

# There and back again:

From applied research to  
academic entrepreneurship



George Papagiannakis

ORamaVR co-founder, CEO  
[george@oramavr.com](mailto:george@oramavr.com)

&

Prof. University of Crete,  
Affiliated Researcher at FORTH  
Visiting Prof. University of Geneva



**FORTH**

Foundation for Research & Technology - Hellas

**ORama** VR



UNIVERSITÉ  
DE GENÈVE

# Overview

- Computational medical XR
- ORamaVR case study
- Academic entrepreneurship?



Midjourney prompt:  
*"a there and back again hobbit house looking from inside towards outside through the open door, cinematic, atmospheric lighting"*

## *My Career arcs*



# VHD++ Development Framework: Towards Extendible, Component Based VR/AR Simulation Engine Featuring Advanced Virtual Character Technologies

Michal Ponder<sup>(\*)</sup>, George Papagiannakis<sup>(\*\*)</sup>, Tom Moeller<sup>(\*)</sup>,  
Nadia Magnenat-Thalmann<sup>(\*\*)</sup>, Daniel Thalmann<sup>(\*\*)</sup>

### **Abstract**

This paper presents the architecture of the FEDS—time domain framework that after several years intensive research, design, and development effort has been successfully applied to solve many problems. The key features of the FEDS—time domain framework are the key concepts method in architectural structure, design and practical application of the time domain framework based on the modern 3D—game—engine technology, and the real-time validation system. The FEDS—time domain framework is developed by the engineering department of FEDS systems featuring advanced virtual simulation environment, real-time validation system, main concepts, memory of related work, the function of simulation, design, response, redesign, design validation, and other functions. The validation system of the FEDS—time domain framework is based on the initial validation results including various engineering FEDS—based TRMM variant character

### 1. Introduction: The Demand

The very recent evolutionary advancements in computer graphics and in mid-time virtual character animation have made it possible to generate VR/AR content and to popularize on their scaled down devices interactive video games. In the extremely competitive VR/AR market, the game developer always needs, always faster and always more in order to stay competitive. The game developer systems in principle change exponentially with the number of constraints and requirements of the consumer and user. In a single dimension, the game developer needs to create a multi-dimensional, multi-sensorial application. This requires the game developer to constantly update his/her knowledge in the field of computer graphics and mid-time, studio-quality rendering. This explains the need for the game developer to constantly learn, to keep up with the latest trends and to constantly improve his/her skills.

UNIVERSITÉ DE GENÈVE  
Département de systèmes d'information  
DÉPARTEMENT D'INFORMATIQUE  
FACULTÉ DES SCIENCES  
ÉCONOMIQUES ET SOCIALES  
Professeur Nadia Magruder-Thalmann

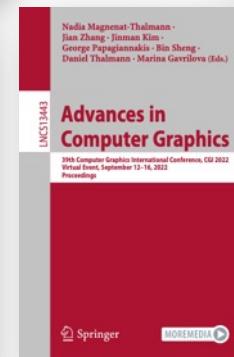
An Illumination Registration Model for Dynamic Virtual Humans in Mixed Reality  
THÈSE  
présentée à la Faculté des Sciences de l'Université de Genève  
pour obtenir le grade de Docteur ès sciences mention Informatique

par  
Georgios Papagiannakis  
de  
*Côte d'Or*

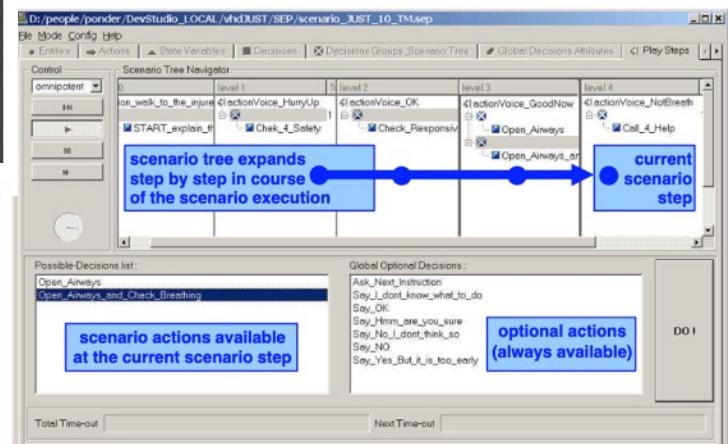
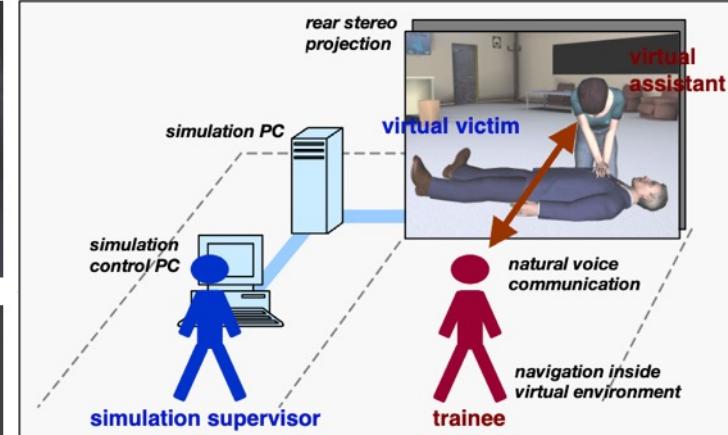
## GENÈVE



UNIVERSITÉ  
DE GENÈVE



# XR and Spatial computing for medical training?



- M Ponder, B Herbelin, T Molet, S Schertenleib, B Ulicny, G Papagiannakis, N Magnenat-Thalmann, and D Thalmann. 2002. Interactive Scenario Immersion:Health Emergency Decision Training in JUST Project. Proc. Of 1st International Workshop on Virtual Reality Rehabilitation, VRMHR2002, Lausanne, (November 2002), 87–101.
- Michal Ponder, Bruno Herbelin, Tom Molet, Sébastien Schertenleib, Branislav Ulicny, George Papagiannakis, Nadia Magnenat-Thalmann, and Daniel Thalmann. 2003. Immersive VR decision training: telling interactive stories featuring advanced virtual human simulation technologies. DOI:<https://doi.org/10.1145/769953.769965>

# XR and Spatial computing for education?



Papagiannakis, G. et al. LIFEPLUS: Revival of life in ancient Pompeii. *Proc. of Virtual Systems and Multimedia, VSMM02*, Gyeongju (2002)

Papagiannakis, G. et al. Mixing Virtual and Real scenes in the site of ancient Pompeii. *Computer Animation and Virtual Worlds*, John Wiley and Sons Ltd 16, 11–24 (2005)

A reproduction of Rembrandt's painting 'The Anatomy Lesson of Dr. Nicolaes Tulp'. It depicts a group of men in 17th-century Dutch attire gathered around a table where a cadaver is being dissected. The central figure, Dr. Nicolaes Tulp, is shown in profile, holding a scalpel and pointing towards the body. Several other men look on, some holding anatomical charts or books. The painting is signed 'Rembrandt f. 1632' in the upper left corner.

