

There and back again:

From applied research to
academic entrepreneurship



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FORTH

Foundation for Research & Technology - Hellas

ORama



**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"

[illegible]


UNIVERSITÉ DE GENÈVE	FACULTÉ DES SCIENCES ÉCONOMIQUES ET SOCIALES
Département de systèmes d'information	Professeur Nadia Magnien-Thalmann
Département d'informatique	FACULTÉ DES SCIENCES Professeur José Rullier

**An Examination 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 en sciences, mention informatique

par
 Georgios Papagiomidis
 de
 Cète (Séoul)


Thèse N° 3795

GENÈVE
 Année de reproduction de la Section de physique
 2006

[illegible]

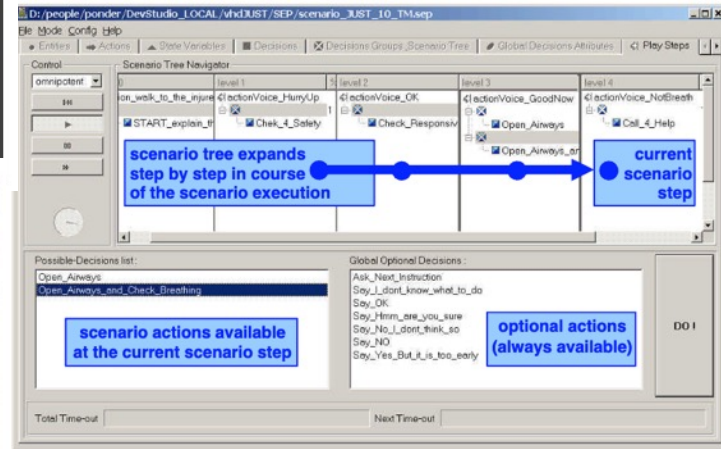
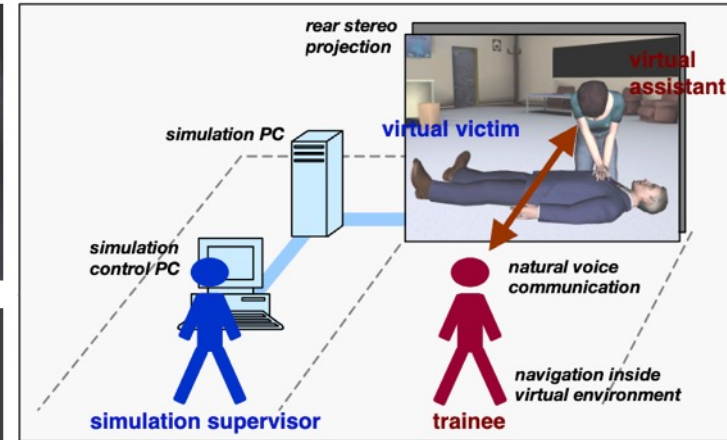
Marinos Ioannides
Nadia Magnenat-Thalmann
George Papagiannakis *Editors*

Mixed Reality and Gamification for Cultural Heritage

 Springer

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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, Sebastien Schertenlieb, 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)



150+

Years outdated
medical educational
residency model:
master - apprentice

18M

Medical professionals'
shortage by 20230

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



MILLION PEOPLE (4.9% OF POPULATION)

INTO EXTREME POVERTY



25 MILLION CHILDREN MISSED OUT ON IMPORTANT ROUTINE IMMUNIZATIONS IN 2021

6 MILLION MORE THAN IN 2019

MALARIA CASES HAVE SURGED WORLDWIDE

MALARIA CASES (MILLIONS)



A WOMAN DIES EVERY TWO MINUTES FROM PREVENTABLE CAUSES RELATED TO PREGNANCY AND CHILDBIRTH (2020)



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

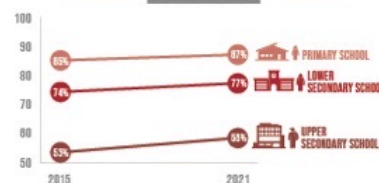


THE PANDEMIC

CAUSED LEARNING LOSSES IN 4 IN 5 OF 104 COUNTRIES STUDIED

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 Metaverse¹ and Digital Twins are revolutionizing healthcare and education

81%²

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

5B\$³

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

570%⁴

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 XR¹ is a new interdisciplinary field, bridging life sciences, with mathematics, engineering and computer science.

