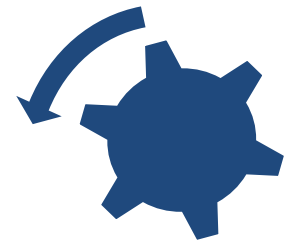


Storage of the images

IBEC technology is still to be developed. We have proposed several storage options from where they will be able to choose once they have all the information about images.

 Local storing	 Local + cloud storing
<ul style="list-style-type: none">❑ Incubator will be sold with a computer where clinics can keep their pictures.❑ For larger clinics an additional external server could be considered.❑ In this case, IBEC will need to request data about cycles periodically in order to improve the algorithm.	<ul style="list-style-type: none">❑ Local storing in clinics computer for those on-going cycles.❑ Cloud storing for already closed cycles.❑ In this case IBEC would have direct access to the records and study the outcomes to improve the algorithm.

Confidentiality is a big issue in this market, IBEC would need to ask for permission from patients to clinics whether they go for one option or the other.



Identification of embryos

Having a stackable incubator where microscope and dishes are moving, identification of embryos becomes an important issue. How to identify embryos once they are on the move?



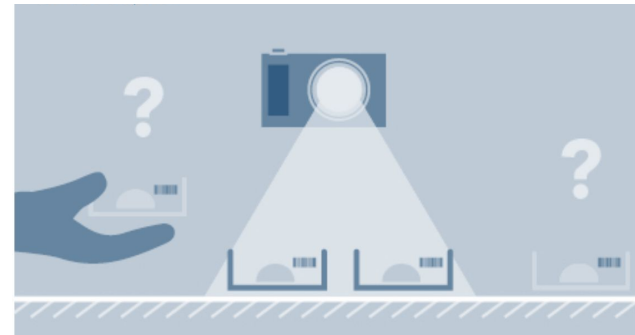
RFID tags

- RFID systems check the whole working space constantly
- RFID work 24/7
- Some clinics are already working with RFID tags



Barcodes

- Barcodes systems only check the dishes when placed in front of the sensor
- It is the embryologist that has to remember to check the samples





Identification of embryos

Having a stackable incubator where microscope and dishes are moving, identification of embryos becomes an important issue. How to identify embryos once they are on the move?



Drawbacks:

- Sterilization process may damage circuitry
- Embryos may be damaged at high powers

Sterilization depends on:

- The material the petri dish is made of (plastic, glass)

Tag endurance depends on:

- The material attaching the chip and the antenna (epoxy, solder)
- The RFID model and chip

Most used sterilization techniques:

- **Gamma rays:** damages RFID circuitry under certain circumstances and EPROM based memory chip. Use FRAM memories instead.
- **Heat:** RFID tags endure until 200°C depending on the frequency ¹
- **Gas:** Ethylene Oxide (EtO) may affect chip battery ²

¹ <https://www.rfidinc.com/applications/extreme-temperature-rfid-tags/>

² https://www.researchgate.net/publication/224139170_Real_time_detection_and_tracking_of_Gauzes_by_RFID_UWB_technique

Conclusion & Next Steps (I)

We recommend the IBEC team to validate the business assumptions with further research, evaluate the possibility of using compression algorithms and explore the feasibility of the microscope idea

Business Questions to be Explored

Will a **leasing model** be accepted by the clinics?

What is the **willingness to pay** for clinics purchasing new equipment?

Are there any other (no clinic) segments willing to acquire the technology? (e.g: big labs)

Engineering Questions to be Explored

How will be the **movement** of the dishes and microscope to avoid disturbing embryos and affecting microscope stability?

What are the **requirements** for the prediction algorithm? (Number of pictures, how often are to be taken)

