EPFL

Also part of :

E4S
Enterprise for Society

IMD
REAL LEARNING. REAL IMPACT

Unil
UNIL | Université de Lausanne

Innovation for construction & the environment

Dr. Dimitrios Terzis

09/09/2025

Senior Scientist & chargé de cours (2019-aujourd'hui)
Post-doc (2018-2019)
PhD in Mechanics (2017)

Co-author of 20+ publications
Co-inventor of 4 EPFL patents
Co-founder of Medusoil SA
Supervisory board member EPFL Leaders4impact
Representative ENAC diversity office
Board member Géotechnique Suisse
10+ years in engineering & business consulting

Dimitrios Terzis
dimitrios.terzis@epfl.ch

Soutenu par:

Dans les media:

Today's introductory lecture

1) The goal of the course & how can we define innovation in the most conservative sector?
2) Program of the semester
3) Structure of the project
4) Course's material & guidelines

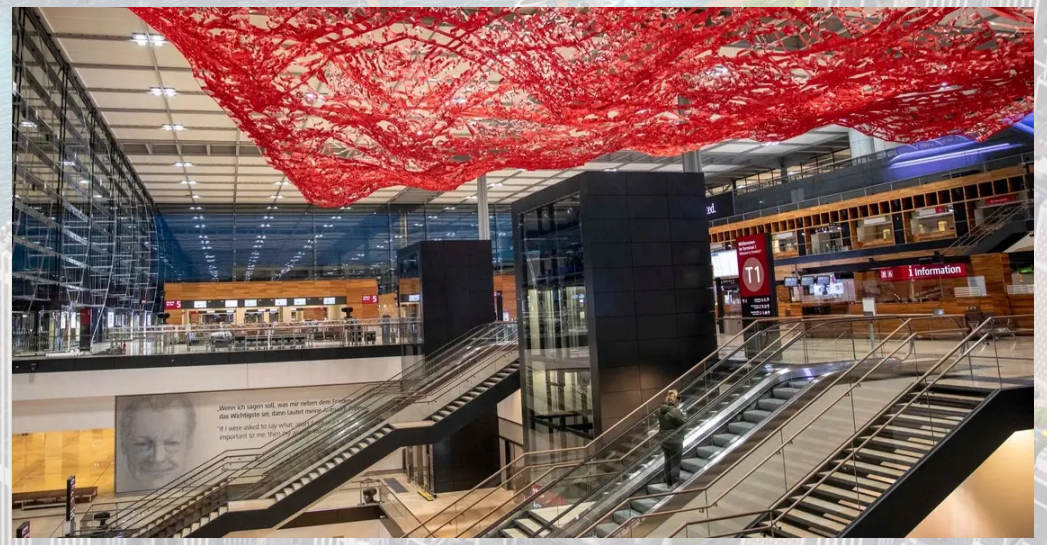
Break

1) The productivity of the construction sector
2) Incremental Vs disruptive innovation
3) Innovation as an engineering process
4) Mapping the innovation construction landscape

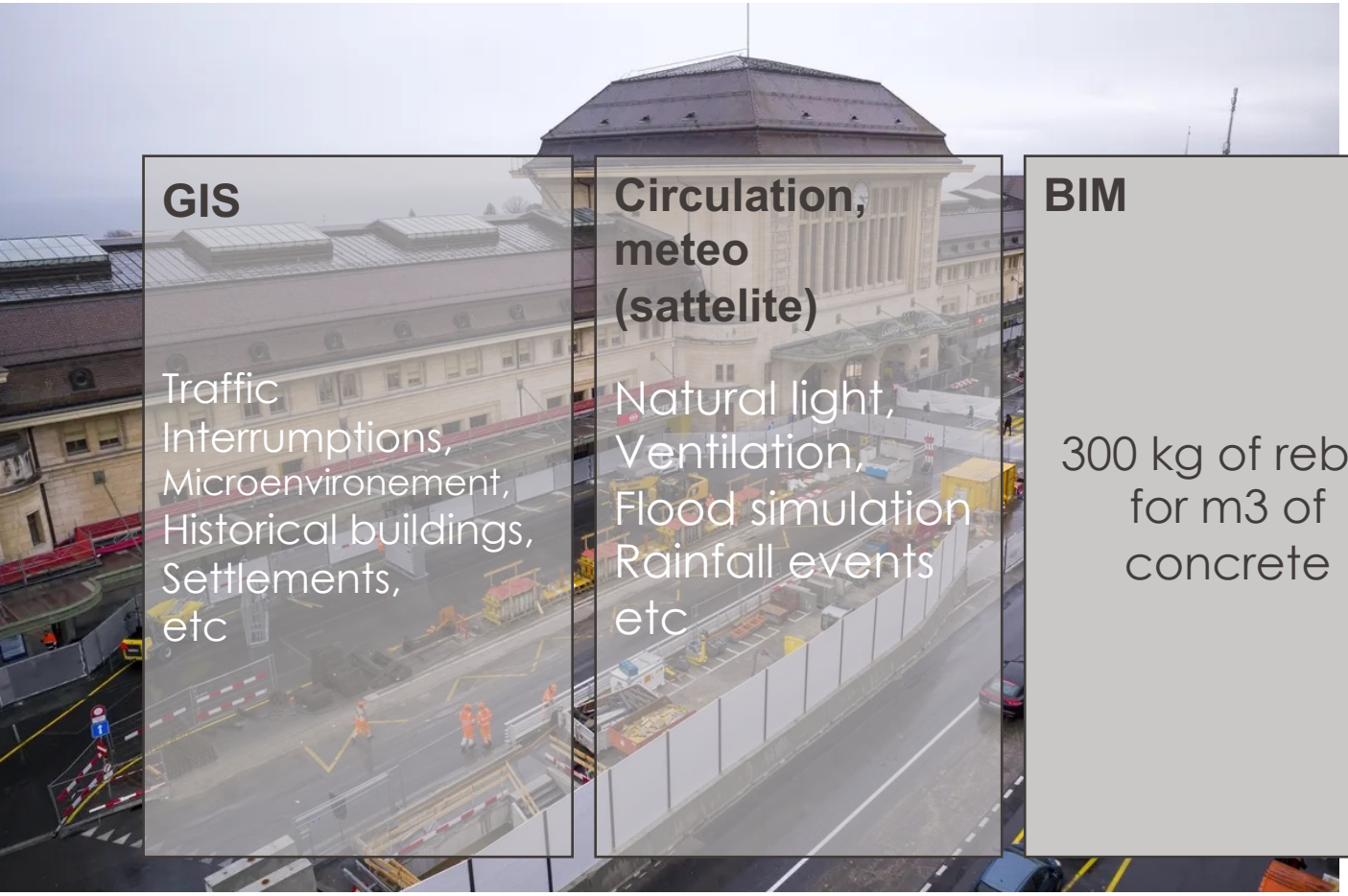
Brief guidelines for your projects

Dr. Dimitrios Terzis

A quick quiz: Do you recognize these images?



Can innovation help prevent disasters?



GIS

Traffic Interrumptions, Microenvironement, Historical buildings, Settlements, etc

Circulation, meteo (sattelite)

Natural light, Ventilation, Flood simulation Rainfall events etc

BIM

300 kg of rebar for m3 of concrete

Passenger behaviour

Emergency exits, cleaning schedule…

Income

Commercial zones, rental price/m2

Dr. Dimitrios Terzis

Problems for civil engineers that you probably have not heard of…

[24] VAUD & RÉGIONS

1er mois offert | Se connecter | Menu

Politique locale | Ma commune | Lausanne & Région | Riviera-Chablais | Nord vaudois-Broye | La Côte | Signé ma ville | L'actu en dessins

Accueil | Vaud & Régions | Politique environnementale: La terre issue de la construction ne sait plus où se mettre

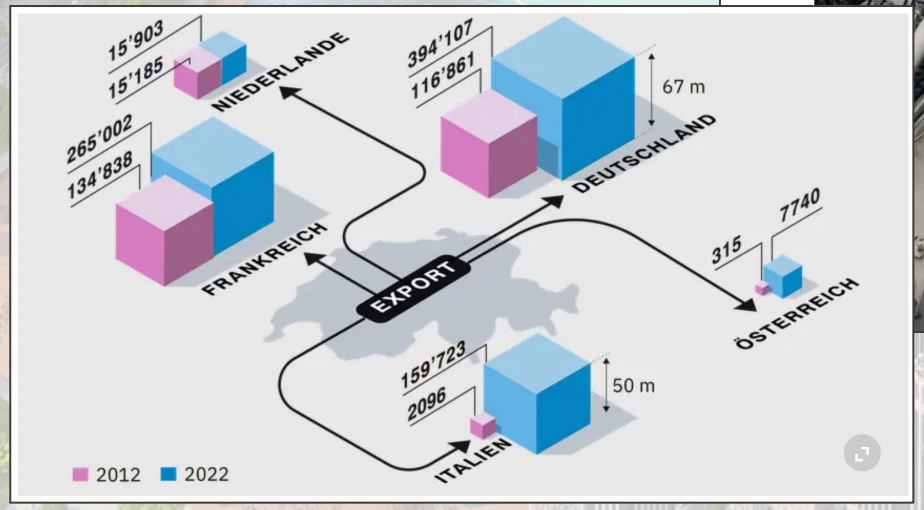
Abo Politique environnementale

La terre issue de la construction ne sait plus où se mettre

Plusieurs projets de décharges pour matériaux d'excavation sont fortement contestés dans le canton de Vaud. Face à ces levées de boucliers, l'État a commencé à revoir sa copie.

David Genillard
Publié: 11.12.2023, 07h00

33

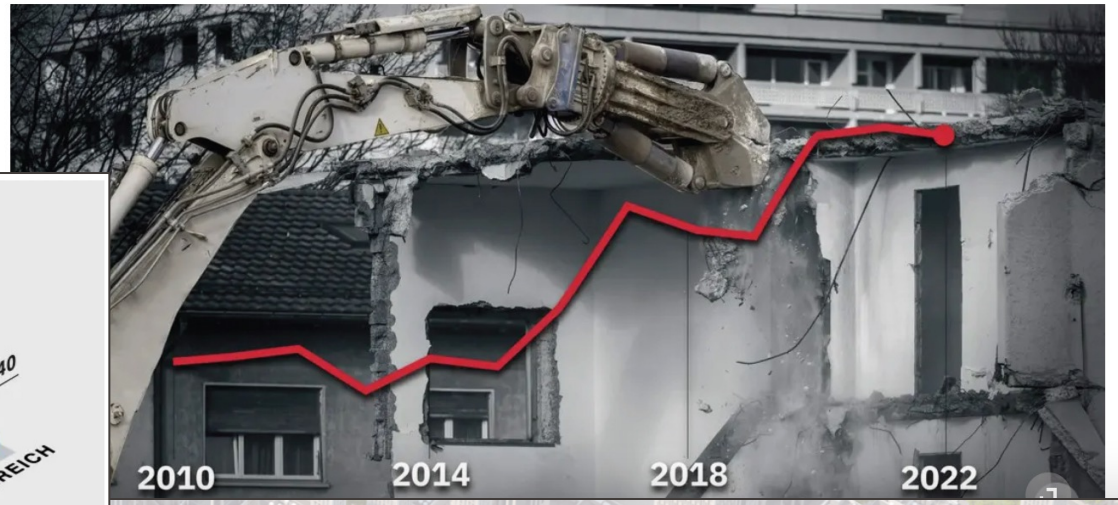


La Suisse exporte trop souvent ses déchets de construction

Plus de 80% de nos déchets proviennent des chantiers. Au lieu de rester en Suisse, 800 000 tonnes par an finissent à l'étranger. Pourquoi?

Roland Gamp, Lukas Lippert, Anielle Peterhans
Publié: 05.01.2024, 06h52
Mis à jour: 05.01.2024, 08h14

30



The course's goal

"We developed this course because we believe that a modern civil engineering profession requires graduates who understand innovation as a structured, engineering process and prioritize efficiency across all phases of a project's cycle."

"Need to cultivate the essential technical and economic skills necessary to tackle real-world sustainability issues."