It unifies **computational science²** (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**

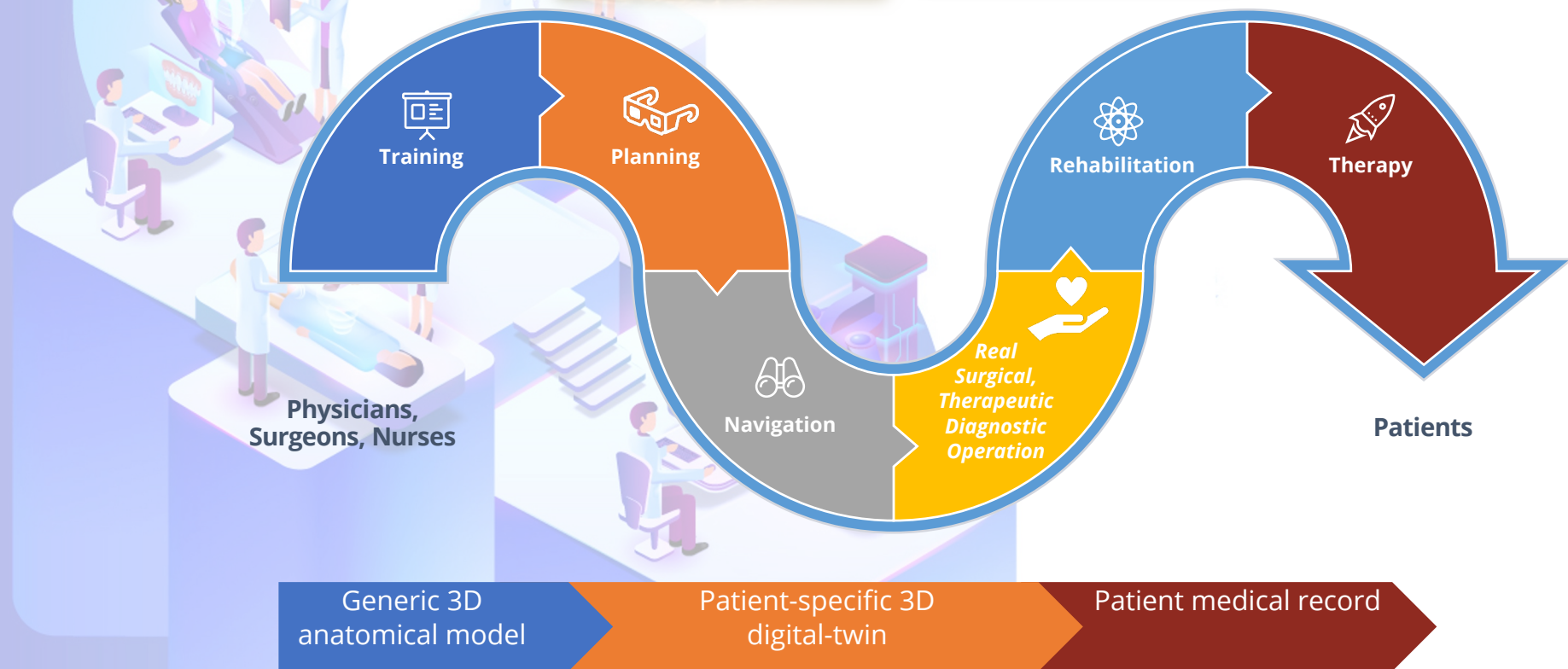
¹ Papagiannakis, G., "A computational medical XR discipline", <https://arxiv.org/abs/2108.04136v3>, 2023

² 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 talk¹

Frontiers SIGGRAPH 2023 workshop²



¹ https://s2023.siggraph.org/presentation/?id=ftalk_101&sess=sess408

² 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/>



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]