**150+**

Years outdated  
medical educational  
residency model:  
master - apprentice

**18M**

Medical professionals'  
shortage by 2030

**5B**

People lack access to  
affordable surgical and  
anesthesia care  
according to WHO

*The Anatomy Lesson of Dr.  
Nicolaes Tulp, 1632, Rembrandt,  
Mauritshuis museum,  
The Hague, Netherlands*

# United Nations Sustainable Development Goals



## ENSURE HEALTHY LIVES AND PROMOTE WELL-BEING FOR ALL AT ALL AGES

NOTABLE STRIDES HAVE BEEN MADE TOWARDS IMPROVING GLOBAL HEALTH OUTCOMES



146 OUT OF 200 COUNTRIES OR AREAS HAVE ALREADY MET OR ARE ON TRACK TO MEET THE UNDER-5 MORTALITY TARGET



EFFECTIVE HIV TREATMENT HAS CUT GLOBAL AIDS-RELATED DEATHS BY 52% SINCE 2010



AT LEAST ONE NEGLECTED TROPICAL DISEASE HAS BEEN ELIMINATED IN 47 COUNTRIES



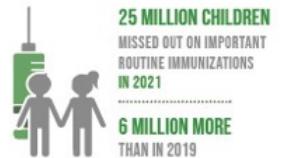
### OUT-OF-POCKET PAYMENTS

FOR HEALTH PUSHED OR FURTHER PUSHED

381

MILLION PEOPLE  
(4.9% OF POPULATION)

INTO EXTREME POVERTY



MALARIA CASES HAVE SURGED WORLDWIDE

MALARIA CASES (MILLIONS)



## ENSURE INCLUSIVE AND EQUITABLE QUALITY EDUCATION AND PROMOTE LIFELONG LEARNING OPPORTUNITIES FOR ALL

DESPITE SLOW PROGRESS,

### THE WORLD IS FALLING FAR BEHIND IN ACHIEVING QUALITY EDUCATION

WITHOUT ADDITIONAL MEASURES, BY 2030:



84 MILLION CHILDREN AND YOUTH WILL BE OUT OF SCHOOL



300 MILLION STUDENTS WILL LACK BASIC NUMERACY/LITERACY SKILLS

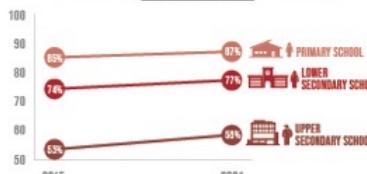


ONLY 1 IN 6 COUNTRIES WILL ACHIEVE UNIVERSAL SECONDARY SCHOOL COMPLETION TARGET



PRIMARY AND SECONDARY SCHOOL COMPLETION RATES ARE RISING, BUT THE PACE IS SLOW AND UNEVEN

COMPLETION RATES



LOW- AND LOWER-MIDDLE-INCOME COUNTRIES FACE A NEARLY

\$100 BILLION ANNUAL FINANCING GAP

TO REACH THEIR EDUCATION TARGETS

# Spatial Computing, Medical Metaverse<sup>1</sup> and Digital Twins are revolutionizing healthcare and education

**81%**<sup>2</sup>

Of healthcare executives say the metaverse will have a positive impact on their organizations

**5B\$**<sup>3</sup>

By 2030, the healthcare metaverse market will grow by 48.3% CAGR and be worth \$5.37 billion

**570%**<sup>4</sup>

Reduction in learning time by using immersive medical VR training



1. <https://ieeexplore.ieee.org/document/9940237>

2. <https://www.accenture.com/us-en/insights/health/digital-health-technology-vision>

3. <https://finance.yahoo.com/news/healthcare-metaverse-market-projected-worth-122100949.html>

4. Lohre, R., Bois, A. J., Athwal, G. S. & Goel, D. P. Improved Complex Skill Acquisition by Immersive Virtual Reality Training. *J Bone Joint Surg Am* **Latest Articles**, 1–10 (2020).

# Computational Medical XR

## Intro



**Computational medical XR<sup>1</sup>** is a new interdisciplinary field, bridging life sciences, with mathematics, engineering and computer science.

It unifies **computational science<sup>2</sup>** (scientific computing) with intelligent **extended reality** and **spatial computing** for the **medical field**.

It integrates **computational methods** from computer **graphics**, computational **geometry**, **vision** and **deep learning** to solve hard problems in medicine and neuroscience:

- low-code/no-code **authoring** XR platforms
- XR medical **training**
- XR surgical **planning**
- XR operative **navigation**
- XR for **rehabilitation** and **therapeutics**

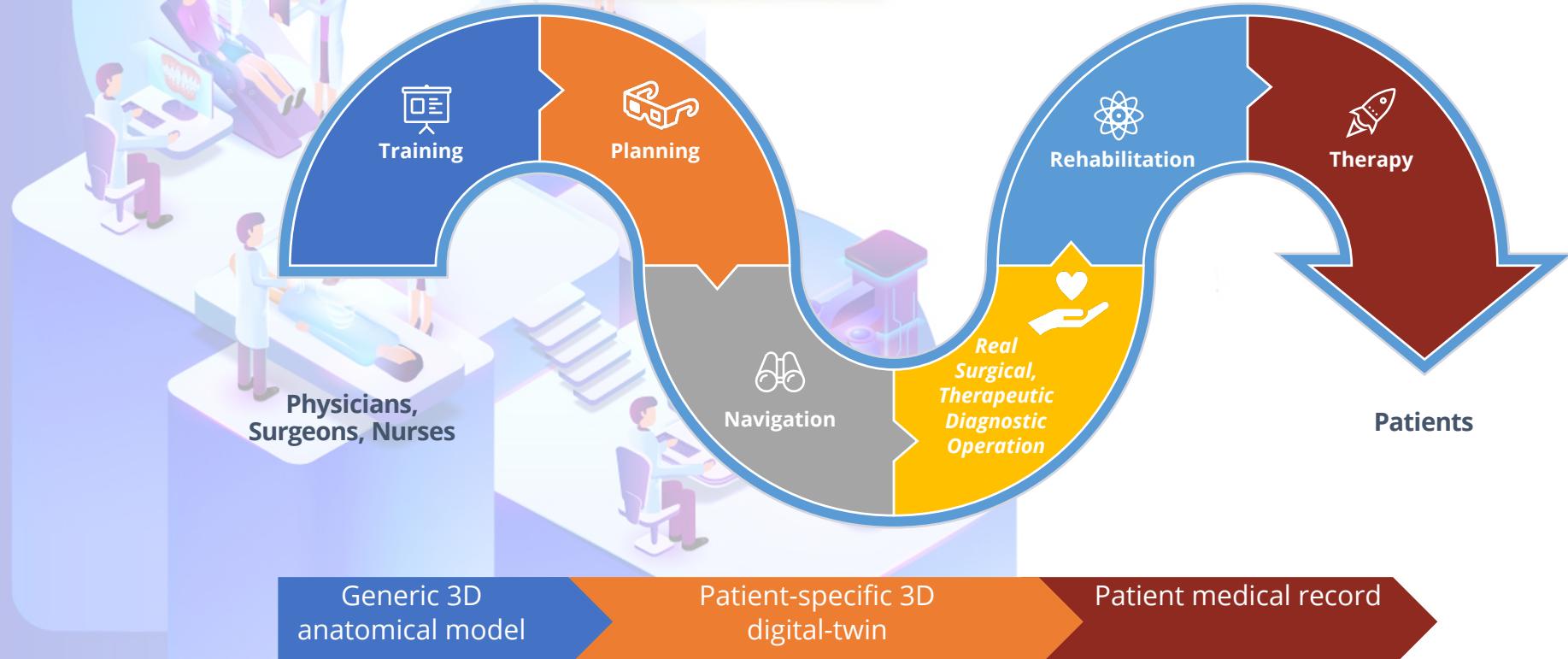
<sup>1</sup> Papagiannakis, G., "A computational medical XR discipline", <https://arxiv.org/abs/2108.04136v3>, 2023