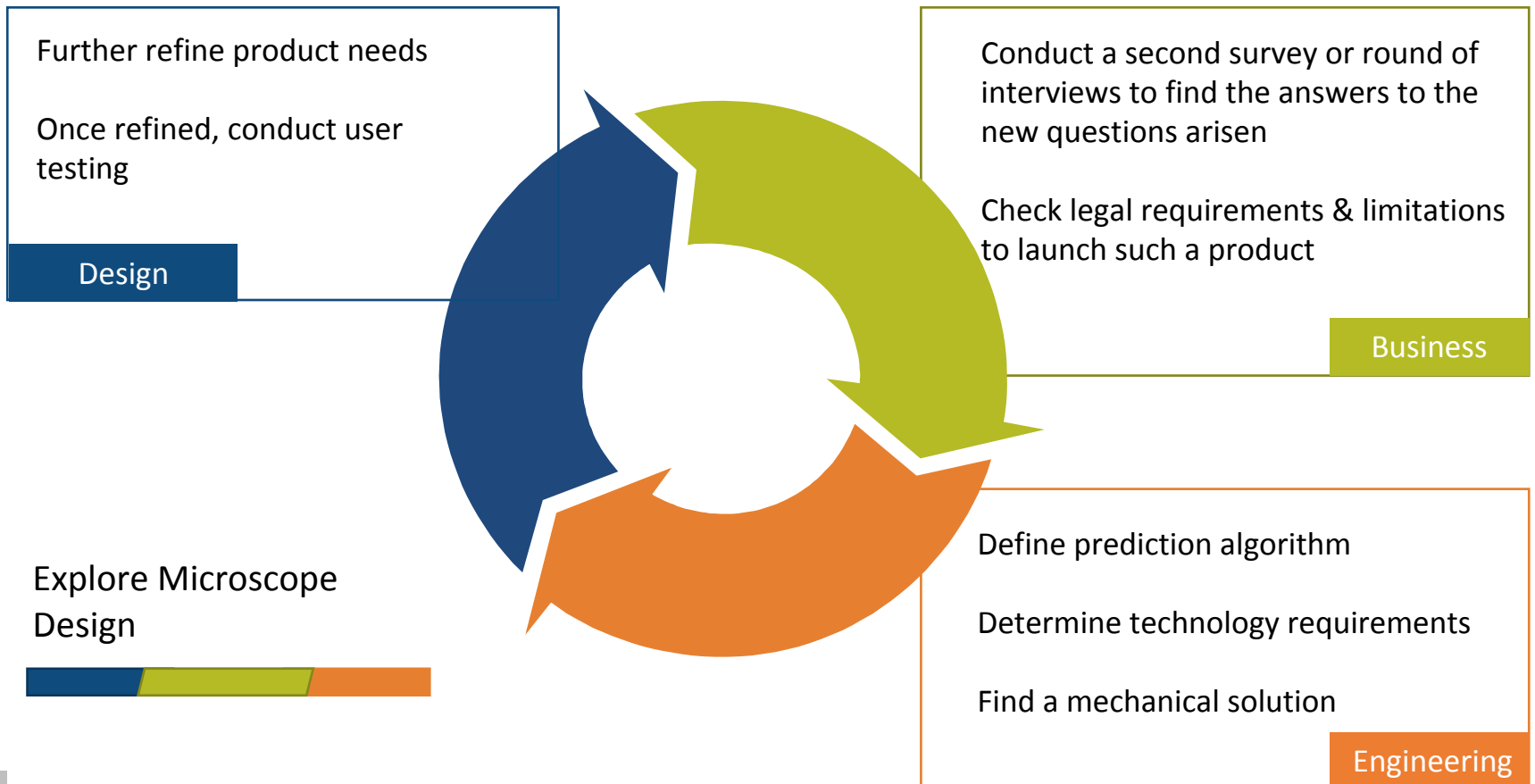
These requirements will determine the compression algorithms that can be used and the storage of the images

Design Conclusions

Each design option sacrifices on one aspect of the product. A **further understanding** of the product needs to be reached before the design can get settled on.

Conclusion & Next Steps (II)

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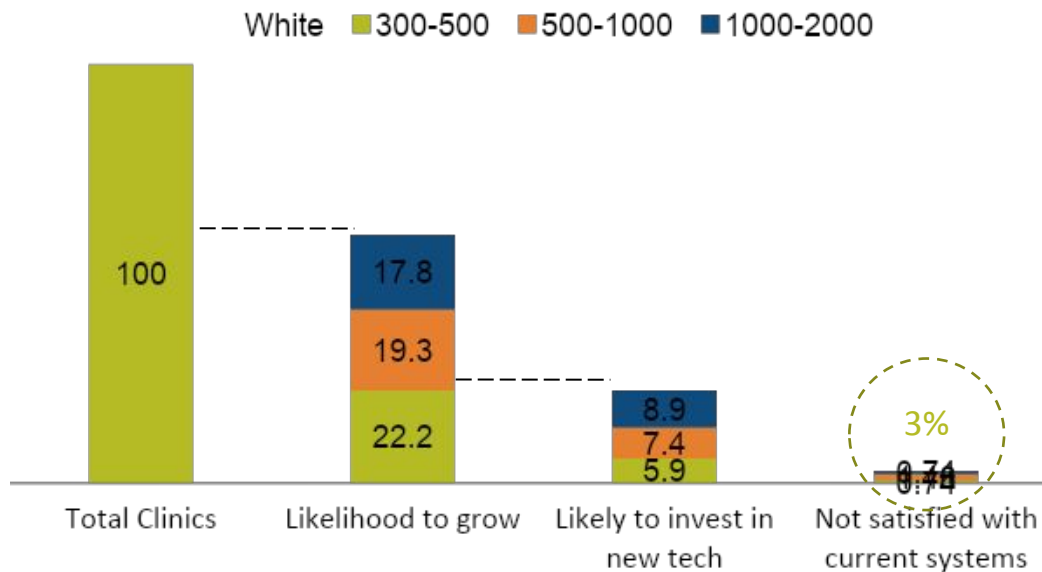
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Thank you for your time


Q&A

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