The skill to innovate…

…is in fact a combination of the skills to:

- Research
- Quantify
- Compare
- Learn from return of experiences
- Synthesize individual elements to more complete systems
- Communicate
- Solve disputes

Dr. Dimitrios Terzis

The program of the semester

CIVIL-424 Innovation for construction and the Environment / Fall 2025

Tuesdays 16:15-18:00 pm Lectures
Tuesdays 18:00 - 19:00 pm Project discussions and continuous reporting
Office hours: Tuesdays morning (upon email request and confirmation)

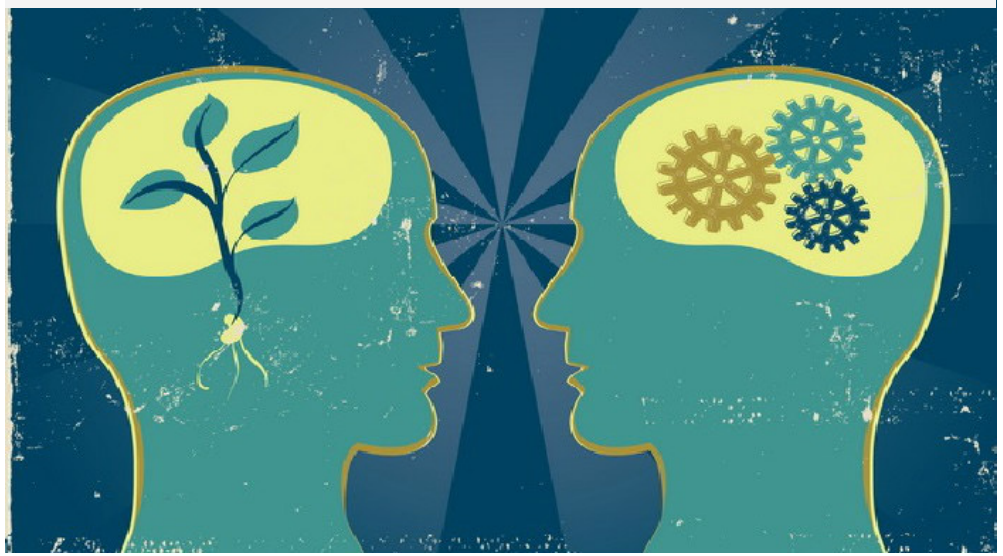
Room GRA331

			Title
Week 1	09.Sep	45 mins	Introduction to the course
		45 mins	Disruptive, Incremental Innovation and Research, Projects from last year and takeaways
Week 2	16.Sep	45 mins	Cement-free concrete
		45 mins	Cement-free concrete
Week 3	23.Sep	45 mins	Circular economy, Impact and Life Cycle Assesement
		45 mins	Sustainalytics
Week 4	30.Sep	45 mins	Harnessing renewables for buildings
		45 mins	Harnessing geo-energy for buildings
Week 5	07.Oct	45 mins	Data-driven structural health monitoring and damage detection for smart infrastructure and buildings
		45 mins	Data-driven structural health monitoring and damage detection for smart infrastructure and buildings
Week 6	14.Oct	45 mins	Project preparation / Paper reading
		45 mins	Project preparation / Paper reading
Week 7	28.Oct	45 mins	Industrial innovation from the perspective of a construction giant
		45 mins	Industrial innovation from the perspective of a construction giant
Week 8	04.Nov	45 mins	Sustainalytics
		45 mins	Sustainalytics
Week 9	11.Nov	45 mins	Traffic Operations, Unmanned Aerial Systems (UAS) and Data Science for smart mobility
		45 mins	Traffic Operations, Unmanned Aerial Systems (UAS) and Data Science for smart mobility
Week 11	18.Nov	45 mins	Monitoring and surveillance
		45 mins	GIS and BIM for construction and risk management
Week 12	25.Nov	45 mins	Nature-based innovations
		45 mins	Nature-based innovations
Week 13	02.Dec	45 mins	Parametric design
		45 mins	Robotic construction
Week 14	09.Dec	45 mins	Project presentations - schedule to be announced
		45 mins	Project presentations - schedule to be announced
Week 15	16.Dec	45 mins	Synthesis of Innovation project and takeaways
		45 mins	Synthesis of Innovation project and takeaways

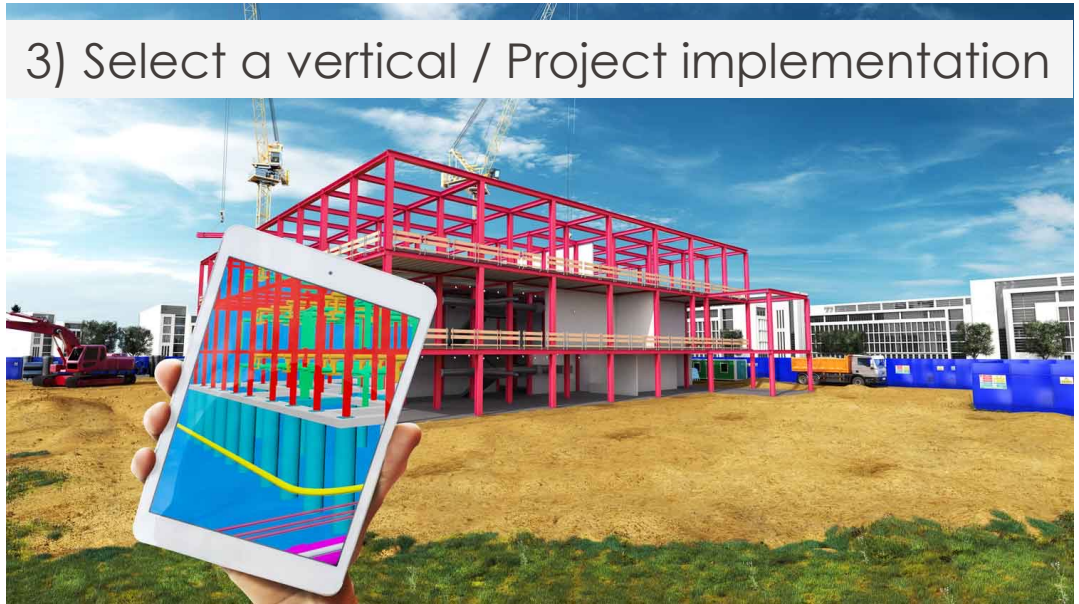
14 weeks, 4 principles

1) Analyzing the innovation landscape

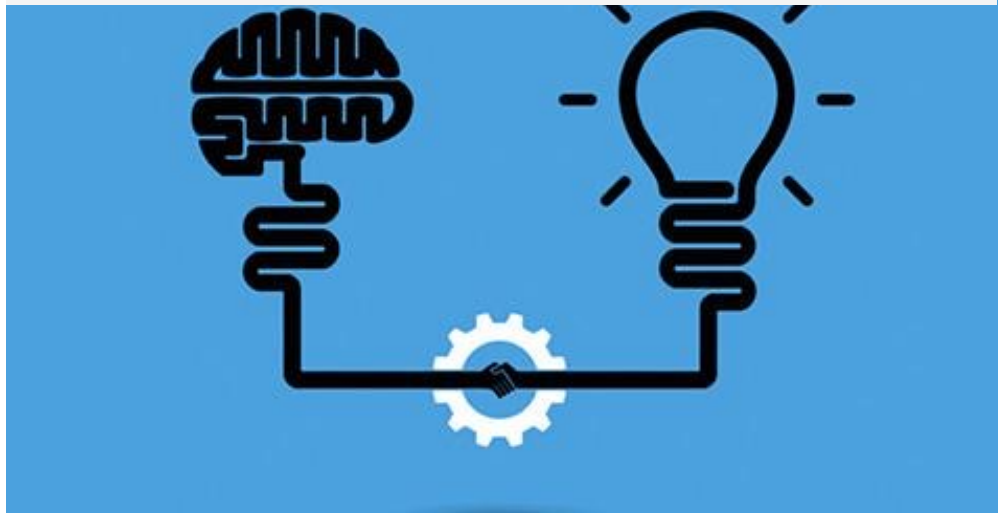
2) Collaboration and Impact



3) Select a vertical / Project implementation



4) Learn to innovate



Dr. Dimitrios Terzis

Structure of your project

Join at menti.com | use code 8174 6528

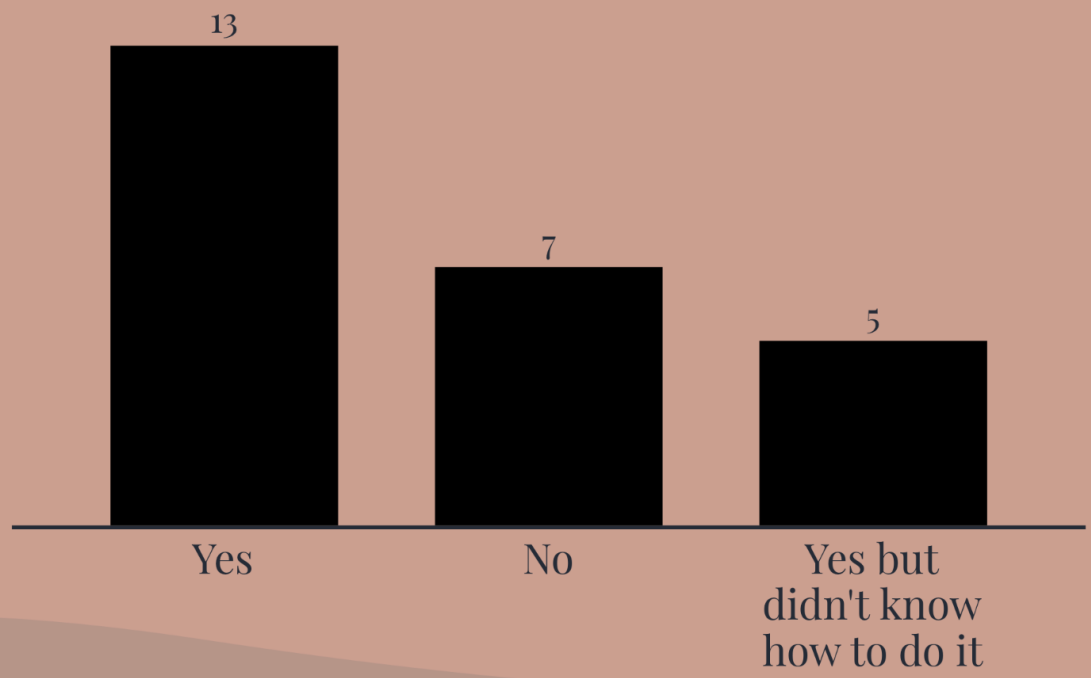
Mentimeter

Have you heard of state-of-the-art / literature review before?

Go to **www.menti.com** and use the code **21 98 90 5**

Have you heard of state-of-the-art / literature review before?

Mentimeter



25

What are the first 3 words that come to your mind after hearing "innovation & construction"

Join at menti.com | use code 8174 6528

Mentimeter

What are the first 3 words that come to your mind after hearing "innovation & construction"

66 responses

25

Structure of your project

		Contents	Weighting factor
Literature review	1.	**Problem statement** *What problem are you solving? How big is the need to solve this problem in our field? What are some key relevant quantities in volumes/costs/damages/environmental impact?*	5%
	2.	**Current solutions overview** *What are existing solutions to tackle the above problem? Which are their main technical features? What is their level of maturity and under what conditions these solutions can be implemented?*	20%
	3.	**Use cases** *What are the use cases of the above solutions and their outcomes? What are key advantages and drawbacks/limitations?*	15%

Dr. Dimitrios Terzis

Structure of your project

		Contents	Weighting factor
Literature review	**1.**	**Problem statement** *What problem are you solving? How big is the need to solve this problem in our field? What are some key relevant quantities in volumes/costs/damages/environmental impact?*	5%
	2.	**Current solutions overview** *What are existing solutions to tackle the above problem? Which are their main technical features? What is their level of maturity and under what conditions these solutions can be implemented?*	20%
	3.	**Use cases** *What are the use cases of the above solutions and their outcomes? What are key advantages and drawbacks/limitations?*	15%
Innovation and impact creation	**4.**	**Room for innovation** *Have you identified opportunities to innovate and if yes what lies in the core of studied innovation (hardware/software/infrastructure?)*	25%
	5.	**Value creation** *Who benefits from your studied innovation? What is the value you create and for which partners? Who do you depend on and who depends on you (regulations, technology manufacturers, service providers etc)? You can use elements of your business model canvas to facilitate this section*	20%
	6.	**Potential Risks** *Have you identified any potential risks or barriers from regulations or competition from existing solutions? Are there any technological limitations that could hinder your studied innovation?*	5%
	7.	**Impact created** *What is the created environmental/societal/economic impact of your studied innovation?*	5%
	Overall quality of presentation and of used references from literature.		5%

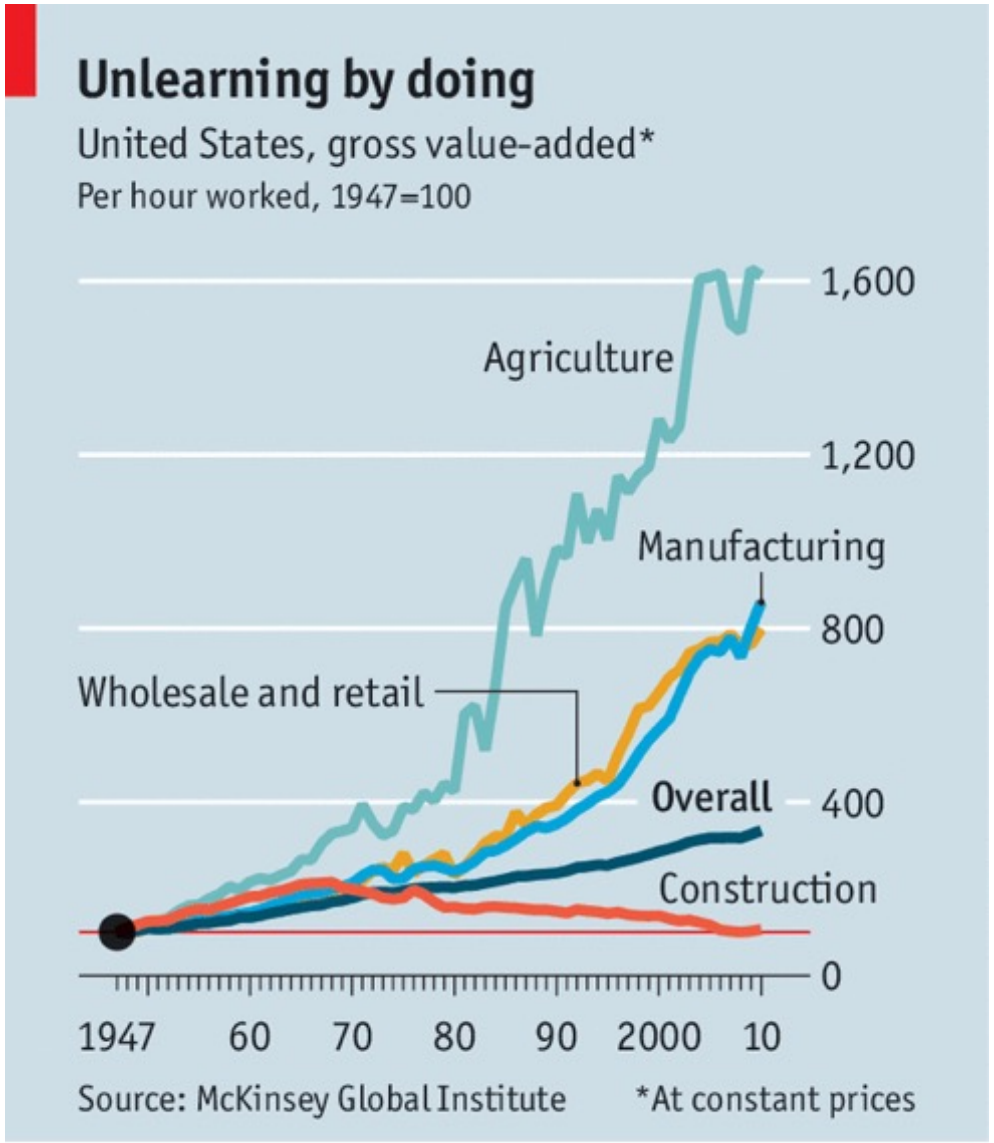
- Search
- Quantify
- Compare
- Learn from return of experiences

Let's get things started...