<sup>2</sup> D. E. Stevenson. 1994. Science, computational science, and computer science: at a crossroads. *Commun. ACM* 37, 12 (Dec. 1994), 85–96. DOI:<https://doi.org/10.1145/198366.198386>

# Computational Medical XR Overview

Frontiers SIGGRAPH 2023 talk<sup>1</sup>

Frontiers SIGGRAPH 2023 workshop<sup>2</sup>



<sup>1</sup> [https://s2023.siggraph.org/presentation/?id=ftalk\\_101&sess=sess408](https://s2023.siggraph.org/presentation/?id=ftalk_101&sess=sess408)

<sup>2</sup> [https://s2023.siggraph.org/presentation/?id=fwork\\_109&sess=sess287, 2023](https://s2023.siggraph.org/presentation/?id=fwork_109&sess=sess287, 2023)

# Why now for computational medical XR?



Stable Diffusion prompt:

"doctors and nurses with 3D VR and AR glasses in digital and real objects and environments integrated and communicating between each other based on immersive experiences"

**"After years of validation and use by early adopters – XR medical technology is poised to move to the mainstream; recent changes in access and cost make XR quite affordable"**

*Dr. Walter Greenleaf,  
Stanford Health Care & Virtual Human Interaction Lab*

**"The biggest challenges in healthcare are (1) access—there aren't enough good doctors to provide timely care to all who need it (and clinicians are leaving the field in droves due to burn out), and (2) cost—the cost of healthcare has skyrocketed, largely because of increasing labor costs.**

**AI will solve both of these issues."**

*Daisy Wolf and Vijay Pande,  
<https://a16z.com/2023/08/02/where-will-ai-have-the-biggest-impact-healthcare/>*



Operation Progress:  
Lesson 1: Knee Incision  
Actions: 0 / 68

Cut Epidermis

Operation Start  
Action Time: 13.98 Sec  
Score: 100%  
Errors: 1

# METAVERSE LOW-CODE AUTHORING FRAMEWORKS



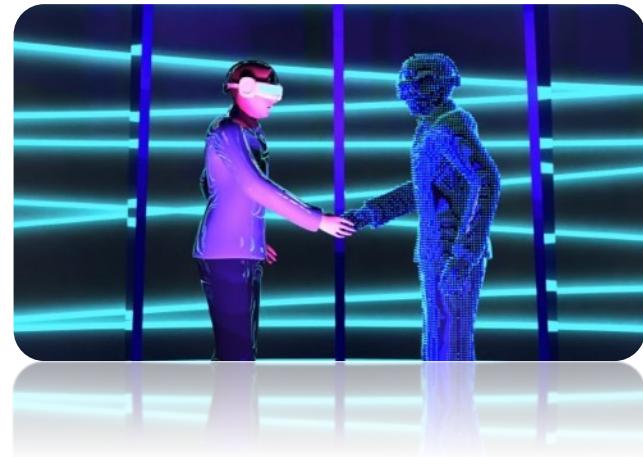
Numerous **authoring frameworks** have emerged to sustain the creation of VR/AR applications

Main characteristics of virtual reality authoring tools: [1]

- Virtual environment **creation**
- Manipulating and importing **3D** objects
- Interactive **human characters** development
- Artificial intelligence **automation**

"Our medical virtual-worlds (**or digital twins**) will seem fundamentally different in the future due to the incorporation of developing technology" [3]

"The most evaluated metrics were **usability**, **effectiveness**, **efficiency**, and **satisfaction**." [2]

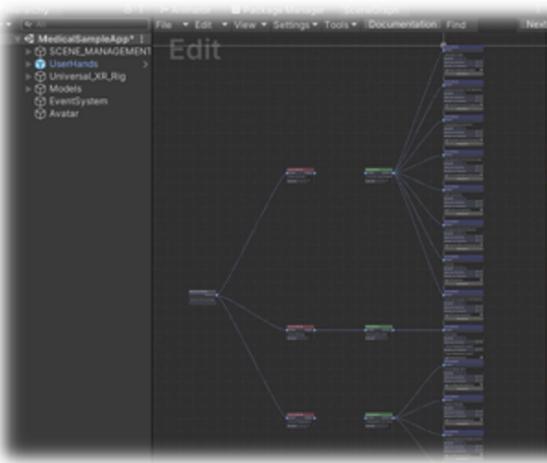


[1] Chamusca, I. L., Ferreira, C. V., Murari, T. B., Apolinario, A. L. & Winkler, I. Towards Sustainable Virtual Reality: Gathering Design Guidelines for Intuitive Authoring Tools. *Sustainability-basel* **15**, 2924 (2023)

[2] Coelho, H., Monteiro, P., Gonçalves, G., Melo, M. & Bessa, M. Authoring tools for virtual reality experiences: a systematic review. *Multimed Tools Appl* 1–24 (2022) doi:10.1007/s11042-022-12829-9

[3] Bansal, G., Rajgopal, K., Chamola, V., Xiong, Z. & Niyato, D. Healthcare in Metaverse: A Survey On Current Metaverse Applications in Healthcare. *Ieee Access* **PP**, 1–1 (2022)

# METAVERSE AUTHORING FRAMEWORKS: MAGES 4.0



## MAGES 4.0 introduces

- Automations in VR design-patterns for interaction-design **Actions development**
- VR recorder to capture and replay VR sessions
- Realistic real-time **cut, tear and drill** algorithms
- AR and mobile (iOS/Android) support
- Dissected edge physics engine
- Edge-cloud **remote visual rendering**
- Optimized networking layer with collaboration of **AR/VR** devices
- Convolutional **neural network** automatic assessment
- New template applications (open source)

The cover of the March/April 2023 issue of IEEE Computer Graphics and Applications. The title "Computer Graphics AND APPLICATIONS" is prominently displayed in large, bold letters. Below the title, it says "VOLUME 43, NUMBER 2" and "MARCH/APRIL 2023". The central image is a dark, atmospheric scene of a metaverse environment, showing a desk with a laptop and other equipment. The IEEE logo and the journal's website "www.computer.org/cga" are at the bottom.



