7th Annual
Global TechMining Conference
2017.Oct.9 • Atlanta, Georgia

TRANSLATING PATENTOMETRICS INTO USEFUL INTELLIGENCE:

THE CASE OF 3D BIOPRINTING

Tecnológico de Monterrey
UPV EHU
Dr. Marisela Rodríguez-Salvador
B.E. René Lezama-Nicolás
Dr. Rosa Río-Belver
Dr. Ismael Etxeberría

TECNOLOGICO DE MONTERREY

MANCHESTER 1824
The University of Manchester
Alliance Manchester Business School

Tecnológico de Monterrey

#7 in Latin America

QS UNIVERSITY RANKINGS LATIN AMERICA

QS University Rankings: Latin America 2014.

Tecnologico de Monterrey, Mexico.
Established in 1943.
31 campi in Mexico and 21 locations in 13 countries.
100,000 students and almost 9,000 faculty.

UPV EHU

University of the Basque Country (UPV/EHU), Spain.
Established in 1980.
44,241students and almost 4,062 faculty.

2

http://inteligenciacompetitiva.mty.itesm.mx/mission.htm

Dr. Marisela Rodriguez
Full profesor
Tecnologio de
Monterrey

3

CONTENTS

- OBJECTIVES.
- INTRODUCTION: 3D BIOPRINTING.
- RELEVANCE.
- BACKGROUND: PATENTOMETRICS.
- COMPETITIVE TECHNOLOGY INTELLIGENCE METHODOLOGY.
- RESULTS: ROADMAPPING.
- CONCLUSION.
- REFERENCES.

Dr. Marisela Rodríguez-Salvador, B.E. René Lezama-Nicolás, Dr. Rosa Río-Belver & Dr. Ismael Etxeberría.
"Translating Patentometrics into Useful Intelligence: the Case of 3D Bioprinting"

4

OBJECTIVES

- To provide a Competitive Technology Intelligence Methodology to track technological and product innovations.
- To translate technological breakthroughs into specific applications.
- To create a roadmap that aids managers and decision-makers to comprehend innovation pathways from technological advances to applications.
- To apply this research to 3D bioprinting.

INTRODUCTION: 3D BIOPRINTING

Additive manufacturing: A revolutionary technology that is bringing important changes to the world.

"Process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing method".

Also known as 3D printing, rapid prototyping or solid free-form fabrication.

Sources:

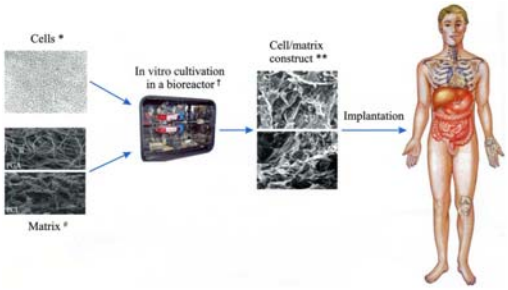
- ASTM International (2015). Standard Terminology for Additive Manufacturing - General Principles - Terminology. http://www.astm.org/cgi-bin/resolver.cgi?ISOASTM52900. Accessed August 31 2017.
- Wohlers, T. T., & Caffrey, T. (2015). Wohlers Report 2015: 3D Printing and Additive Manufacturing State of the Industry Annual Worldwide Progress Report. Wohlers Associates.

Source: Cotteleer, M., Holdowsky, J., & Mahto, M. (2014) 'The 3D opportunity primer'. Deloitte University Press. Available at: https://dupress.deloitte.com/dup-us-en/focus/3d-opportunity/the-3d-opportunity-primer-the-basics-of-additive-manufacturing.html.

INTRODUCTION: 3D BIOPRINTING

Tissue engineering

"Development of biological substitutes that restore, maintain, or improve tissue function"



Source: Langer & Vacanti (1993). "Tissue Engineering". Science. 260(5110), 920-926.

Source: Shieh, S. J., & Vacanti, J. P. (2005). State-of-the-art tissue engineering: from tissue engineering to organ building. *Surgery*, *137*(1), 1-7.

INTRODUCTION: 3D BIOPRINTING

3D Bioprinting

Additive manufacturing + Tissue engineering

"Cell printing in predisigned patterns".