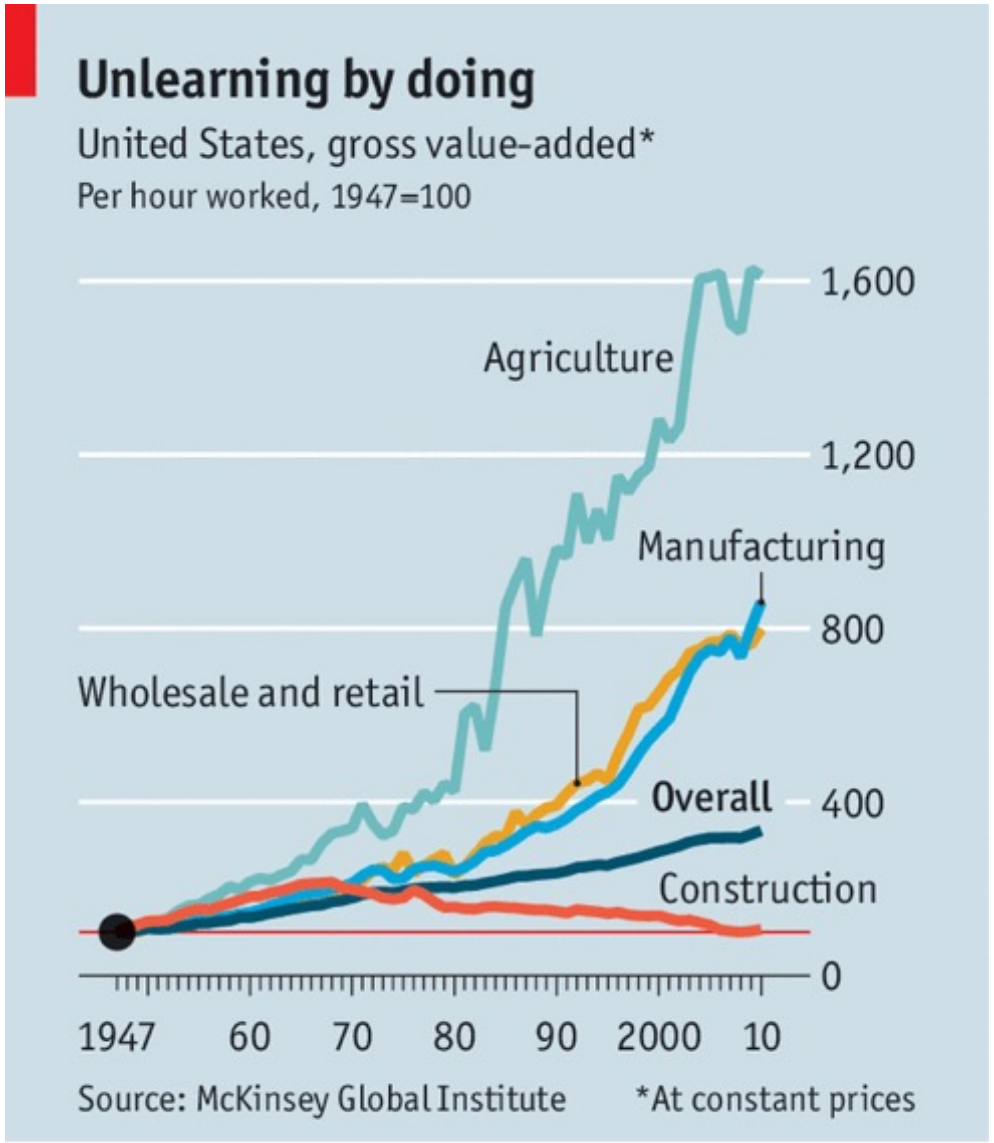
Understanding productivity in relation to innovation

Dr. Dimitrios Terzis

Construction is suffering in terms of productivity



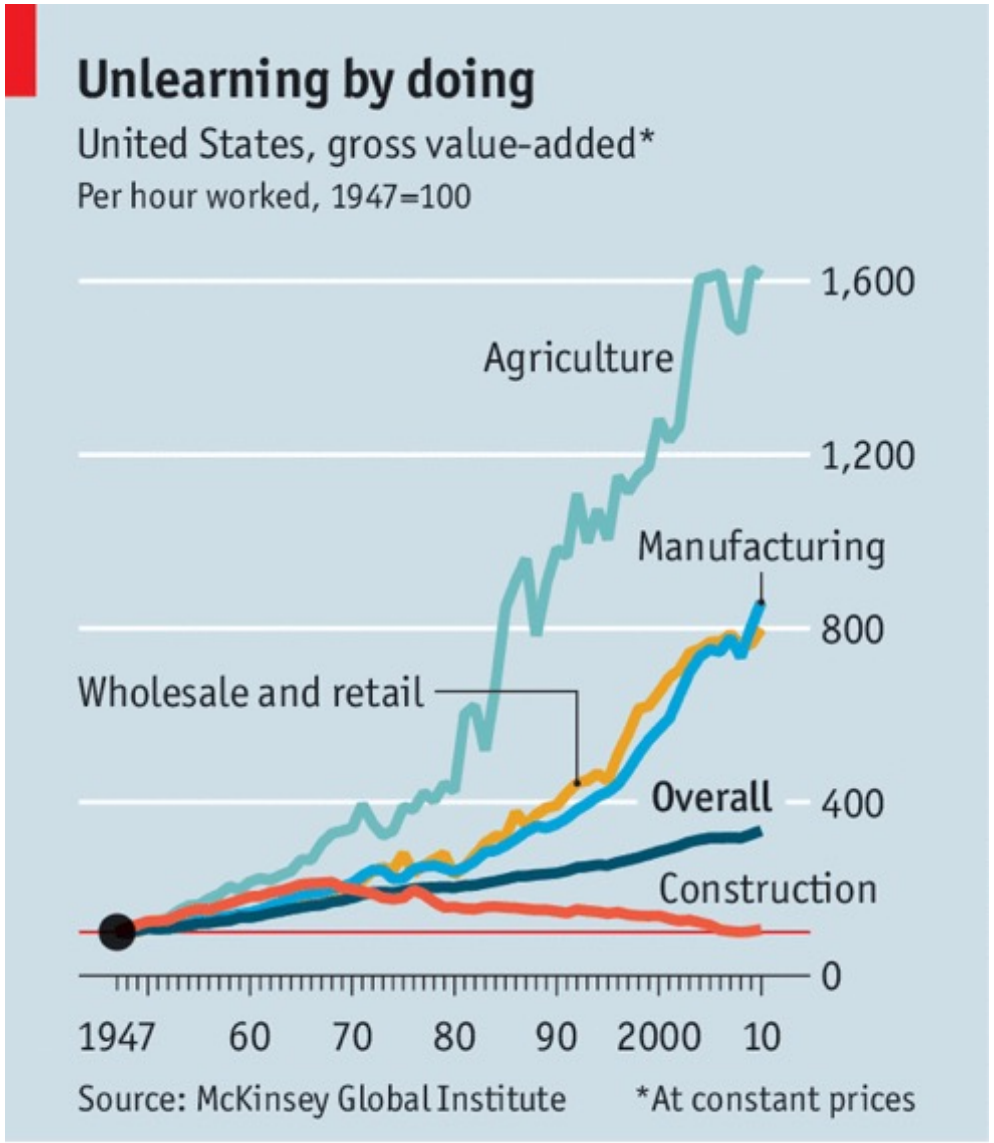
Innovation, R&D are much needed in our field



1947 - 100

2010 – 1600+

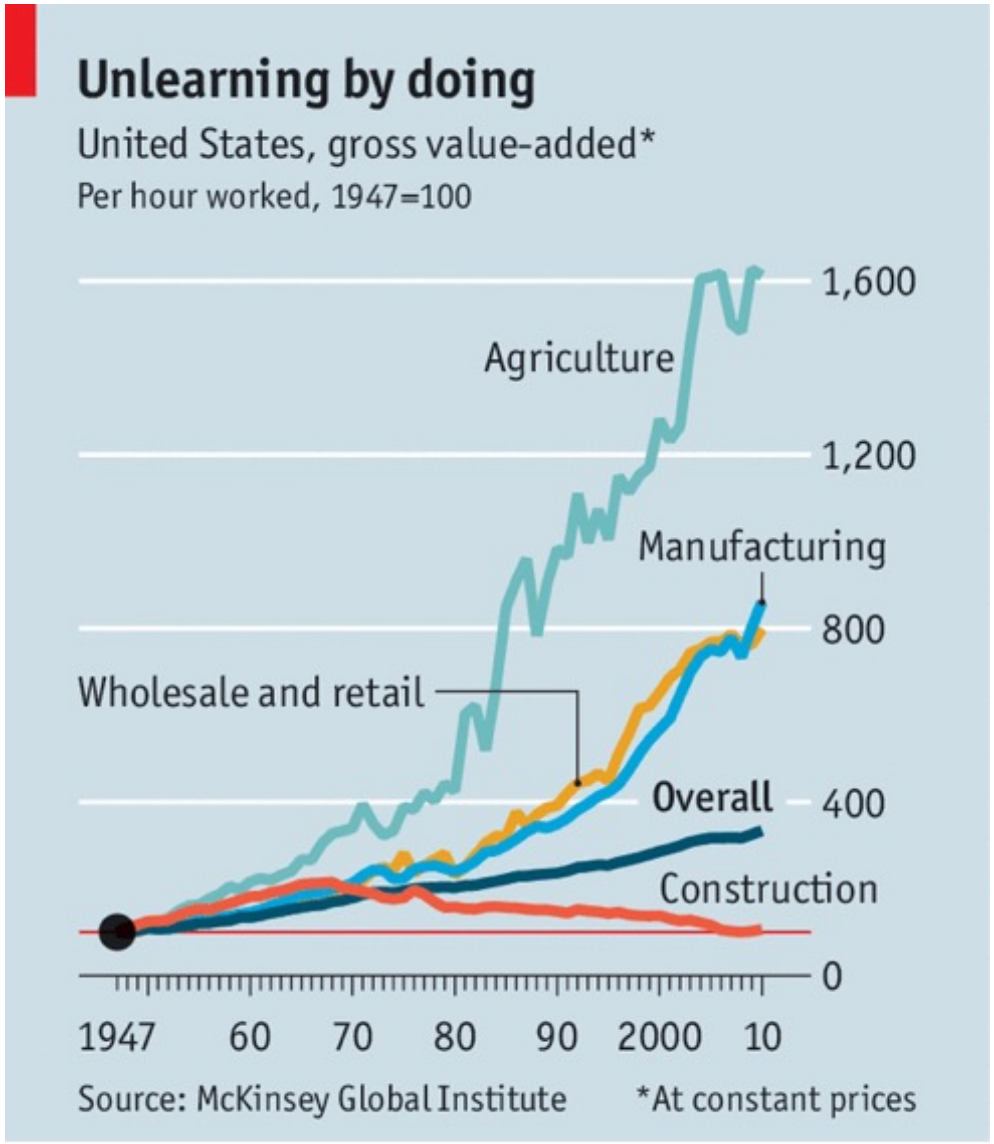
Innovation, R&D are much needed in our field



1947 - 100

2010 – 100

Innovation, R&D are much needed in our field



Why is this happening?

- poor digitalization penetration
- expensive equipment
- expensive resources
- lack of skilled labour
  (innovating to overcome hurdles at the construction site)

Turning points

Materials

CAD

Manufacturing

What kind of innovation is this?

This excavator operator at Bauma in Munich, Germany is digging at a jobsite in South Korea!!

"3D machine guidance solution, 5G link"

Doosan Infracore said it worked with South Korean mobile carrier LG Uplus Corp. to set up the 5G link and that further work is under way to expand the technology to reduce lag and ensure a secure data link.

Dr. Dimitrios Terzis

What kind of innovation is this?

Is the end-product/task the same?

Is it safer?

Is it more precise?