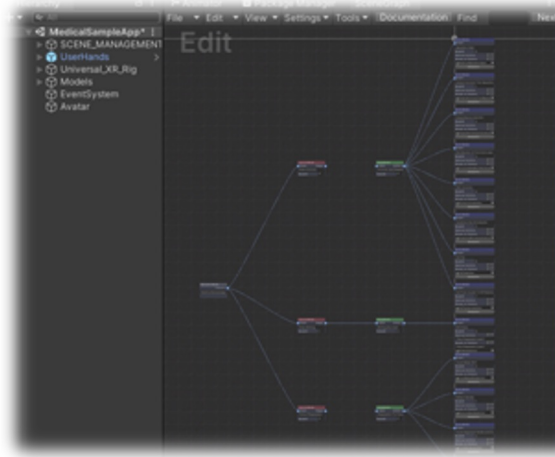


[1] Chamusca, I. L., Ferreira, C. V., Murari, T. B., Apolinario, A. L. & Winkler, I. Towards Sustainable Virtual Reality: Gathering Design Guidelines for Intuitive Authoring Tools. *Sustainability-basel* **15**, 2924 (2023)

[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 AUTHORIZING 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)

IEEE
Computer Graphics
AND APPLICATIONS

VOLUME 43, NUMBER 2

MARCH/APRIL 2023



Metaverse: Technologies for Virtual Worlds

IEEE

IEEE
COMPUTER
SOCIETY
www.computer.org/cga

www.computer.org/cga

IEEE
COMPUTER
SOCIETY

IEEE

www.computer.org/cga

P. Zikas *et al.*, "**MAGES 4.0: Accelerating the World's Transition to VR Training and Democratizing the Authoring of the Medical Metaverse**," in *IEEE Computer Graphics and Applications*, vol. 43, no. 2, pp. 43-56, 1 March-April 2023, doi: 10.1109/MCG.2023.3242686.

MAGES 4.0





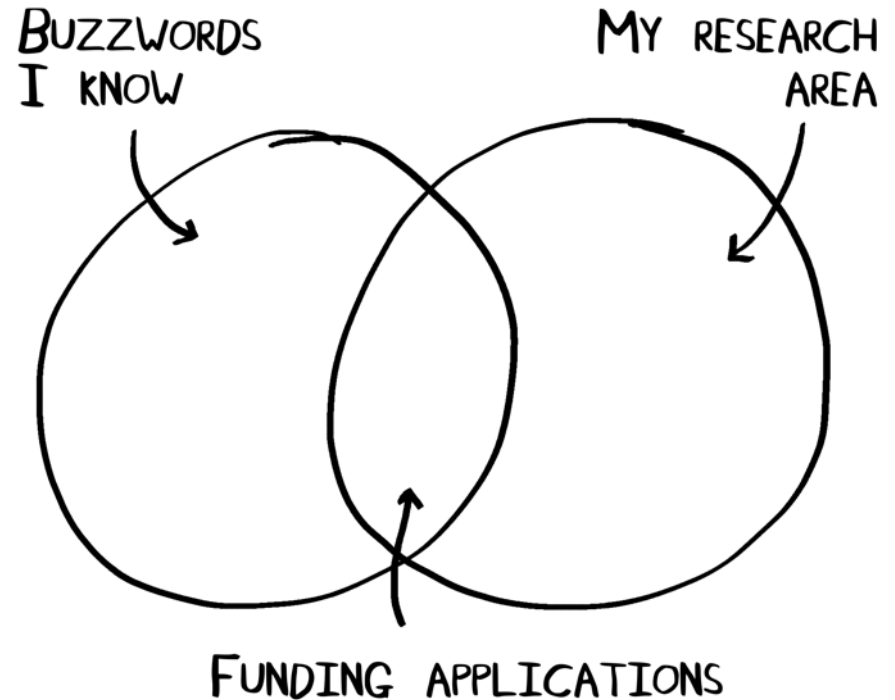
The scene is set for massive change

**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

*Research I
have to
follow to get
funding*

*Research I
want to do*



Deep-tech funded startup

A Venn diagram consisting of two overlapping circles. The left circle is labeled 'Research I have to follow to get funding' with a blue arrow pointing to its left side. The right circle is labeled 'Research I want to do' with a blue arrow pointing to its right side. The intersection of the two circles is labeled 'Deep-tech funded startup'.