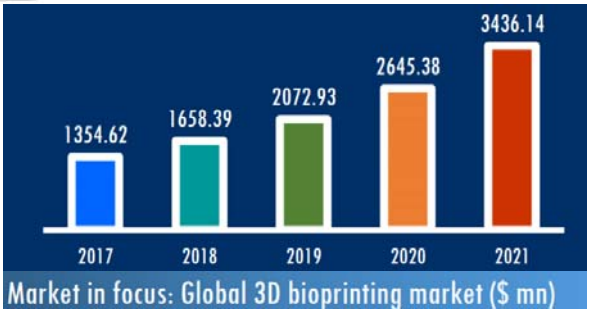
Long-term purpose: **organ printing.**

Source:
Ozbolat IT, Yu Y. (2013). Bioprinting toward organ fabrication: challenges and future trends. IEEE Transactions on Biomedical Engineering, 60(3):691–9.

Source:
Barnatt, C. (2011). Organ printing concept: 3-D functional organs are printed from the bottom up using living cells in a supportive medium.

RELEVANCE

- 3D bioprinting: a breakthrough technology to address health problems and its applications are growing rapidly.
- 3D bioprinting is an innovative technology that is still in a early stage.
- Introduction of products in the market: for example in 2014 Organovo Holdings Inc launched the exVive3D Liver, a liver tissue model for medical and drug research.
- 3D bioprinting market growth over 20% annually and expected to grow to $3,436.14 million by 2021.



Source: Infiniti Research Limited (2017). GLOBAL 3D BIOPRINTING MARKET. Distributed by TechNavio. Available on https://www.technavio.com/report/global-embedded-systems-global-3d-bioprinting-market. Retrieved on September 18, 2017.

BACKGROUND: PATENTOMETRICS

Patentometrics

Extraction of → bibliometric indicators → from patent records.

Through text mining techniques

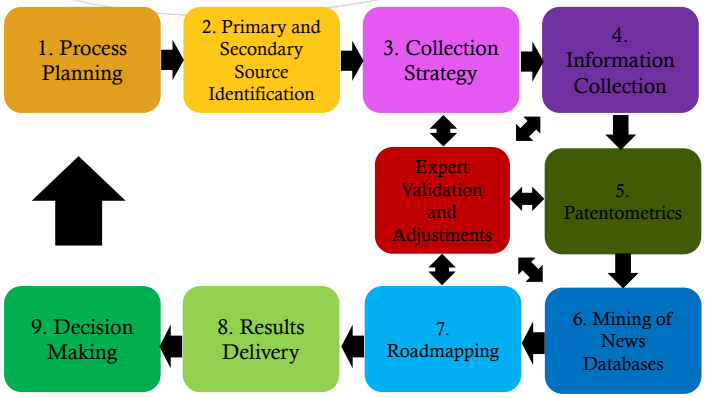
Which are computer aided processing of large volumes of data.

- Number of publications
- Co-authorship
- Co-words
- Co-citation
- Etc.

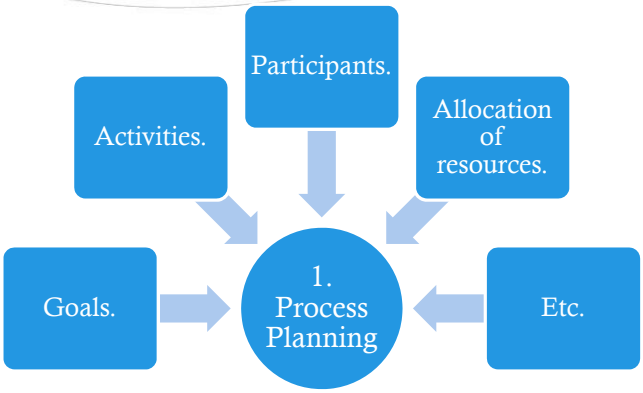
- Title
- Abstract
- Description
- Claims
- Assignees
- Citations
- Etc.

Source: Okubo, Y. (1997). Bibliometric Indicators and Analysis of Research Systems: Methods and Examples. *OECD Science, Technology and Industry Working Papers*, 1997/01, OECD Publishing, Paris.