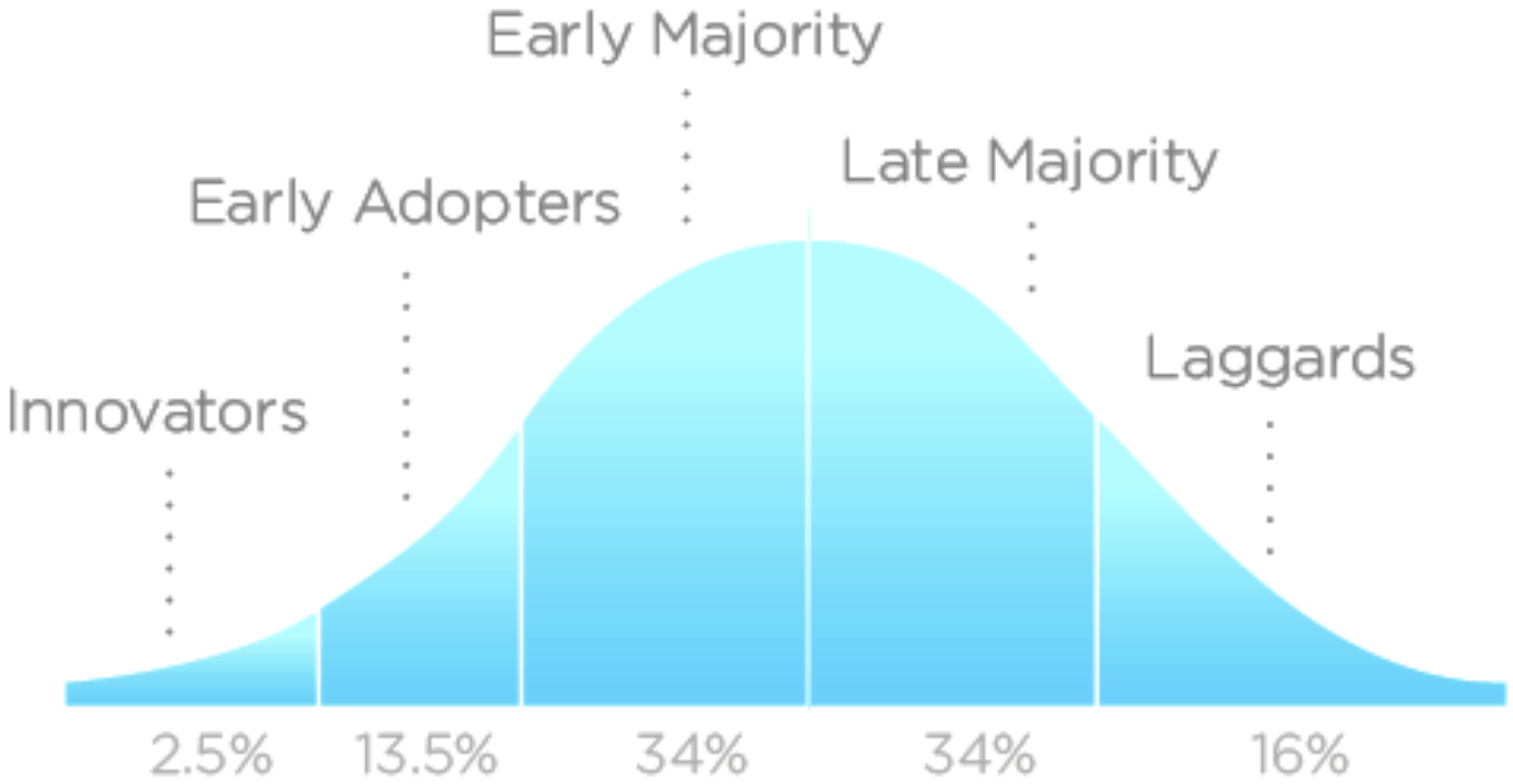
Is it easier?

Does it replace men with machines?

Financial impact?

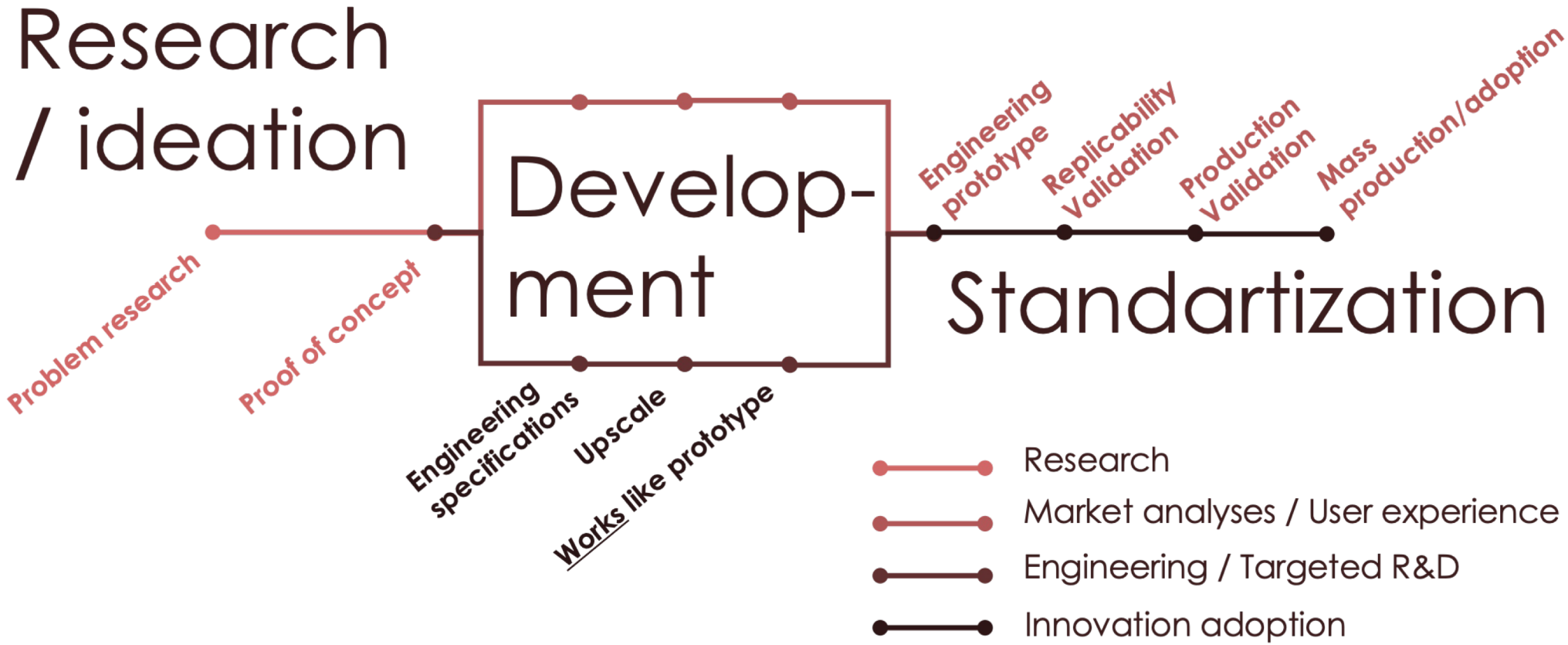
Dr. Dimitrios Terzis

Forget who's developing and focus on who's using



Rogers' bell curve

Let's try to break down the innovation process



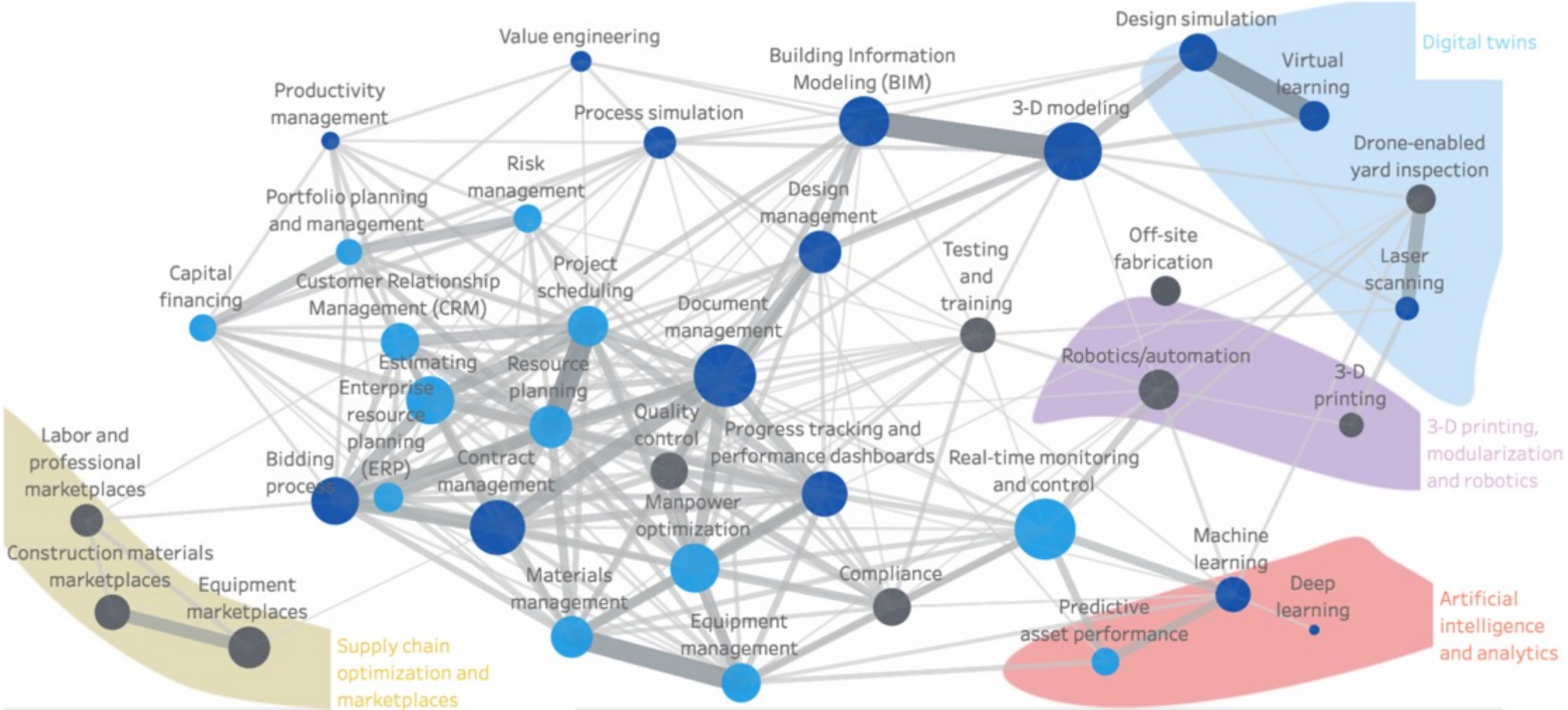
How will things evolve in the next 2–3 years?

FIELD: on-site execution
TEAM: digital collaboration
OFFICE: back-office and adjacencies

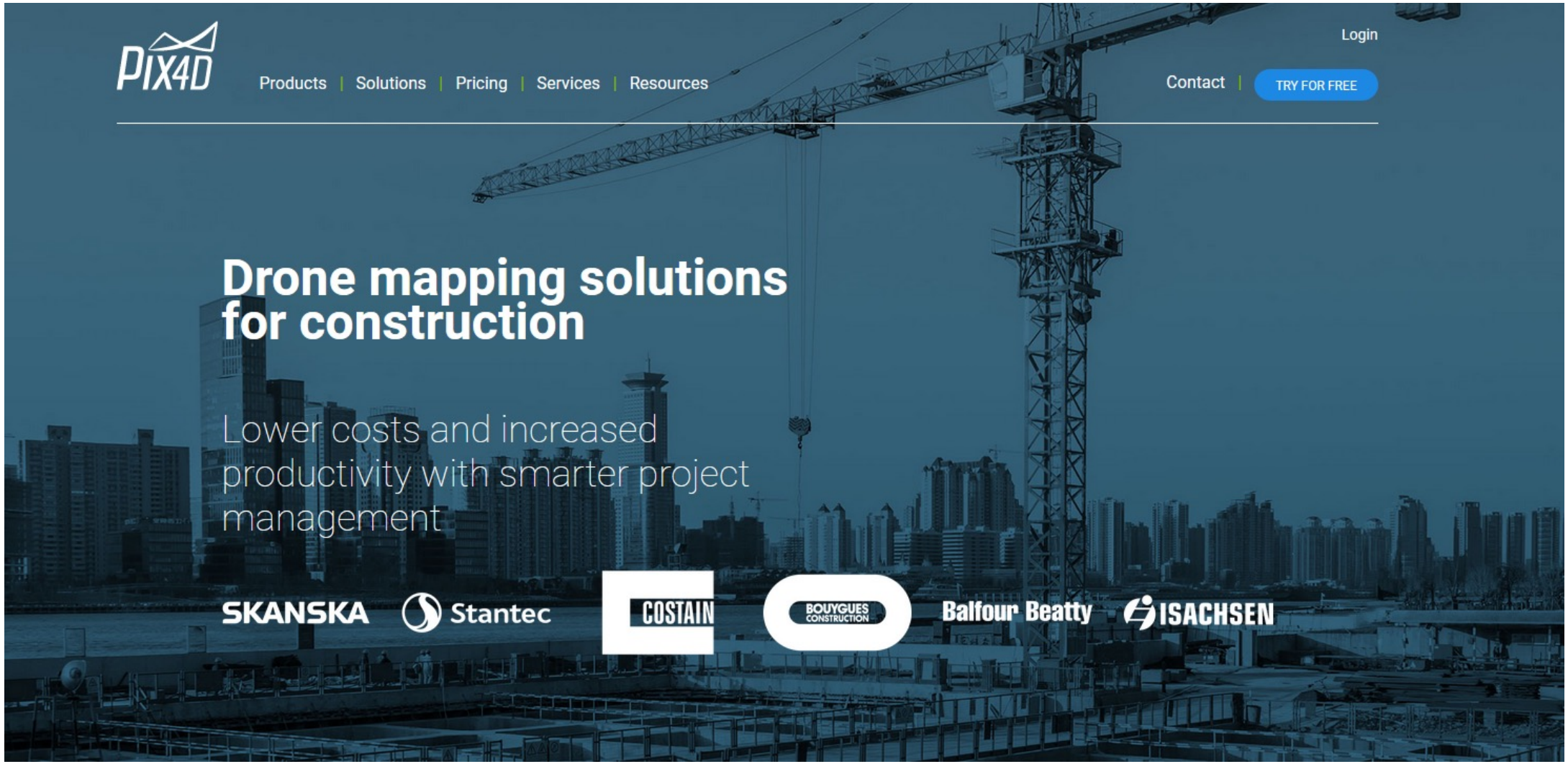
PRE-CONSTRUCTION: concept and feasibility, design
DURING OPERATIONS: engineering, preconstruction, construction and operations
POST-CONSTRUCTION: the entire asset life cycle