IEEE COMPUTER GRAPHICS AND APPLICATIONS, MARCH/APRIL 2023, VOL. 43, NO. 2, ISSN 0271-0082, 13.00



# MAGES 4.0



“

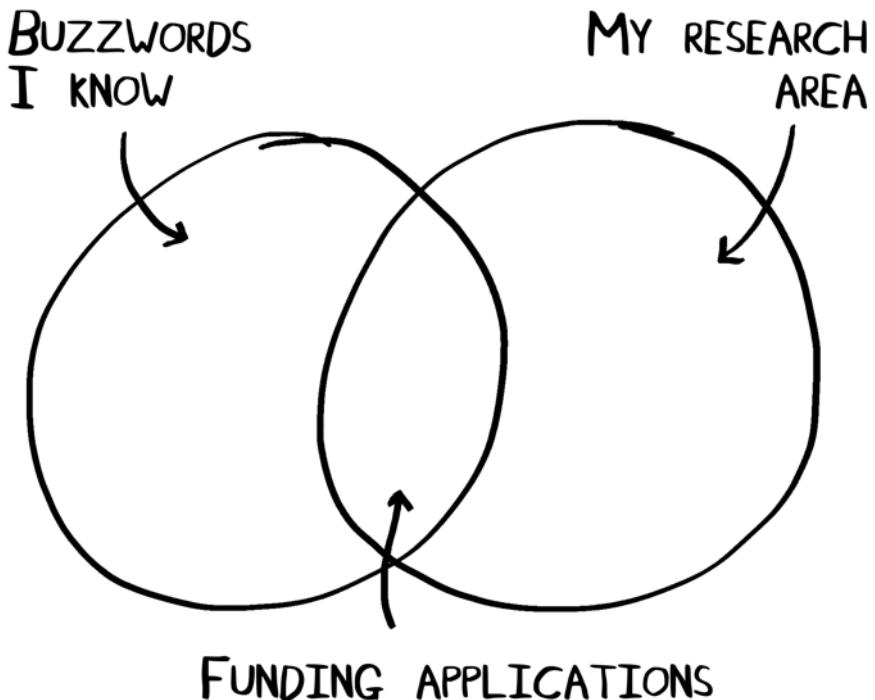
**The scene is set for massive change**

**What about  
academic  
entrepreneurship?**

## Research & funding

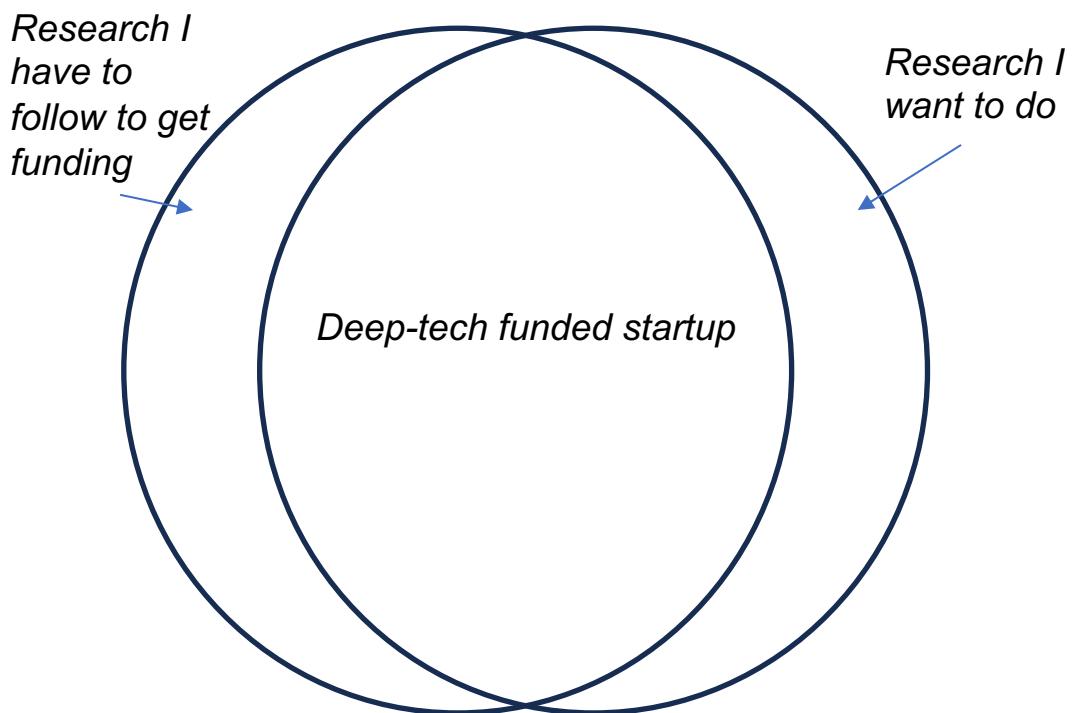
*"Buzzwords I know" == latest research strands I have to incorporate in order to get funding*

### RESEARCH VENN DIAGRAMS BUZZWORDS AND FUNDING ERRANTSCIENCE.COM



## Research & deep-tech

Deep-tech = academic entrepreneurship  
startup with deeper technology  
stacks than regular startups





## What is academic entrepreneurship and deep-tech startups?

- The process by which university faculties and researchers **convert** their **findings** and **research** into **innovative** marketable **products, services, or businesses**
- Deep-tech: “the secret sauce”: algorithm or patent or custom hardware that provides a 12-month **head-start** from anyone else in the field
- Deep-tech: academic startups often have deeper tech foundations than typical startups

### Tips:

- Engage with tech-transfer offices early
- Align academic work with market needs (impact)

\* Source- Midjourney: “a computer scientist using deep learning algorithms to generate compelling computer graphics solutions to a visualization problem”

# Academic Entrepreneurship: “do good” (while making \$)



- Fast-growing FORCE in Universities and Research centres:
- Influence technology and business models:  
**“do good” (while making \$)**
- Growing realization that you can actually set norms and even standards in new ventures for positive social purpose and grand challenges for humanity (health, climate, education), and do this as a FOR-PROFIT (*not as NFP*)
- Over the 30 social innovation champion students at Stanford GSB, 26 are working on big, social problems and are for profits!  
*(complete flip from 7-10 years ago!)*