METHODOLOGY: COMPETITIVE TECHNOLOGY INTELLIGENCE HYBRID METHODOLOGY



METHODOLOGY: COMPETITIVE TECHNOLOGY INTELLIGENCE HYBRID METHODOLOGY



METHODOLOGY: COMPETITIVE TECHNOLOGY INTELLIGENCE HYBRID METHODOLOGY

MANCHESTER 1824
The University of Manchester

2004: *bioprinting* term.

The University of Nottingham

2012: Center for Innovative Manufacturing in Additive Manufacturing.

2. Identification of

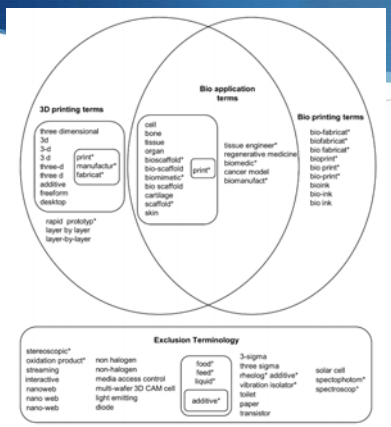
- Primary Sources (Experts)
  - By means of nomitation, citation count, number of highly ranked publications or general presence in the field.
- Secondary Sources (Publications)
  - By means of prestige, coverage and completeness of information among the scientific community.

PATSEER

Covers more than 61 million full text records of 43 authorities; including Patentscope, ESPACENET, USPTO, SIPO, JPO, etc.

METHODOLOGY: COMPETITIVE TECHNOLOGY INTELLIGENCE HYBRID METHODOLOGY

METHODOLOGY: COMPETITIVE TECHNOLOGY INTELLIGENCE HYBRID METHODOLOGY



Main search query

TITLE OR HEADLINE: (((bio-fabricat* OR biofabricat* OR bio fabricat* OR bioprint* OR bio print* OR bio-print* OR bioink OR bio-ink OR "bio ink") OR (((three dimensional OR 3d OR 3-d OR 3 d OR three-d or three d OR additive OR freeform OR desktop) near1 (print* OR manufactur* OR fabricat*) OR rapid prototyp* OR layer by layer OR layer-by-layer) and (((cell OR bone OR tissue OR organ OR bioscaffold* OR bio scaffold OR bio-scaffold OR biomimetic* OR skin OR cartilage OR scaffold*) near1 (print*)) OR (tissue engineer* OR regenerative medicine OR biomedic* OR cancer model* OR biomanufact*))))

Main query terminology for the databases searches. Words marked with (*) are root words.

Source: Rodríguez-Salvador, M., Río-Belver, R. & Garechana, G (2017). Scientometric and patentometric analyses to determine the knowledge landscape in innovative technologies: The case of 3D bioprinting. *PLOS ONE. Available open source at:* https://doi.org/10.1371/journal.pone.0180375.

15

METHODOLOGY: COMPETITIVE TECHNOLOGY INTELLIGENCE HYBRID METHODOLOGY

Expert Validation and Adjustments	**4. Information Collection**	3D Bioprinting patents
	Results retrieval.	706 records (including both applications and grants) from 2000-2016.
	Deduplication and grouping by patent families.	601 patents after deduplitation. 345 patent families.

Source: EPO (2017). Patent Families. Extracted from: https://www.epo.org/searching-for-patents/helpful-resources/first-time-here/patent-families.html. Retrieved on September 19, 2017.

Dr. Marisela Rodríguez-Salvador, B.E. René Lezama-Nicolás, Dr. Rosa Río-Belver & Dr. Ismael Etxeberría. "Translating Patentometrics into Useful Intelligence: the Case of 3D Bioprinting"

16

METHODOLOGY: COMPETITIVE TECHNOLOGY INTELLIGENCE HYBRID METHODOLOGY

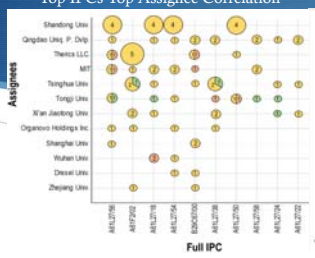
Expert Validation and Adjustments

5. Patentometrics

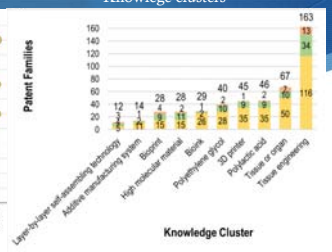
Datamining.