Let's analyze trends established in a 2018 report by McKinsey & Co based on 2'400 technology solutions companies

Mapping the construction technology Ecosystem

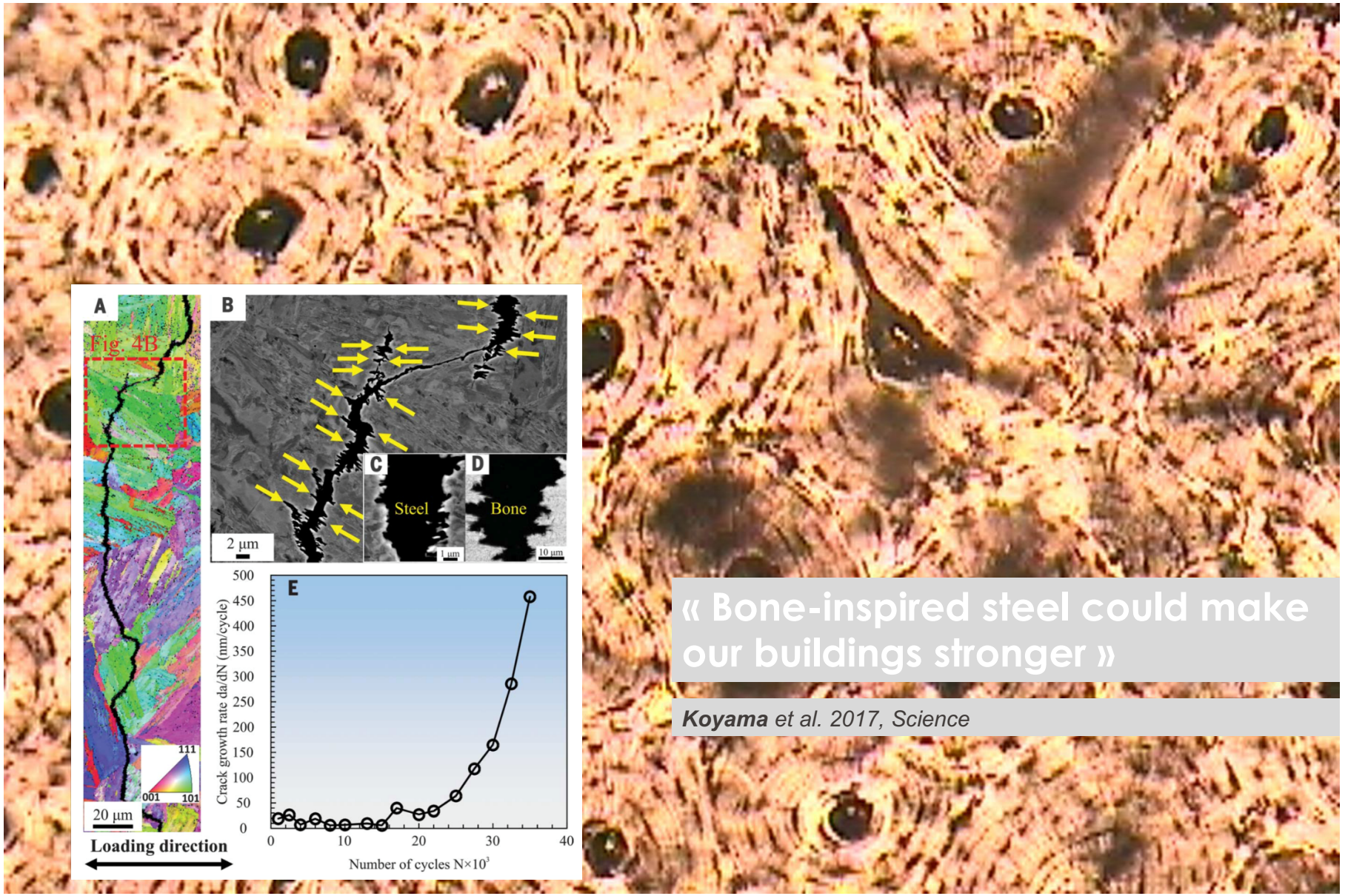


GIS & BIM



Dr. Dimitrios Terzis

Material innovation



« Bone-inspired steel could make our buildings stronger »

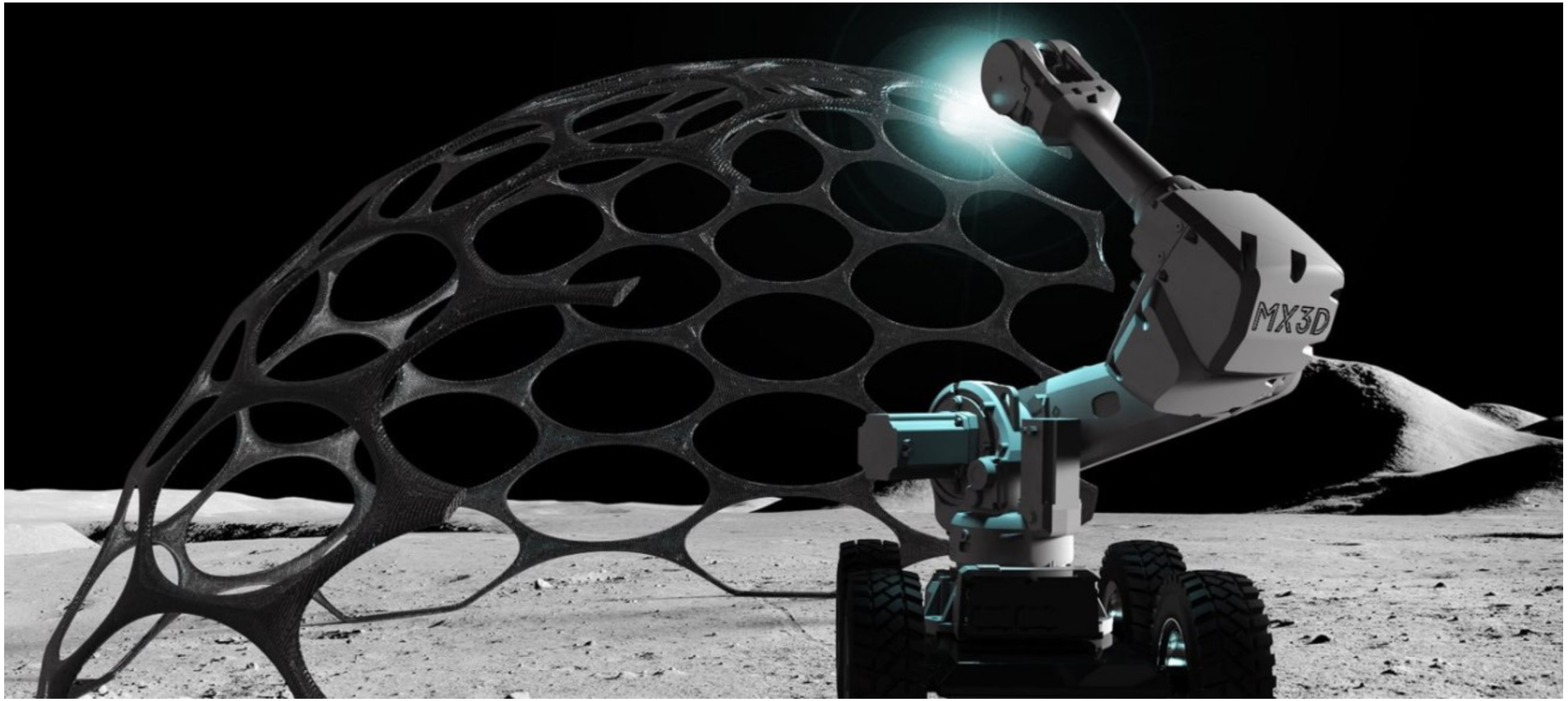
***Koyama** et al. 2017, Science*

Dr. Dimitrios Terzis

VR-assisted design

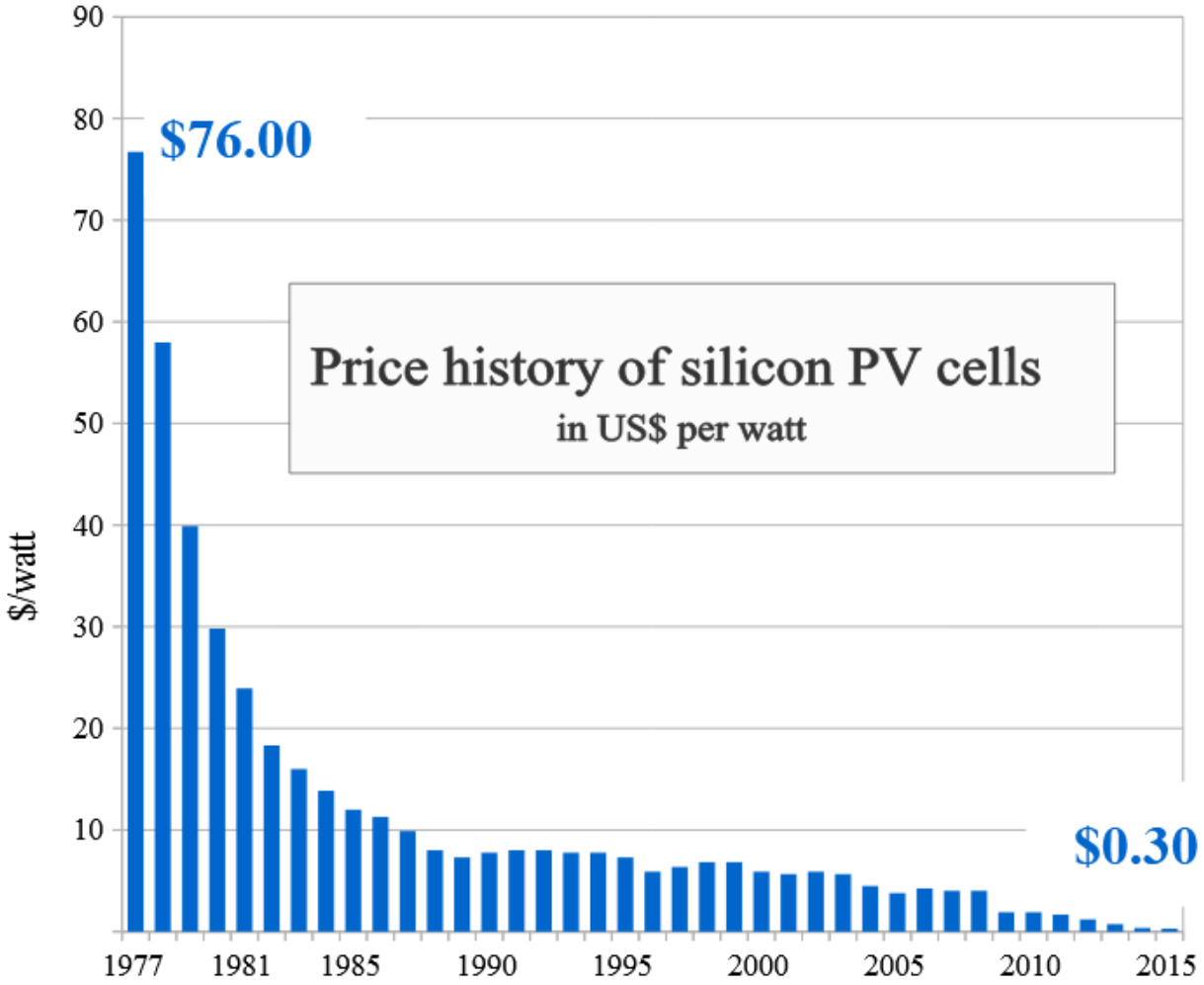
CL3VER

3D printing



Dr. Dimitrios Terzis

Innovation or Science fiction?