*Steve Ciesinski, Stanford GSB and ex-SRI president*

## Why academic entrepreneurship deep-tech startups matter?

- Deep-tech startups address global challenges (climate, health, education)
- They create economic growth through innovation, knowledge and jobs
- They create wealth for their founders\*, (early) employees and investors
- Startup success (and failure) creates positive spillover effects into more entrepreneurial activity
- Startups' products and services provide consumers with greater choices
- Enabling countries to build independent critical tech infrastructure: tech sovereignty

Source - Midjourney: “*a computer scientist using deep learning algorithms to generate compelling computer graphics solutions to a visualization problem*”





# Academic entrepreneurship and Academic Research?

- Self-conviction
- Skill
- Luck
- Resilience
- Funding
- Just like academic research!
- Are there differences?
- Scientists: *ask the questions to seek answers*
- Innovators: *take those answers and ideas and turn them to products*

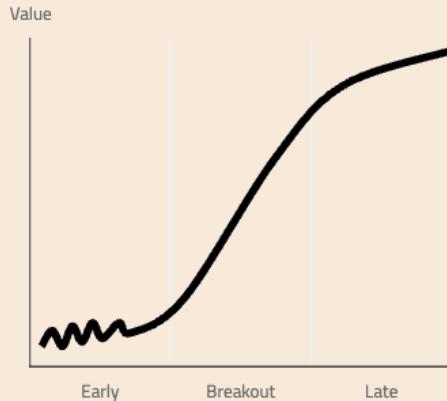
\* Source - Midjourney: "minimalism 4k pure background two human figures and two 3d spheres"

# Regular vs. Deep-tech vs. Biotech startups

**Deep Tech and Biotech startups have different paths than regular startups.**

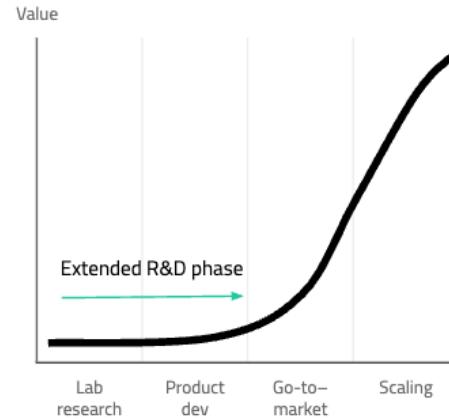
## Regular startup

Exploit new but proven technologies  
Validate product-market fit as early as possible  
R&D and patent ownership is rare



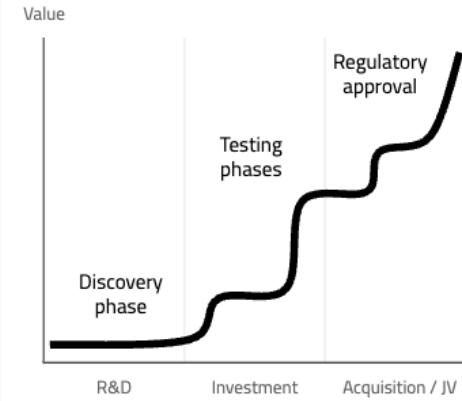
## Deep Tech startup

Starts with extended R&D phase  
Higher share of technical staff  
Often involves hardware and/or IP



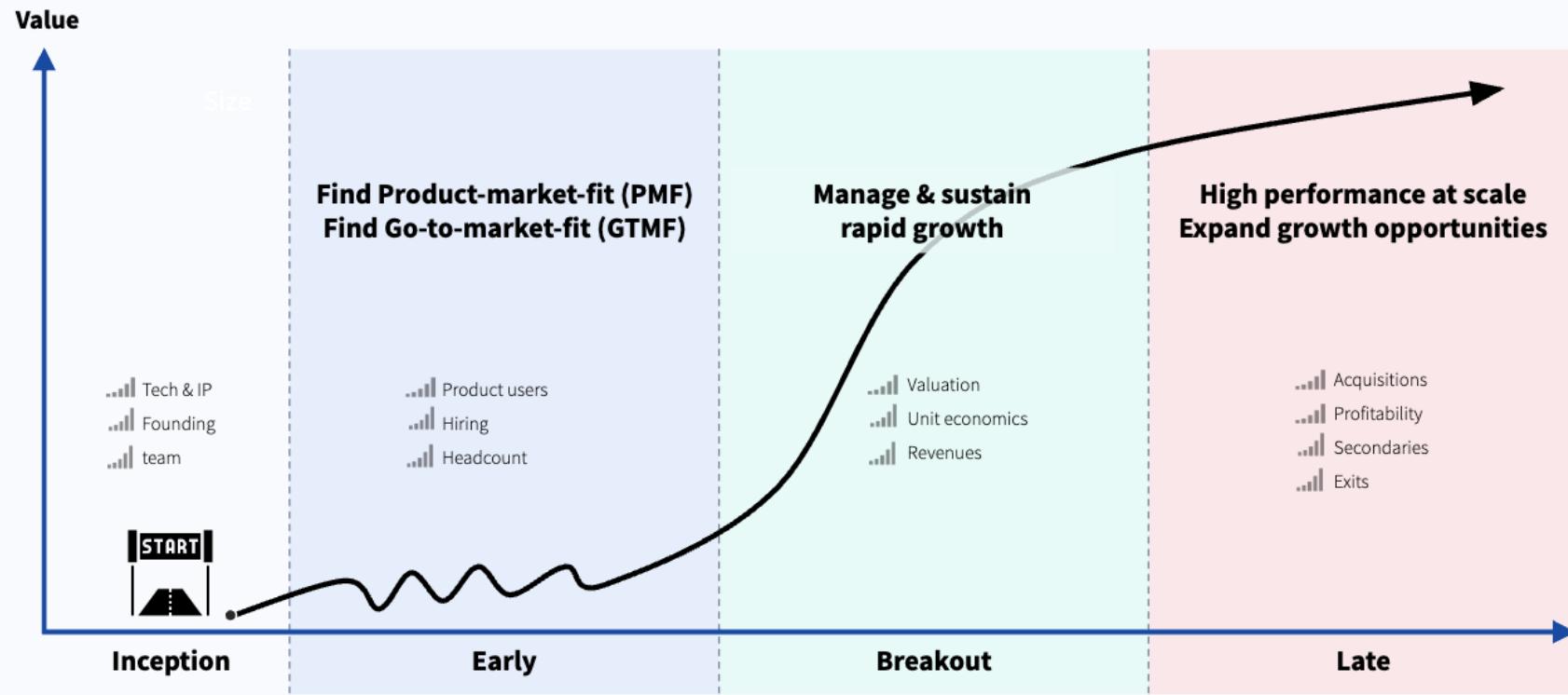
## Biotech startup

Long and costly testing phases  
Discovery phase becoming shorter \*  
Less market risk \*\*



# Startup development stages

The startup journey can be broken into three stages, with new milestones and performance indicators at each stage.