Technical domain and key players

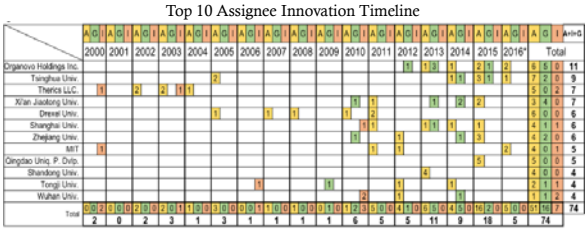
Top IPCs-Top Assignee Correlation



Knowlege clusters



Top 10 Assignee Innovation Timeline



Source: Rodríguez-Salvador, M., Río-Belver, R. & Garechana, G (2017). Scientometric and patentometric analyses to determine the knowledge landscape in innovative technologies: The case of 3D bioprinting. *PLOS ONE. Available open source at:* https://doi.org/10.1371/journal.pone.0180375.

METHODOLOGY: COMPETITIVE TECHNOLOGY INTELLIGENCE HYBRID METHODOLOGY

Expert Validation and Adjustments

6. Mining of News Databases

Takes the insights created from step 5 and refines the search query to scan news databases to determine the ultimate products and applications created from 3D bioprinting.

3D Bioprinting search query filtered by top organizations

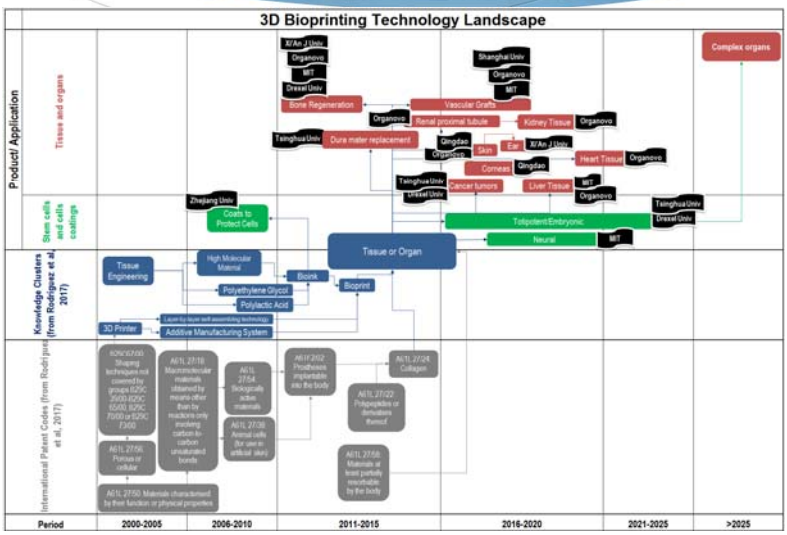
METHODOLOGY: COMPETITIVE TECHNOLOGY INTELLIGENCE HYBRID METHODOLOGY

Databases results (2000-April 2017).

Organization	EMIS	Factiva	Google News	LexisNexis	Proquest
Organovo Holdings	31	527	2450	54	489
Tsinghua Univ	1	37	239	0	45
Xi'an Jiaotong	2	517	58	0	8
Drexel Univ	0	56	196	7	108
Shanghai Univ	0	3	17	0	4
Zhejiang Univ	0	1	52	0	42
MIT	0	117	6790	27	4939
Qingdao Uniq P. Dvlp	0	0	29	0	0
Shandong Univ	0	9	59	0	1
Tongji Univ	0	7	63	0	8
Wuhan Univ	0	6	85	0	1