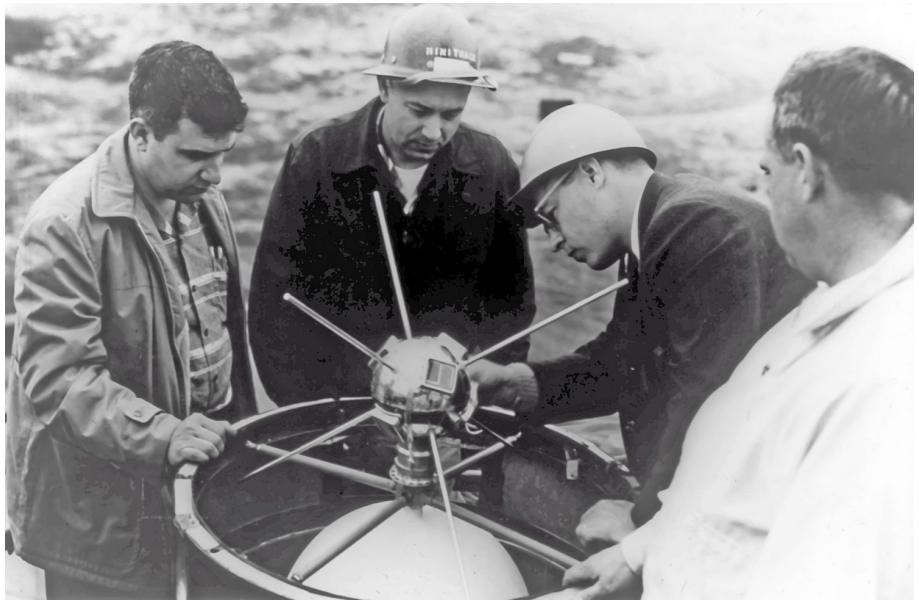
Source: Bloomberg New Energy Finance & pv.energytrend.com

Vanguard 1

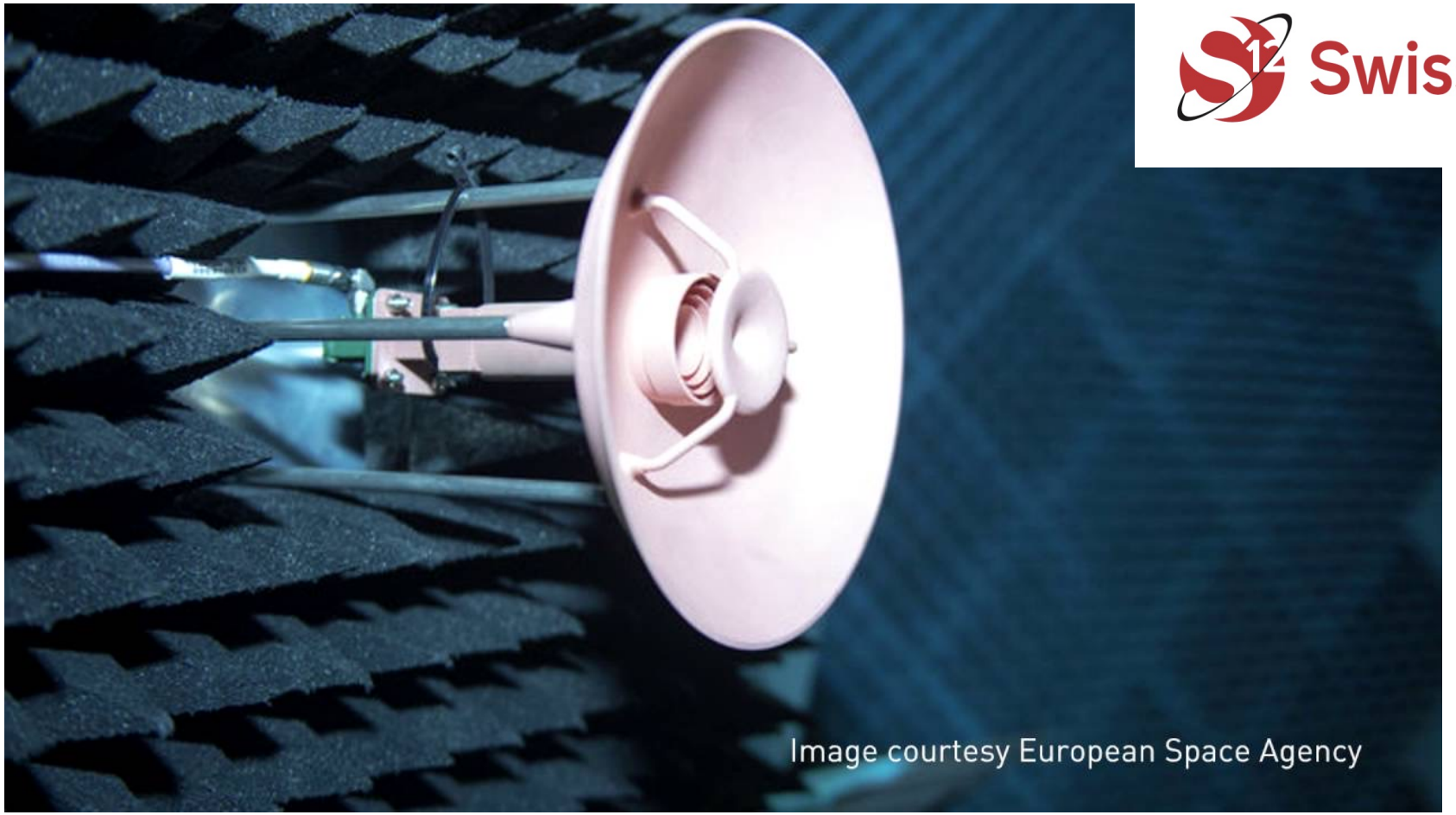
The **first** spacecraft to use **solar panels** was the Vanguard 1 **satellite**, launched by the US in 1958. This was largely because of the influence of Dr. Hans Ziegler, who can be regarded as the father of spacecraft **solar** power.

Solar panels on spacecraft - Wikipedia

https://en.wikipedia.org › wiki › Solar_panels_on_spacecraft



Innovation or Science fiction?



Innovation or Science fiction?

Spin-off SWISSto12 raises 18.1 million

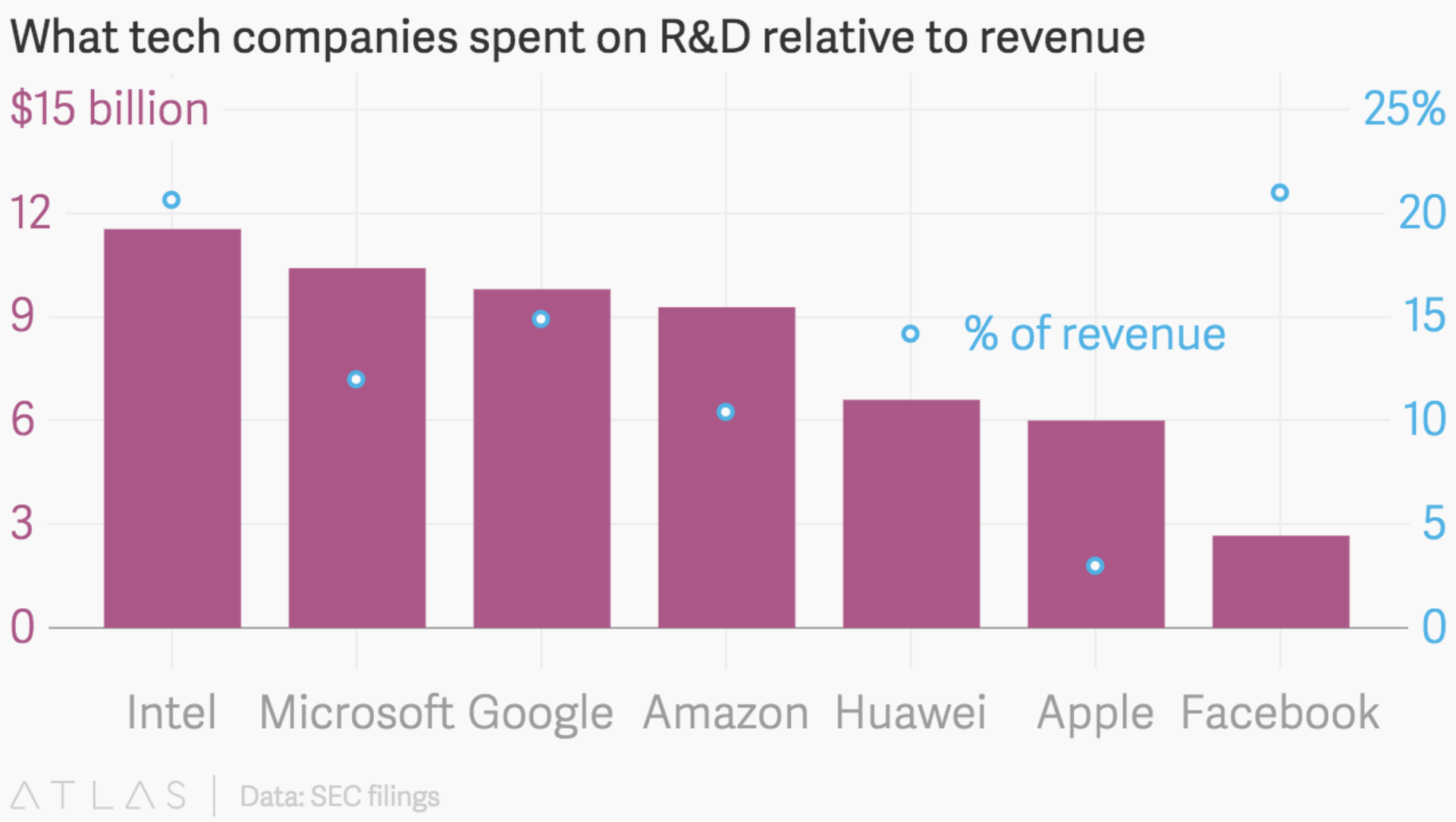
EPFL spin-off SWISSto12, which manufactures antennas for satellite communications, has raised CHF 18.1 million from investors. The firm will use the fresh injection of capital, announced today, to ramp up marketing of its 3D-printed waveguides and expand its offices in the US and Israel.

29.08.19

LINKS

- Swissto12

How do we quantify innovation?



Dr. Dimitrios Terzis

How do we quantify innovation?

120 patents filed per month.

75000 active patents and over **2200** more since the beginning of 2017 (as of 06/2018).

Revenue: **233.2 billion EUR** (2018)
A R&D budget of around **6 Billion $** (2016)

21 patents filed in 2016

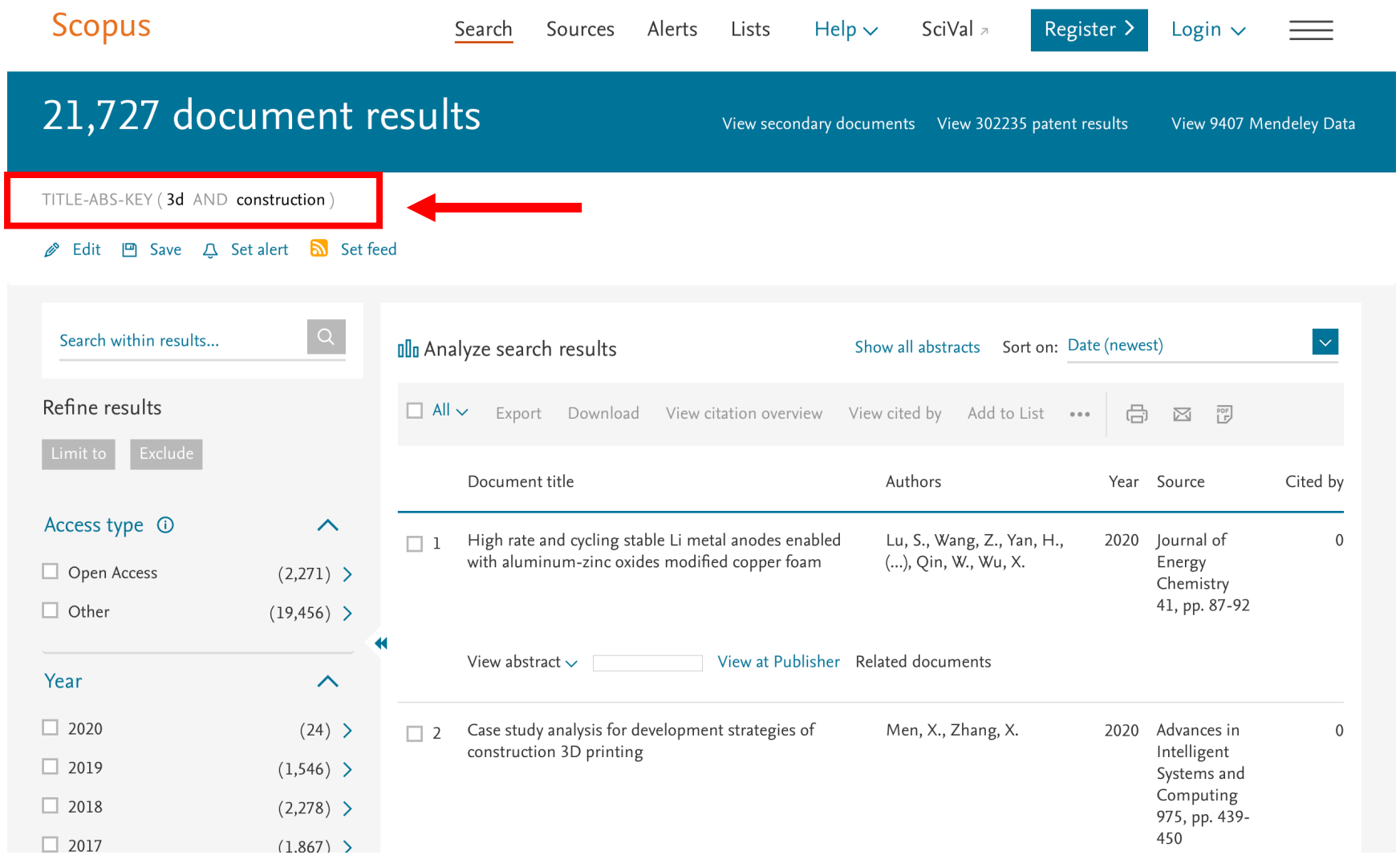
3172 active patents

Revenue **43.5 billion EUR** (2018)
A R&D budget of around **50 million EUR** a year