## Idea/Research phase?

- Start with the research question or discovery
- Identify commercial potential
- Form the team
- “Move fast and break things”

### Tips

- Not every research outcome has commercial potential
- Regularly assess commercial viability
- Universities can be both a boon and a bottleneck
- Navigating IP rights between researcher and institution early
- Licensing vs. ownership

\* Source - Midjourney: “a computer scientist using deep learning algorithms to generate compelling computer graphics solutions to a visualization problem”



## Prototyping & Validation?

- Transfer research into a prototype
- Seek feedback from potential users (ideally not your friends as they will be nice to you)
- Refine based on feedback

### Tips

- Aim for simplicity and usability in first iterations
- Leverage alumni networks for outreach and support
- Deep-tech requires significant customer education
- Stay flexible and open to feedback
- Most successful deep-tech startups pivot multiple times

\* Source - Midjourney: “a computer scientist using deep learning algorithms to generate compelling computer graphics solutions to a visualization problem”

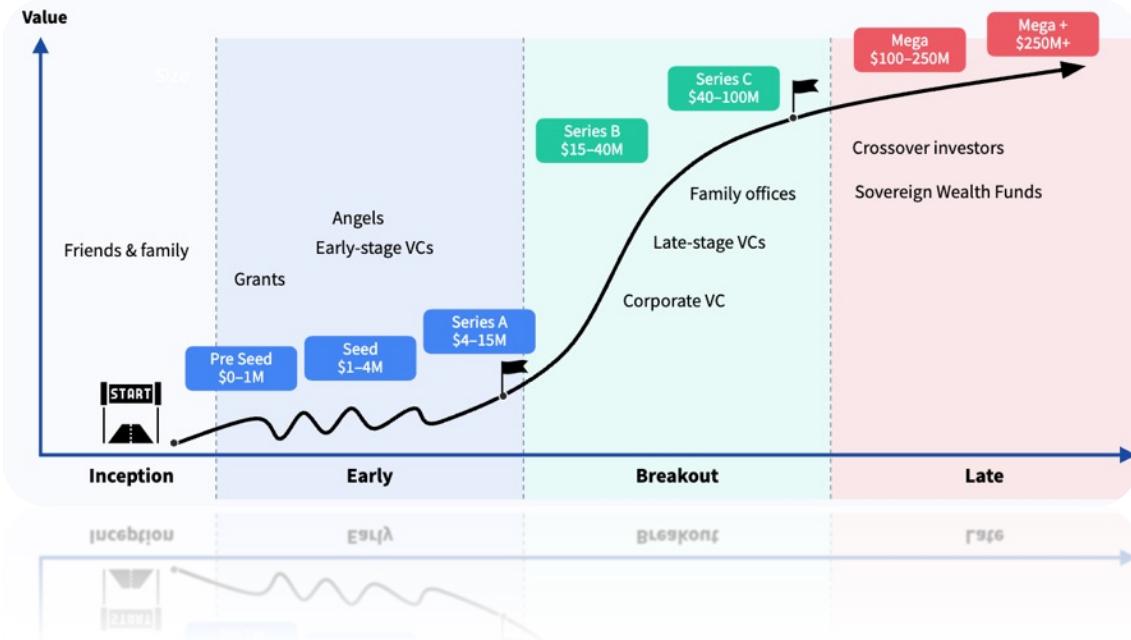
# Startup journey I

## Pre-seed and Seed Funding?

- Pitch to early-stage investors
- Convertible notes or equity investments
- Use funds for further validation and initial growth

### Tips

- Refine your pitch and financial projections based on feedback

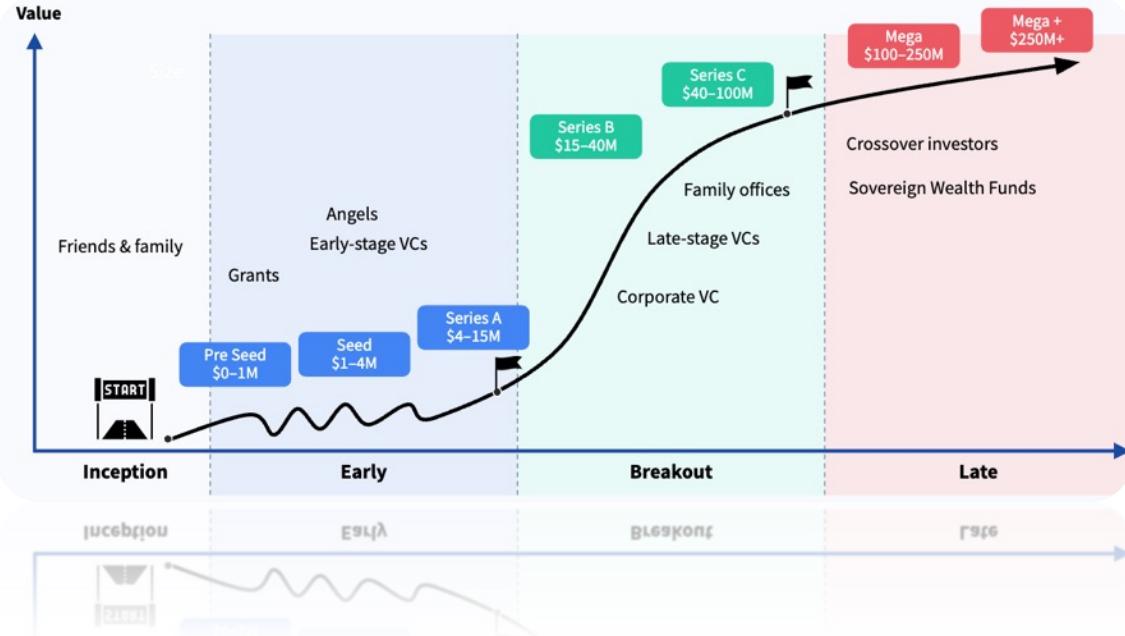


Source: dealroom.co,  
<https://dealroom.co/uploaded/2023/08/Dealroom-Startup-Demographics.pdf?x92057>, 2023

# Startup journey II

## Series-A and Growth Funding?

- Prove there is a large potential market
- Have some revenue or clear path to revenue
- Use funds for expanding the team, tech-dev and market penetration