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 form 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*

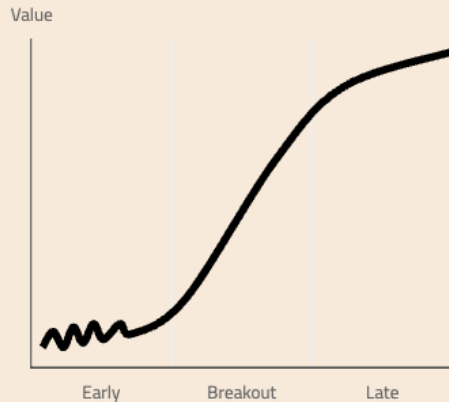
* Source - Midjourney: "minimalism 4k pure background two human figures and two 3d spheres"

Regular vs. Deep-tech vs. Biotech startups

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

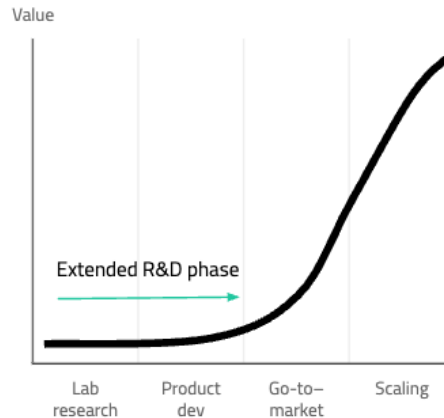
Regular startup

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



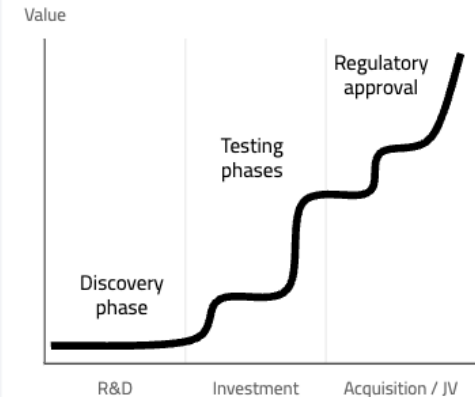
Deep Tech startup

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



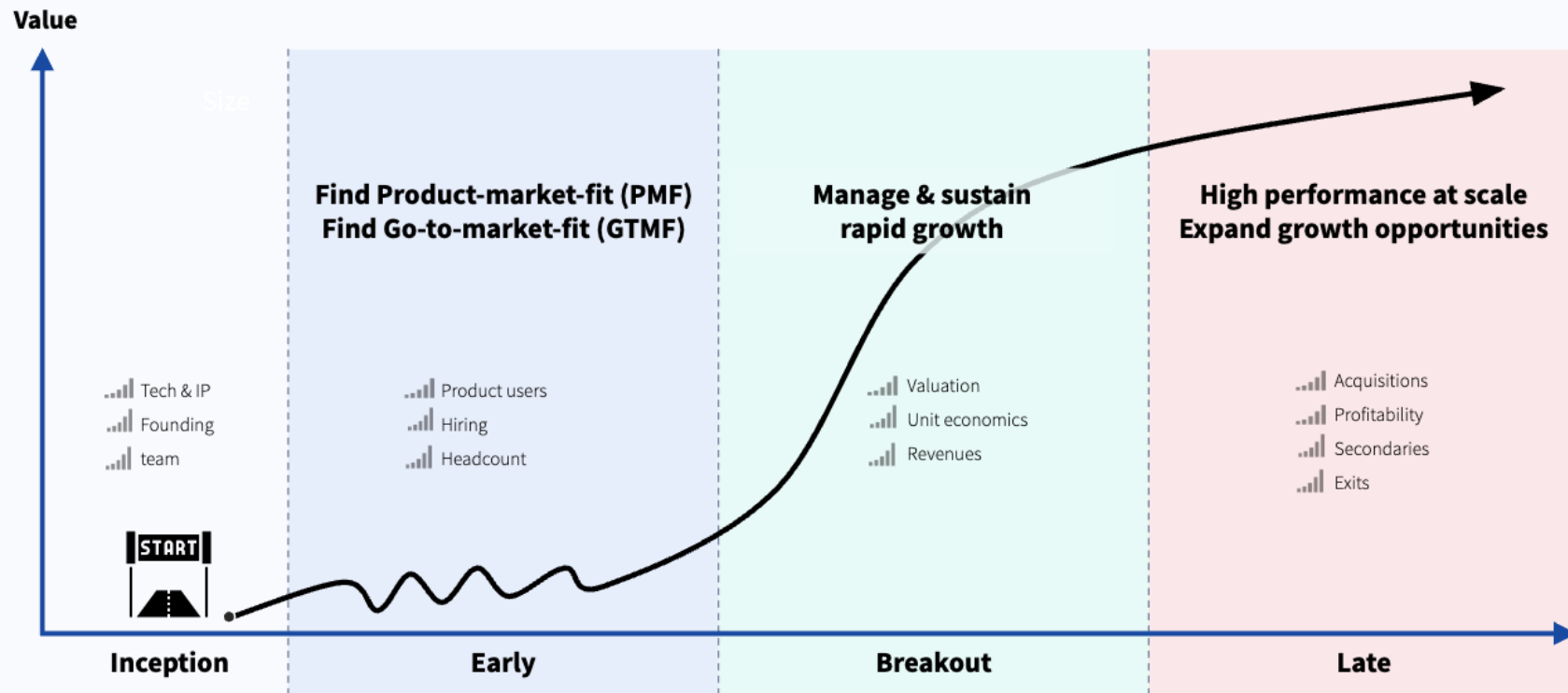
Biotech startup

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”