A 5.4 times higher revenue and a 120-fold higher R&D investment

Dr. Dimitrios Terzis

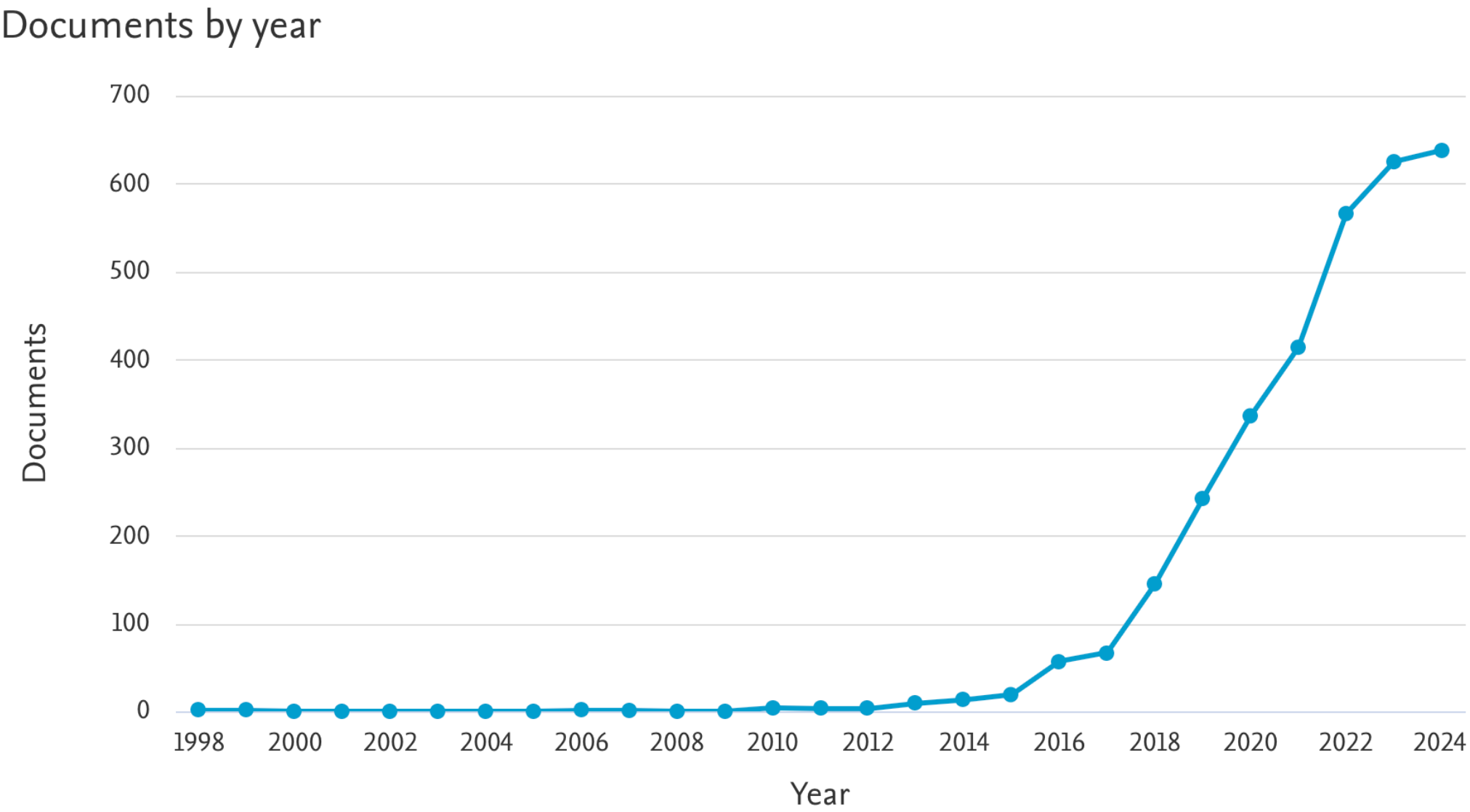
Do research



CITED BY

51	Mobile 3D mapping for surveying earthwork projects using an Unmanned Aerial Vehicle (UAV) system	Siebert, S., Teizer, J.	2014	Automation in Construction 41, pp. 1-14	281

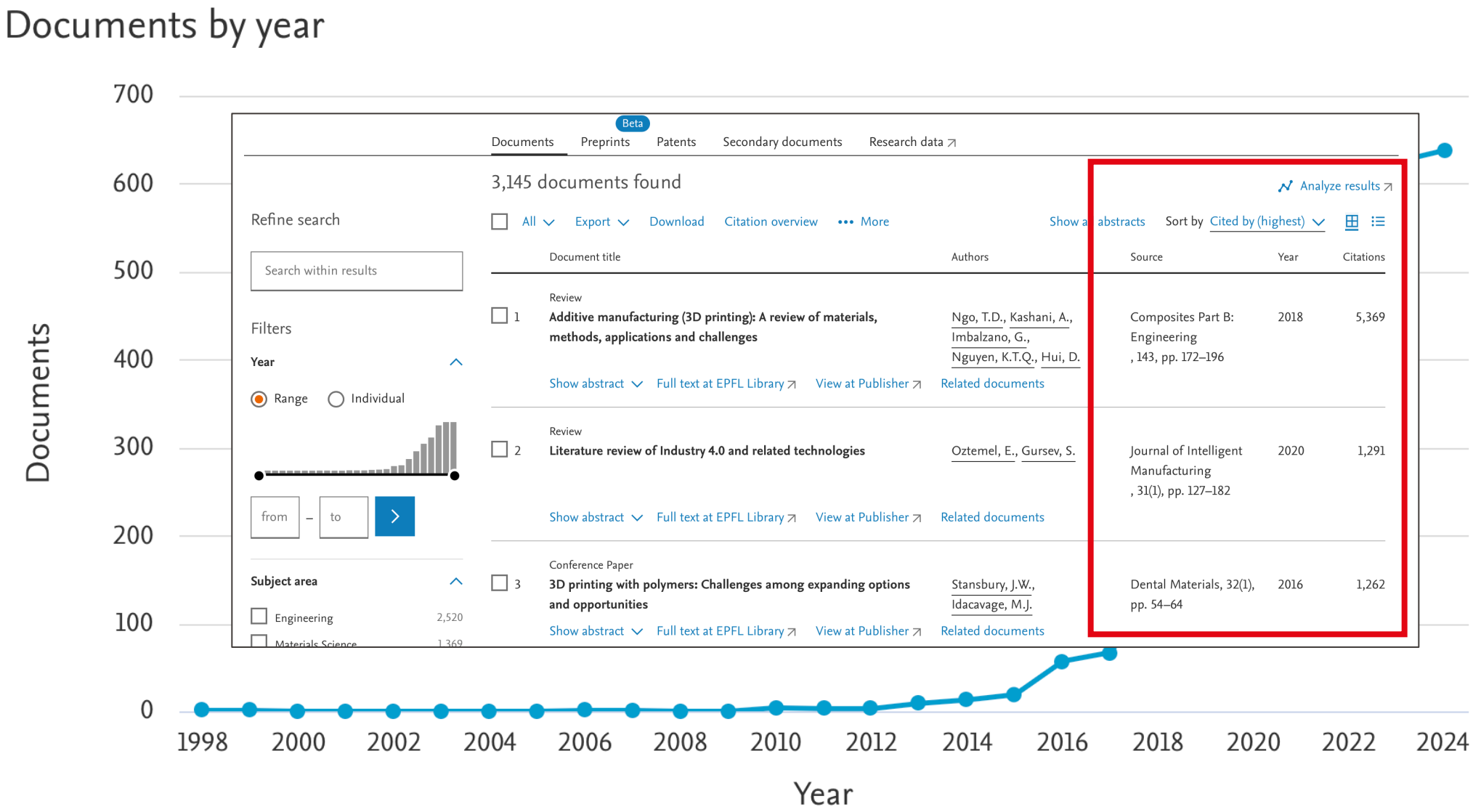
3D AND PRINT* AND CONCRETE



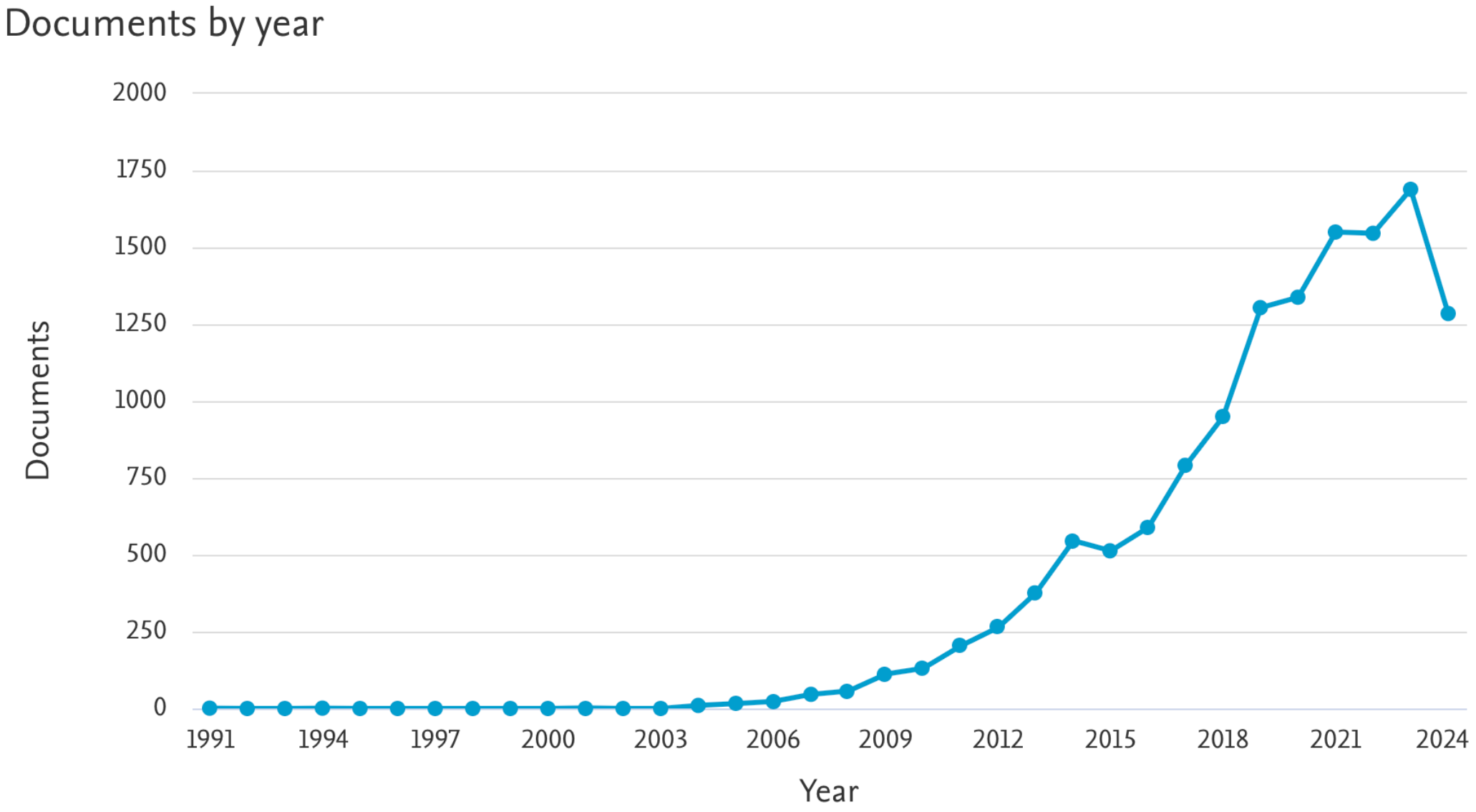
Dr. Dimitrios Terzis

Dr. Dimitrios Terzis

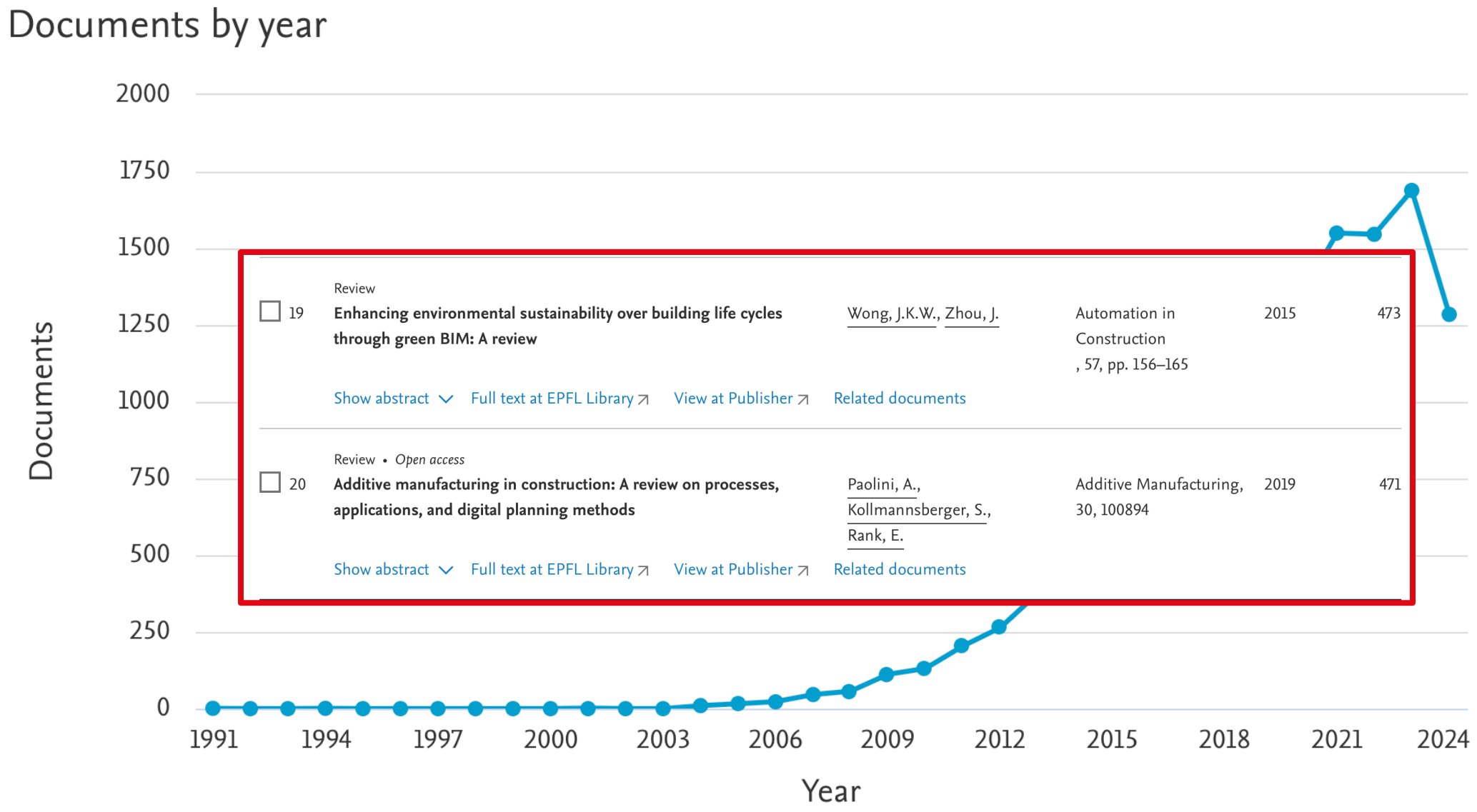
3D AND PRINT* AND CONCRETE



BIM AND CONSTRUCTION OR CIVIL



BIM AND CONSTRUCTION OR CIVIL



Dr. Dimitrios Terzis

Choose a vertical

Structure and Infrastructure Engineering
Volume 12, Issue 10, 2 October 2016, Pages 1267-1280