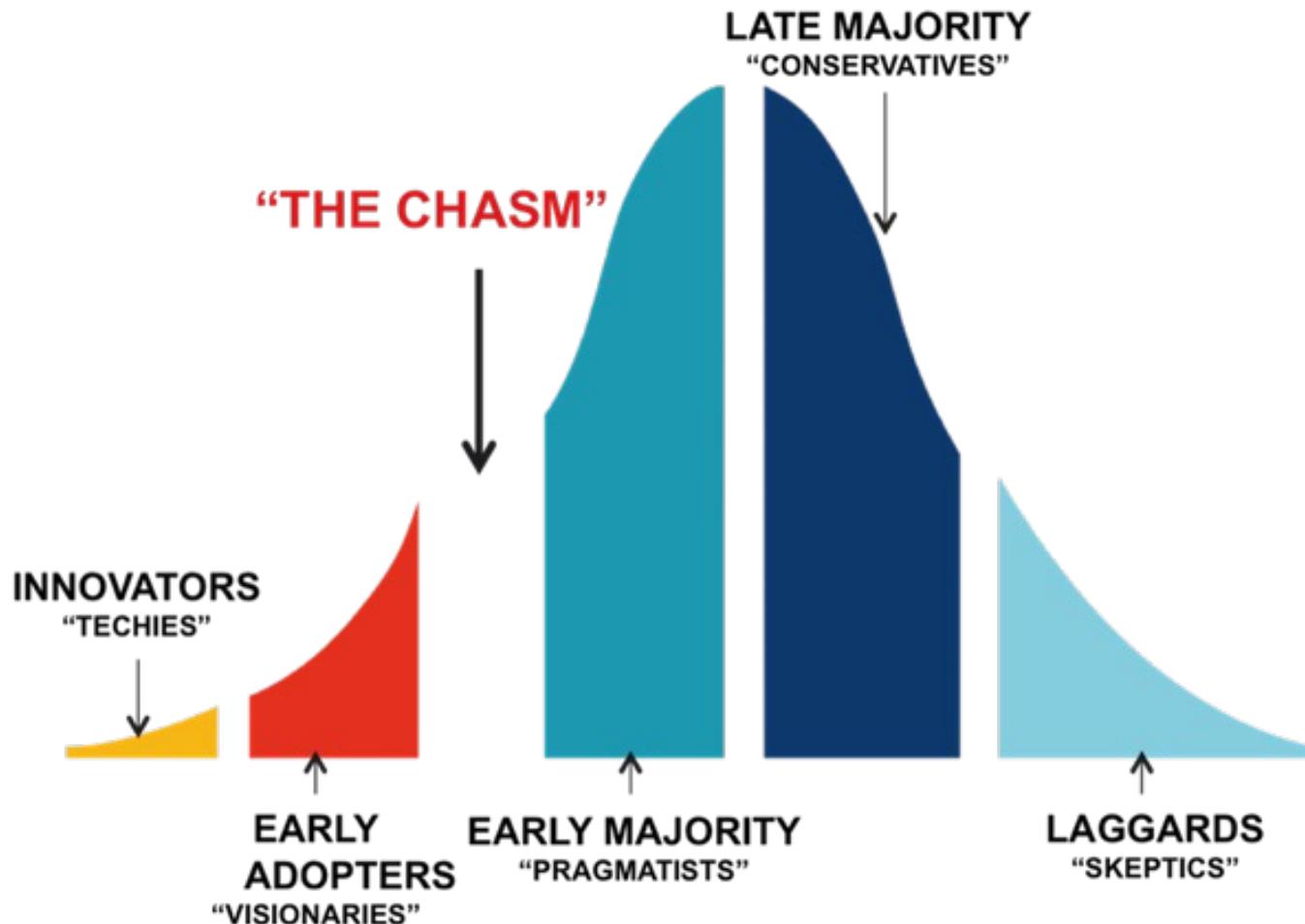


### Tips

- Refine your growth strategies based on real market data

Source: [dealroom.co](https://dealroom.co/uploaded/2023/08/Dealroom-Startup-Demographics.pdf?x92057),  
<https://dealroom.co/uploaded/2023/08/Dealroom-Startup-Demographics.pdf?x92057>, 2023

# Mind the gaps!



# Startup valuation methods

## DISCOUNTED CASH FLOW VALUATION

### Assumptions

Discount rate - WACC  
 EBITDA YoY growth rate  
 Long term CF growth rate  
 Capital investment % of EBITDA

Annual sales (current year)  
 Average number of days it takes a the customers pay  
 Average annual purchases (stock, material, services totally)  
 Average number of days it takes a the customers pay suppliers  
 Average number of days it takes for a company to sell its inventory

10.5%
7.0%
1.5%
15.0%
10,000
60
8,000
60
75

Discounted Cash Flows	Current year	notes	2024	2025	2026	2027	2028
\$							
EBITDA / Operating profit	2,000		2,140	2,290	2,450	2,622	2,805
Net Working capital adjustments	(25)		(41)	(7)	(405)	(80)	(94)
CAPEX adjustments	(150)		(321)	(343)	(368)	(393)	(421)
Free Cash Flow	1,825		1,778	1,939	1,678	2,148	2,290
Discount factor	1.0000		1.1052	1.2216	1.3501	1.4922	1.6493
DCF	1,825		1,609	1,587	1,243	1,439	1,389

## VENTURE CAPITAL METHOD

Parameter	Value	Explanation
Projected Year 5 Revenue	50,000,000	\$50 million
Price-to-sales ratio	5	5x
Estimated Future Exit Value (Year 5)	250,000,000	\$250 million (5 x \$50M)
VC's Desired ROI	10%	10x
Post-money Valuation Today	25,000,000	\$25 million (\$250M / 10)
VC Investment	2,000,000	\$2 million
Pre-money Valuation Today	23,000,000	\$23 million (\$25M - \$2M)

Back of an envelope calculation to determine if the investment makes sense for a VC:

- They will not believe your revenue projections. They will take 50%
- They will not believe your funding projections and they will double them
- They will take your annualized sales x 8 (if you were acquired or do an IPO this is what you will get for a fast-growing company)
- Divide that by the funding projection to calculate the return on the funds

A researcher with dark hair, wearing a blue hoodie, sits cross-legged on a large pile of books in a library. He is looking down at a smartphone held in his hands. The library is filled with floor-to-ceiling bookshelves packed with books. The lighting is warm and focused on the researcher and the books around him, creating a cozy yet scholarly atmosphere.

# Personal Lessons learned from academic entrepreneurship?

- Articulate a clear vision & passion
- Focus R&D efforts on one side, cannot do it in parallel (*academia and startup*)
- Teaching helps identify gaps in your assumptions (as well as hiring)
- Don't overestimate the presence and underestimate the future
- "*we build it and they will come*"
- Cultural divides do exist: different language across business, finance, marketing, technical fields
- Motivating and managing your team is one of the hardest things
- Execution is crucial not just the technology!
- Be mindful of which VC you trust for your funding
- Be mindful of your co-founders and first key employees
- Proper accounting & legal support can make or break your startup
- Never run out of cash!

\* Source - Midjourney: "*a researcher investigating in a library between thousands of scientific papers and books*"

## Some Success stories?

- **TheraPanacea** (<https://www.therapanacea.eu>). Prof. Nikos Paragios (University of Paris - Saclay), Founder and CEO
- **Rheon Medical** (<https://rheonmedical.com>), Prof. Nikos Stergiopoulos (EPFL), Founder and CEO
- **Coursera** ([www.coursera.com](http://www.coursera.com)), Prof. Daphne Koller and Prof. Andrew Ng (Stanford University)

## Outlook

- The boundaries between academia and deep-tech industry are blurring
- Different universities and research centers have different support mechanisms

\* Source - Midjourney: “minimalism 4k pure background human figure walking towards light”



## Is academic entrepreneurship really new?

- **Evans & Sutherland company (1968)**

The company was founded in 1968 by [David C. Evans](#) and [Ivan Sutherland](#), professors in the Computer Science Department at the [University of Utah](#). who were pioneers in [computer graphics](#) technology.