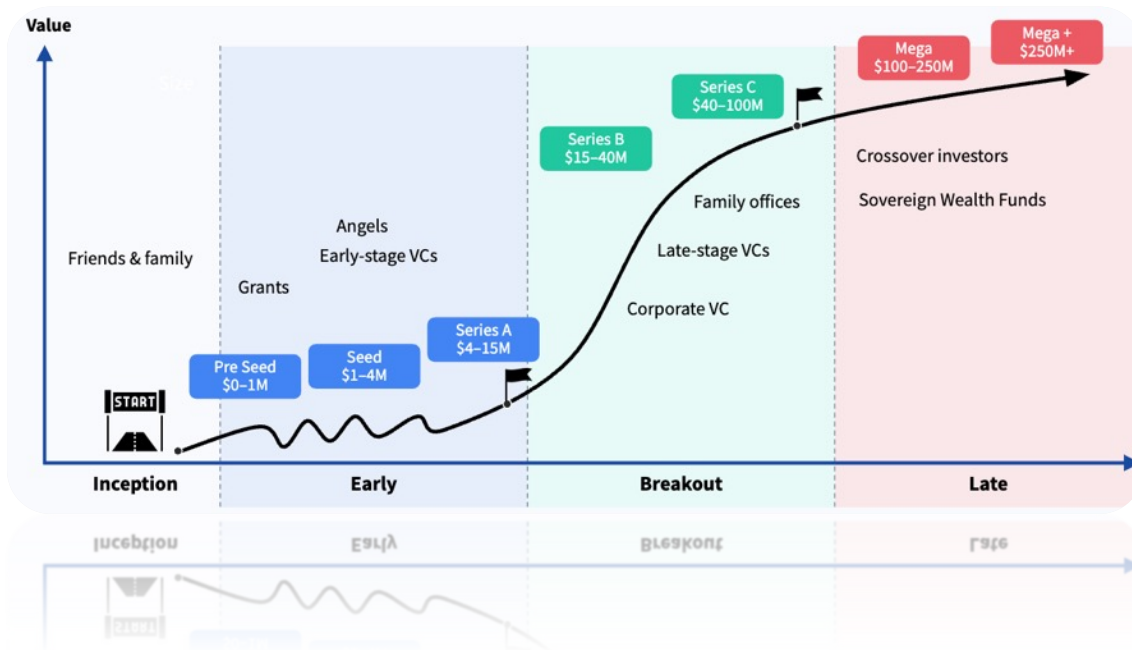
Startup journey I

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

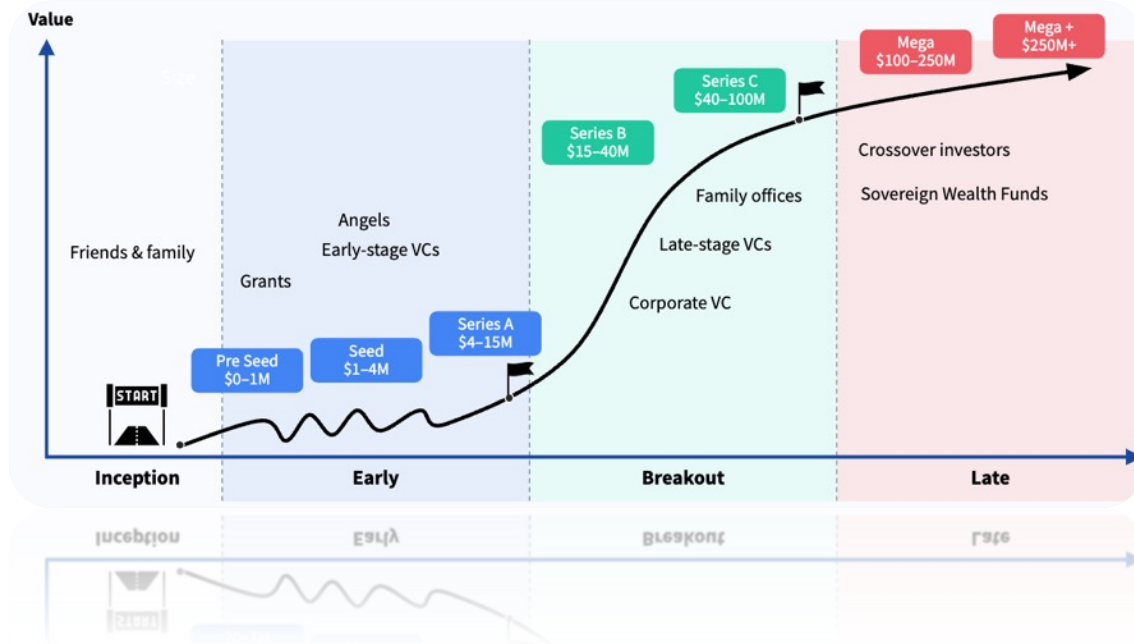
Startup journey II

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

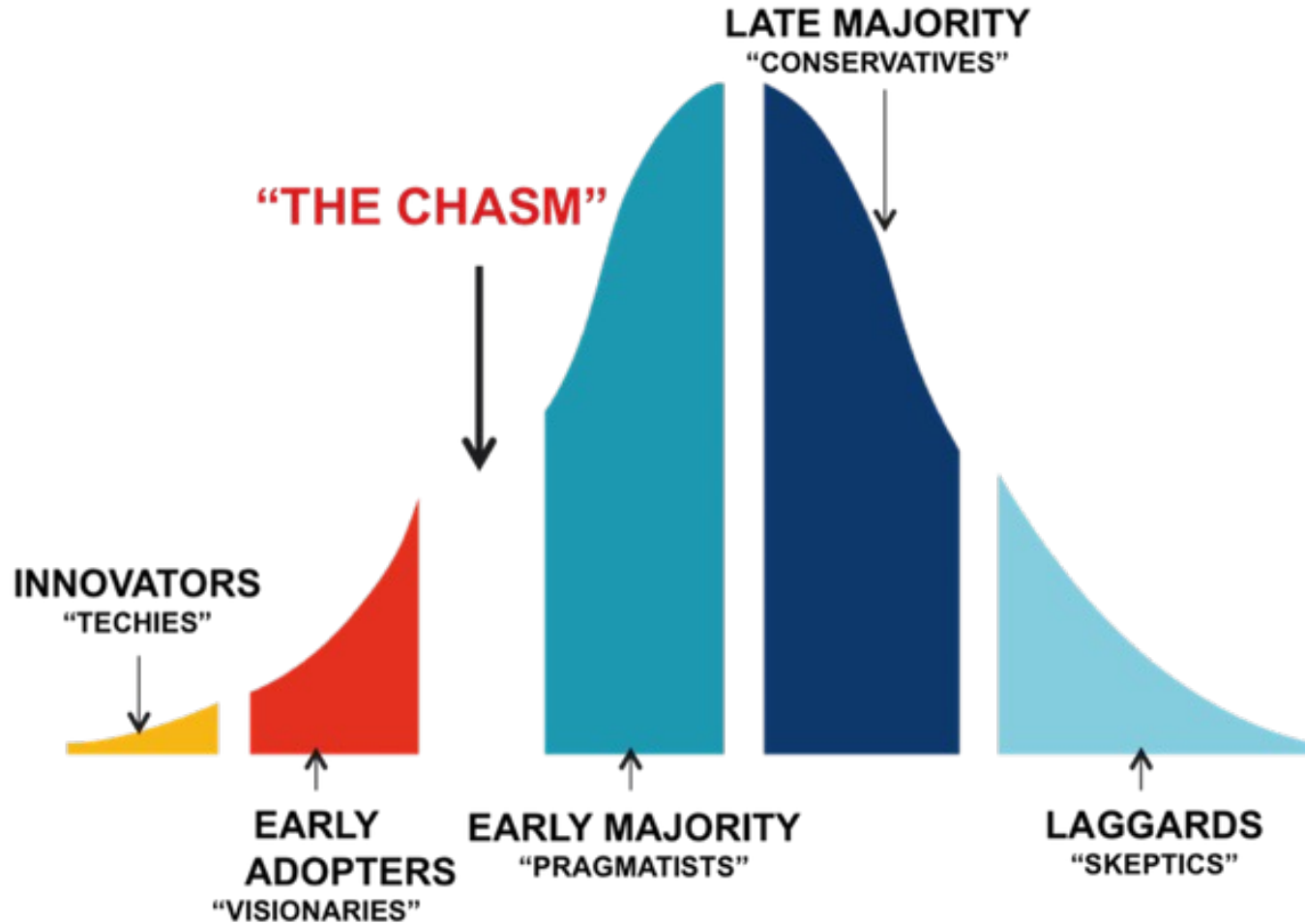
- Refine your growth strategies based on real market data



Source: dealroom.co,

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

Mind the gaps!



Startup valuation methods

DISCOUNTED CASH FLOW VALUATION

Assumptions

Discount rate - WACC	10.5%
EBITDA YoY growth rate	7.0%
Long term CF growth rate	1.5%
Capital investment % of EBITDA	15.0%
Annual sales (current year)	10,000
Average number of days it takes a the customers pay	60
Average annual purchases (stock, material, services totally)	8,000
Average number of days it takes a the customers pay suppliers	60
Average number of days it takes for a company to sell its inventory	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 Based on financial projections
Price-to-sales ratio	5	5x Average valuation multiple for the industry
Estimated Future Exit Value (Year 5)	250,000,000	\$250 million (5 x \$50M) Future value of the company at exit
VC's Desired ROI	10%	10x The return VC wants on their investment
Post-money Valuation Today	25,000,000	\$25 million (\$250M / 10) Value of the startup after receiving the VC investment
VC Investment	2,000,000	\$2 million Amount VC plans to invest
Pre-money Valuation Today	23,000,000	\$23 million (\$25M - \$2M) Value of the startup before receiving the VC investment

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



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 present 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), 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)



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.



Dr. George Papagiannakis
Prof. University of Crete,
Affiliated Researcher at FORTH
Visiting Prof. University of Geneva
&
ORamaVR co-founder, CEO
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*Let's accelerate world's transition to
academic entrepreneurship!*