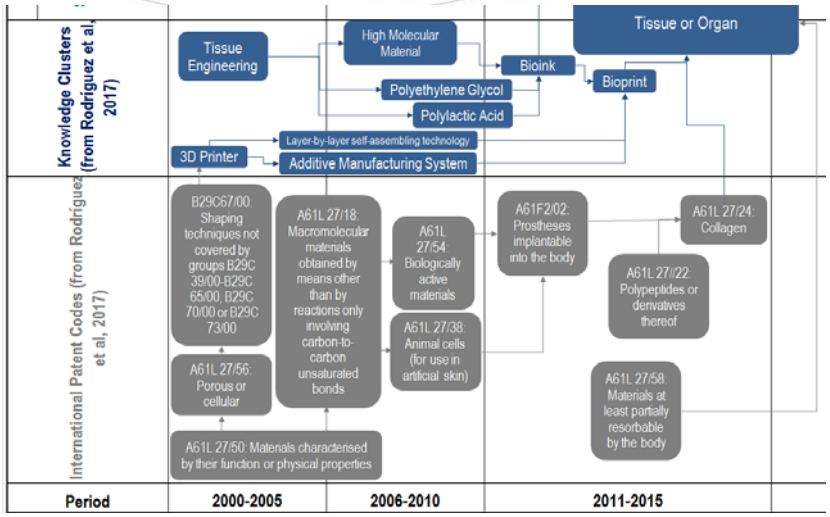
Results were manually reviewed and selected for further integration into a roadmap.

RESULTS: ROADMAPPING



RESULTS: ROADMAPPING

Detail: Lower layers.

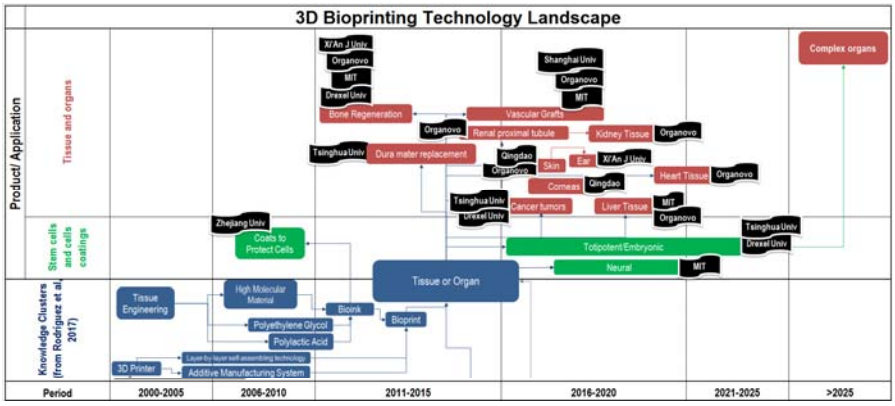


Dr. Marisela Rodríguez-Salvador, B.E. René Lezama-Nicolás, Dr. Rosa Río-Belver & Dr. Ismael Etxeberría.
"Translating Patentometrics into Useful Intelligence: the Case of 3D Bioprinting"

21

RESULTS: ROADMAPPING

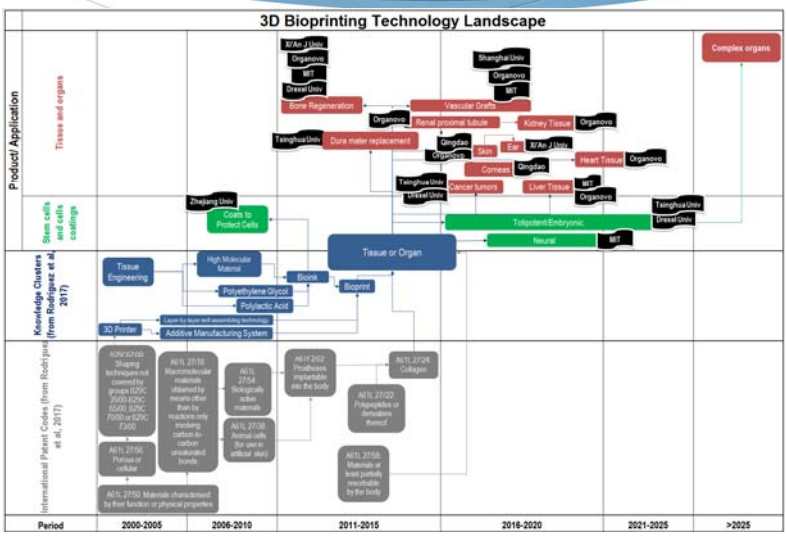
Detail: Upper layers.



Dr. Marisela Rodríguez-Salvador, B.E. René Lezama-Nicolás, Dr. Rosa Río-Belver & Dr. Ismael Etxeberría.
"Translating Patentometrics into Useful Intelligence: the Case of 3D Bioprinting"

22

RESULTS: ROADMAPPING



Dr. Marisela Rodríguez-Salvador, B.E. René Lezama-Nicolás, Dr. Rosa Río-Belver & Dr. Ismael Etxeberría.
"Translating Patentometrics into Useful Intelligence: the Case of 3D Bioprinting" 23

METHODOLOGY: COMPETITIVE TECHNOLOGY INTELLIGENCE HYBRID METHODOLOGY

Final steps:

8. Results Delivery

Results delivery in a suitable format and language for client understanding.