A framework for 3D traffic noise mapping using data from BIM and GIS integration (Article)

Deng, Y.[a], Cheng, J.C.P.[a], Anumba, C.[b]

[a]Department of Civil and Environmental Engineering, The Hong Kong University of Science and Technology, Hong Kong
[b]Department of Architectural Engineering, The Pennsylvania State University, University Park, PA, United States

Abstract

View references (43)

Traffic noise is a major health concern for people living in urban environments. Noise mapping can help evaluating the noise level for certain areas in a city. Traditionally, noise mapping is performed in 2D geographic information system (GIS). The use of 3D GIS is also emerging in noise mapping in recent years. However, the current noise-mapping platforms can only conduct noise evaluation for the outdoor environment and the indoor environment separately. In addition, related information about absorption coefficient and transmission loss (TL) in noise calculation is not properly retrieved and is often replaced with a single value. In this research, building information modelling (BIM) and 3D GIS are integrated in order to combine traffic noise evaluation in both outdoor environments and indoor environments in a single platform. In our developed BIM –GIS integration platform, the built environment is represented in a 3D GIS model that contains information at a high level of detail from BIM . With the integration with BIM , the 3D GIS model now has access to detailed indoor features such as interior walls and interior rooms. Noise evaluation could therefore be performed at a room level in the developed platform. Essential parameters such as absorption coefficient and TL can be extracted directly from BIM for noise calculation. The 3D GIS model is connected with detailed BIM so that any changes in the indoor and outdoor features can be reflected to each other. The Italian C.N.R model is modified and applied in the platform to conduct noise calculation. This paper presents the details for the development of the noise-mapping BIM –GIS platform based on ArcGIS. Two use cases were analysed to show the role of such platform in the decision-making process of both urban planning and interior design. © 2016 Taylor & Francis.

SciVal Topic Prominence

Topic: Noise pollution | Acoustic noise | Noise map

Prominence percentile: 91.552

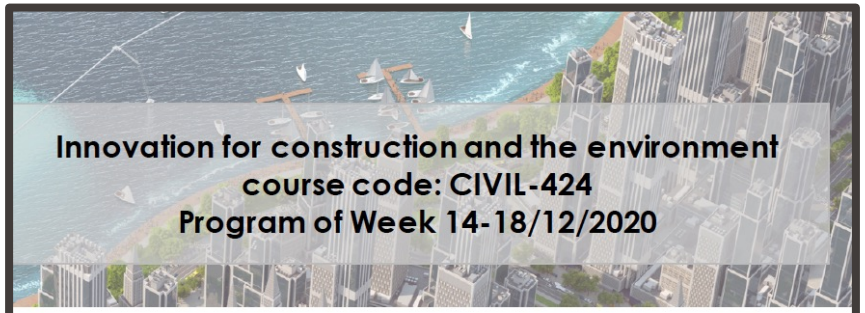
Cited by 25 documents

Integration of BIM and GIS: IFC geometry transformation to shapefile using enhanced open-source approach
Zhu, J. , Wang, X. , Chen, M.
(2019) Automation in Construction

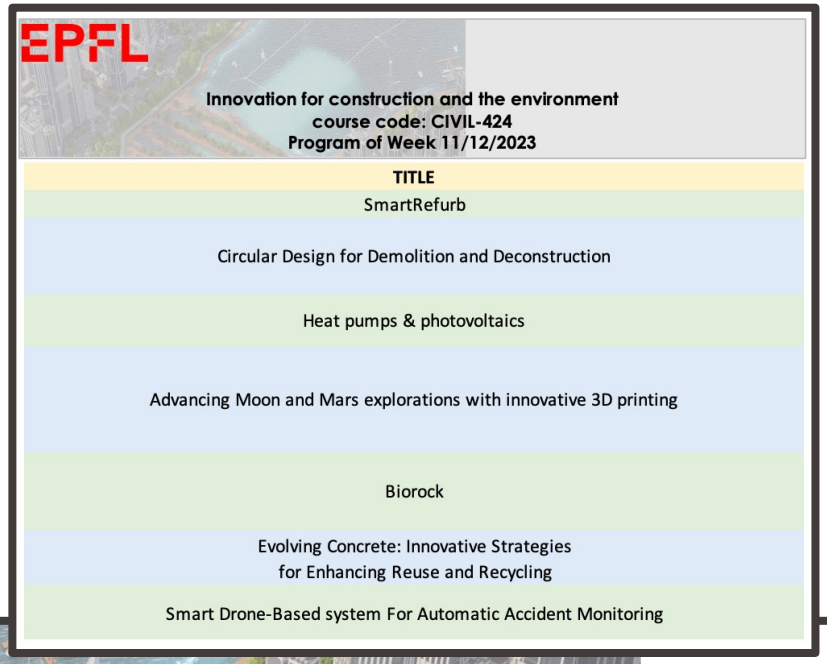
OutDet: an algorithm for extracting the outer surfaces of building information models for integration with geographic information systems
Zhou, X. , Zhao, J. , Wang, J.
(2019) International Journal of Geographical Information Science

Integration of BIM and GIS in sustainable built environment: A review and bibliometric analysis
Wang, H. , Pan, Y. , Luo, X.
(2019) Automation in Construction

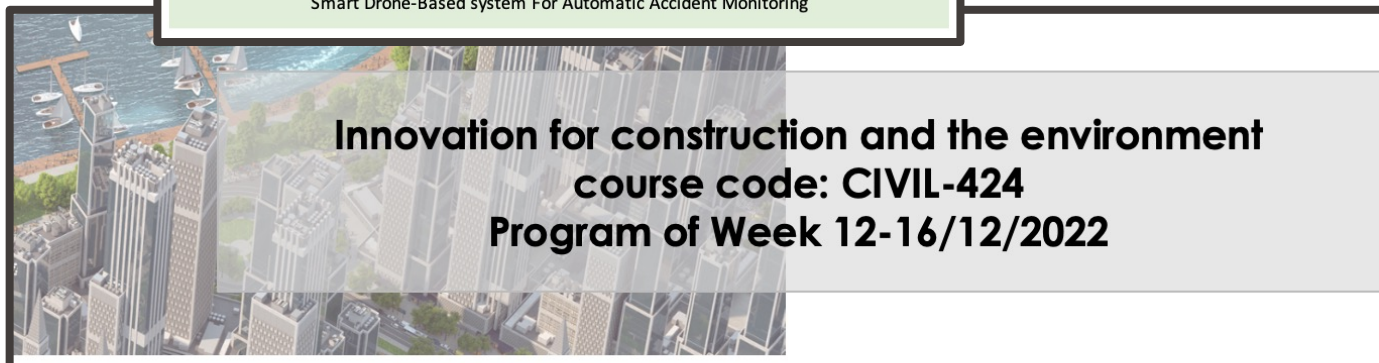
Choose a vertical



Indicative Title
Monitoring and management of air quality and emissions from contruction sites
LiDAR-based tunneling operations and monitoring
BIM-based secondary raw materials database
On the use of recycled plastics in construction
Alternatives for targeted monitoring of various ageing infrastructures
Dam Safety through structural health monitoring
Novel nozzle for 3D printed reinforced concrete
Wind-powered built environments
FRC-based paraseismic reinforcements
Optimization of energy consumption in buildings via hardware-software innovation
Futuristic pavements for urban zones
Temporary and modular critical infrastructures



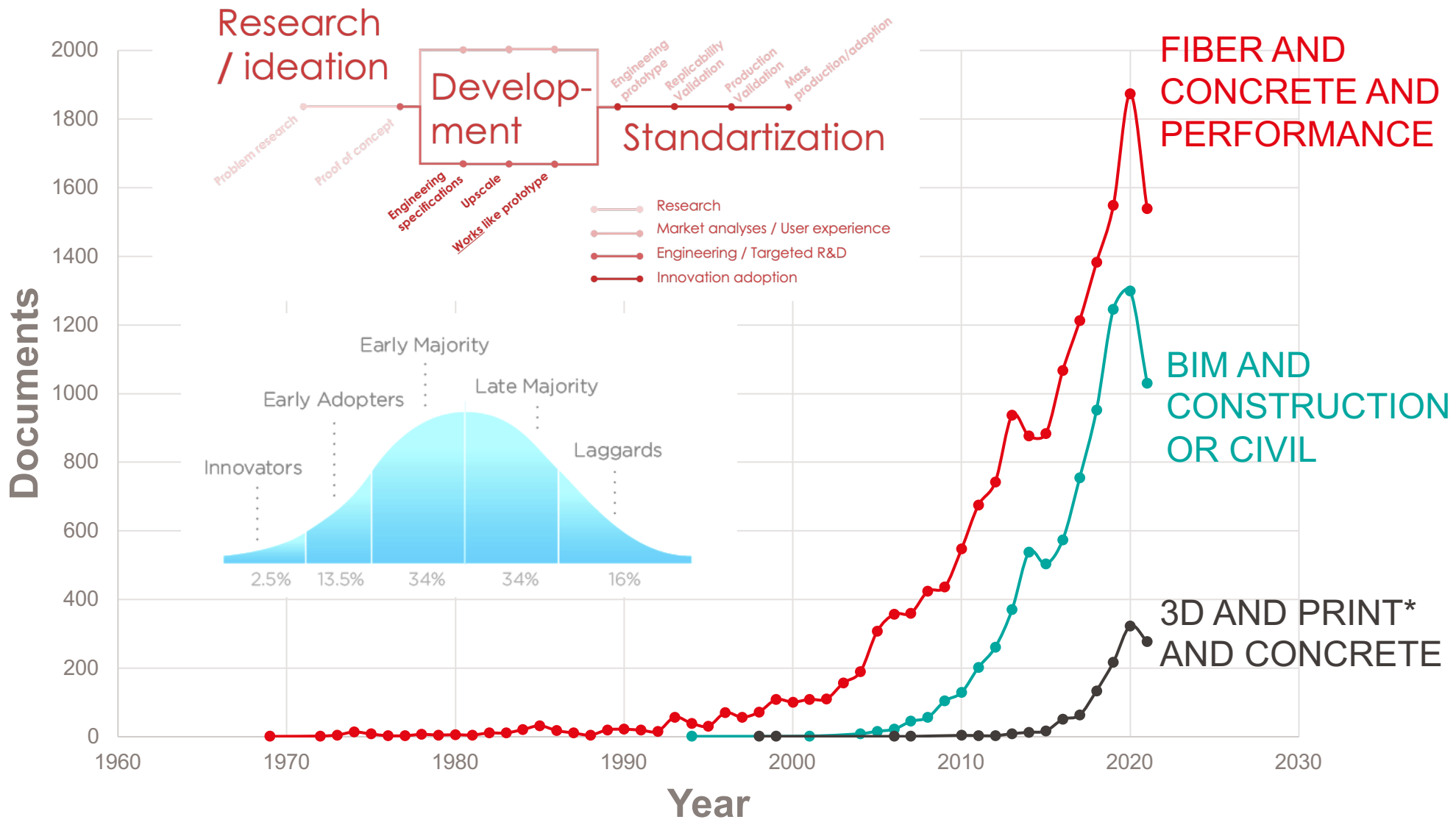
TITLE
SmartRefurb
Circular Design for Demolition and Deconstruction
Heat pumps & photovoltaics
Advancing Moon and Mars explorations with innovative 3D printing
Biorock
Evolving Concrete: Innovative Strategies for Enhancing Reuse and Recycling
Smart Drone-Based system For Automatic Accident Monitoring



Indicative Title
Automated excavation
Solar farms on Dams
Recycled concrete and its innovations in civil engineering
Low CO2 clinker fabrications
WIM - Waste Information Modeling
Next-gen road and pavement construction
Implementing LCA tools in BIM softwares
Global Environmental cost of construction sites
Use of incinerator botom ash (IBA) in combination with bio-concrete in construction

Dr. Dimitrios Terzis

SYNTHESIS



Search for examples, trends and opportunities

- www.scopus.com (literature database)
- www.espacenet.com (patent documents)
- www.crunchbase.com (Discover innovative companies and the people behind them)

Reports by McKinsey&Co
1 2 3