They formed the company to produce hardware to run the systems being developed in the University, working from an abandoned [barracks](#) on the university grounds. The company was later housed in the [University of Utah Research Park](#).

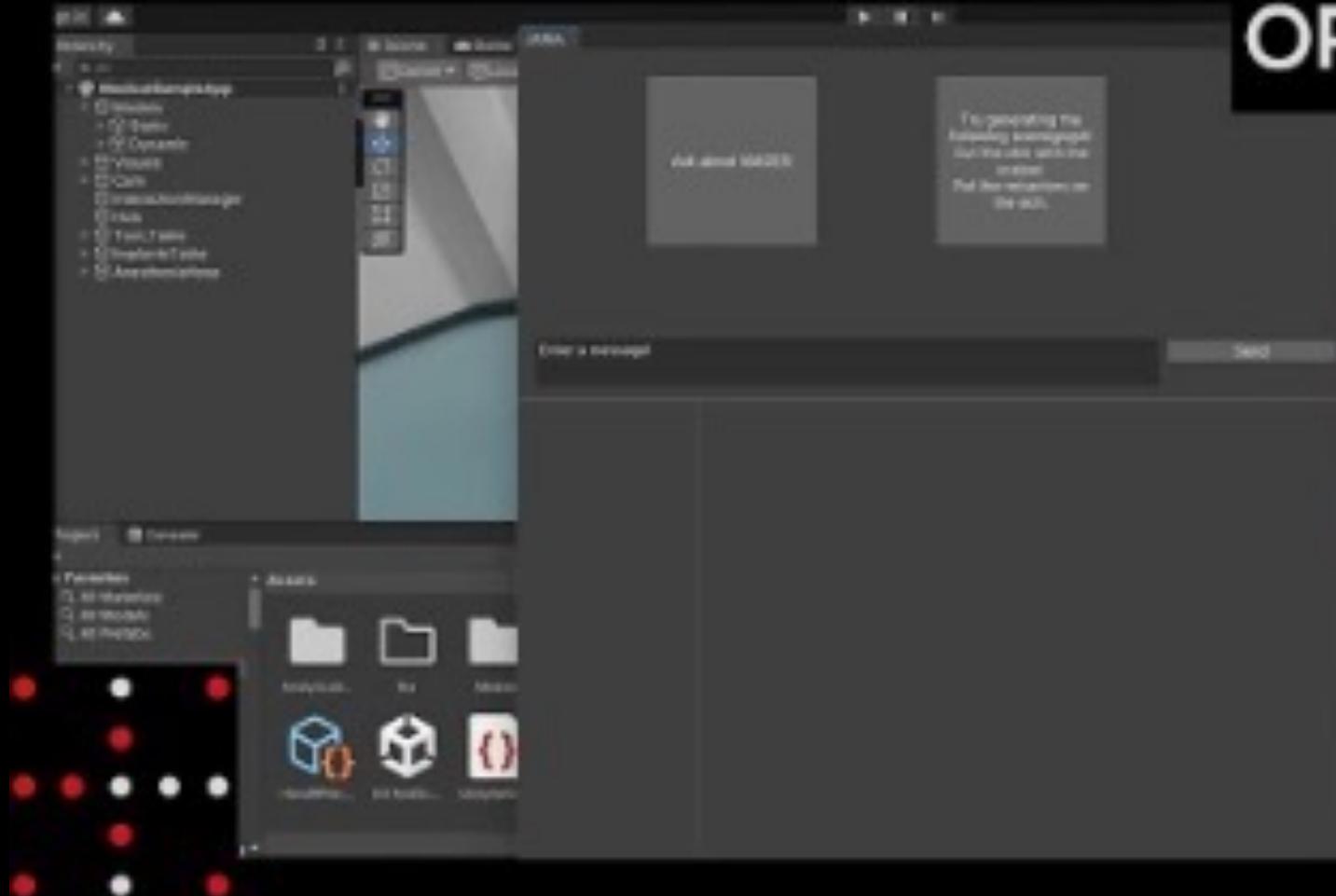
Most of the employees were active or former students, and included [Jim Clark](#), who started [Silicon Graphics](#), [Ed Catmull](#), co-founder of [Pixar](#), and [John Warnock](#), founder of [Adobe](#).

# One more thing

What about  
no-code generative-AI for  
medical XR training?



## JARIA – MAGES SDK NXT (5.0)



ORama | VR

# One last thing



```
# general imports
# import openai and dependencies
import os
import openai
openai.api_key = os.getenv("OPENAI_API_KEY")
openai.Model.list()

import textwrap
# ask ChatGPT via its API and get a response
response = openai.ChatCompletion.create(
model = "gpt-3.5-turbo",
messages=[{"role":"system", "content": "You are a helpful assistant."},
 {"role":"user", "content": "Can you say 80 words to inspire the audience of The Research and Innovation Centre on Interactive Media, Smart System and Emerging Technologies – CYENS Centre of Excellence in Cyprus about academic entrepreneurship and deep-tech startups?"},]
)
chatReply = response['choices'][0]['message']['content']
print(textwrap.fill(chatReply, width=100))
```

...In the realm of academic entrepreneurship and deep-tech startups, incredible possibilities await.

Your expertise and passion have the power to transform cutting-edge research into impactful solutions that shape our future.

Embrace the spirit of innovation, embrace collaboration, and pave the way for ground-breaking technologies.

Let us be the catalysts for change, marrying academia with entrepreneurship, and propelling Cyprus to the forefront of the global technological revolution.

Dare to dream big, and make it a reality.



## Swiss Accelerator innovation project supported by



Schweizerische Eidgenossenschaft  
Confédération suisse  
Confederazione Svizzera  
Confederaziun svizra  
Swiss Confederation  
**Innosuisse – Swiss Innovation Agency**



Funded by the  
European Union  
NextGenerationEU

**Greece 2.0**  
NATIONAL RECOVERY AND RESILIENCE PLAN

**fidal**  
field trials  
beyond 5G.

  
**5G-EPICENTRE**



**Dr. George Papagiannakis**  
Prof. University of Crete,  
Affiliated Researcher at FORTH  
Visiting Prof. University of Geneva  
&  
ORamaVR co-founder, CEO  
[george@oramavr.com](mailto:george@oramavr.com)



**ORama VR**

  
**UNIVERSITÉ  
DE GENÈVE**

*Let's accelerate world's transition to  
academic entrepreneurship!*