9. Decision Making

Anticipation is the best competitive advantage.

This methodology is cyclic, it is intended to be executed iteratively.

Dr. Marisela Rodríguez-Salvador, B.E. René Lezama-Nicolás, Dr. Rosa Río-Belver & Dr. Ismael Etxeberría.
"Translating Patentometrics into Useful Intelligence: the Case of 3D Bioprinting" 24

CONCLUSIONS

- The Competitive Technology Intelligence (CTI) methodology presented herein allows to track the innovation progress of 3D bioprinting: from technology developments to specific applications.
- 3D bioprinting has relevant implications for policy makers. It has a tremendous potential for health industry, including prevention and regenerative medicine. Insights obtained can be used to support 3D bioprinting decisions related to research and innovation efforts.
- Future studies can strengthen the roadmap with economic drivers, regulations, intellectual property rights and ethical issues surrounding 3D bioprinting.
- The proposed CTI methodology can be applied to study emerging innovations, to assess ongoing research trends and expose the innovation landscape.

REFERENCES

- ASTM International (2015). Standard Terminology for Additive Manufacturing - General Principles - Terminology. http://www.astm.org/cgi-bin/resolver.cgi?ISOASTM52900. Accessed August 31 2017.
- Infiniti Research Limited (2017). GLOBAL 3D BIOPRINTING MARKET. Distributed by TechNavio. Available on https://www.technavio.com/report/global-embedded-systems-global-3d-bioprinting-market. Retrieved on September 18, 2017.
- Langer & Vacanti (1993). "Tissue Engineering". Science. 260(5110), 920-926.
- Okubo, Y. (1997). Bibliometric Indicators and Analysis of Research Systems: Methods and Examples. *OECD Science, Technology and Industry Working Papers*, 1997/01, OECD Publishing, Paris.
- Ozbolat IT, Yu Y. (2013). Bioprinting toward organ fabrication: challenges and future trends. IEEE Transactions on Biomedical Engineering, 60(3):691–9.
- Rodríguez-Salvador, M., Río-Belver, R. & Garechana, G (2017). Scientometric and patentometric analyses to determine the knowledge landscape in innovative technologies: The case of 3D bioprinting. *PLOS ONE. Available open source at:* https://doi.org/10.1371/journal.pone.0180375.
- U.S. Department of Health & Human Services (2017). Organ Donation Statistics. Available at: https://www.organdonor.gov/statistics-stories/statistics.html. Extracted on September 18, 2017.
- Wohlers, T. T., & Caffrey, T. (2015). Wohlers Report 2015: 3D Printing and Additive Manufacturing State of the Industry Annual Worldwide Progress Report. Wohlers Associates.
- World Health Organization (2007). "Dilemma over live-donor transplantation". Available at: http://www.who.int/bulletin/volumes/85/1/07-020107/en/ extracted on September 18, 2017.

7th Annual
Global TechMining Conference
2017.Oct.9 • Atlanta, Georgia

THANK YOU FOR YOUR ATTENTION. QUESTIONS?

- Dr. Marisela Rodríguez-Salvador.
- marisrod@itesm.mx
- Centro de Innovación en Diseño y Tecnología (CIDyT).
- Tecnológico de Monterrey, Campus Monterrey, México.

- B.E. René Lezama-Nicolás.
- rene.lz.nicolas@gmail.com
- Centro de Innovación en Diseño y Tecnología (CIDyT).
- Tecnológico de Monterrey, Campus Monterrey, México.

- Dr. Rosa Río-Belver.
- rosamaria.rio@ehu.eus
- Industrial Organization and Management Engineering Department.
- University of the Basque Country UPV/EHU.
- Vitoria Gasteiz, Spain.

- Dr. Ismael Etxeberría.
- ismael.etxeberria@ehu.eus
- Industrial Organization and Management Engineering Department.
- University of the Basque Country UPV/EHU.
- Vitoria Gasteiz, Spain.

27