

# Digital Technologies in Latin American Architecture

## *A Literature Review from the Third to the Fourth Industrial Revolution*

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*This paper approaches the literature that combines the fields of Architectural Computing and Architecture and Urbanism produced in Latin America during the first two decades of the 21st Century. The main objective is to map the advancement of Digital Technology in Architecture and Urbanism in the context of the Third Industrial Revolution, in order to identify perspectives towards a Fourth Industrial Revolution. As methodology was applied a chronological survey of the literature produced in book format, predominantly printed in the 21st Century by Latin Americans researches in leading digital themes. At last, it can be verified that the production is still very scarce and still has not incorporated, in a significant way, the themes related to the Fourth Industrial Revolution.*

**Keywords:** *Latin America, Digital Technologies, Industrial Revolution, Literature Review, Architectural Computing*

### INTRODUCTION

In the history of Architecture, the topics on emerging digital technologies have been transversal to Economy, Society, Industry, where construction and architecture computing are not the exception. Schwab (2015) argues that the Fourth Industrial Revolution has its origin in the automation of production through electronics and informational technology and is not an extension of the Third Industrial Revolution, but a result of three reasons: velocity, scope, and system impact.

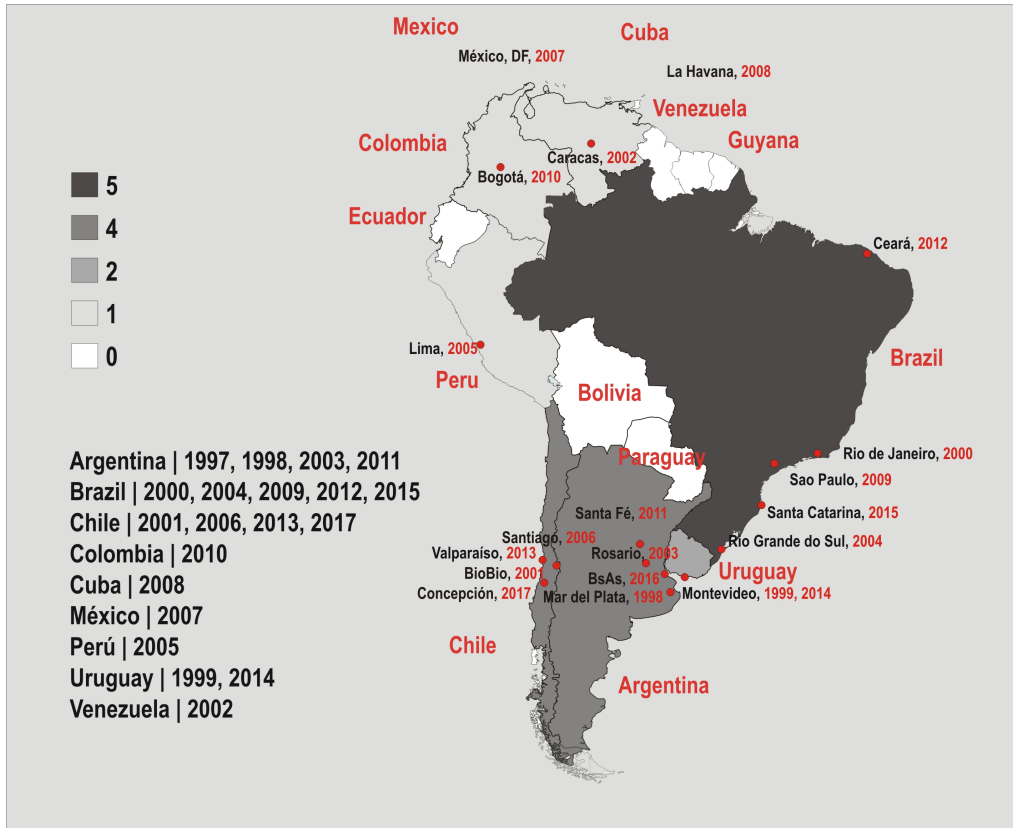
To analyze the evolution of the Third to the Fourth Industrial Revolution in Latin American Architecture, a thematic literature review about digital and emergent technologies was carried out. In this re-

search, the bibliography considered was the one developed in the geographic territory where SIGraDi has been present during the first two decades of the 21st Century.

It is expected that this research contributes to the thematic of History and Future of CAAD, mapping the academic bibliographic field that discusses the issue of the implementation of Architectural Computing in the field of Architecture and Urbanism, identifying topics that may be linked to a Fourth Industrial Revolution in Latin America in the future.

As known, the bibliography published in book format in Latin American territory is very modest when compared to the amount of North American and European books. There are several factors that

Figure 1  
Location of SIGraDi  
Conferences,  
1997-2018



contribute to this, among which it can be supposed the bureaucratic difficulties, the high costs and the scarce resources assigned to books production, as well as the framing of an internationally incipient and little influential (academic) editorial market, and, therefore, not so profitable. Added to these problems is the lack of funding for long-term studies that generate results earning to be published as books.

It is also added the current stimulus and valorization to academic publishing in the form of papers in scientific journals, preferably distributed over the Internet in free access systems. In fact, another prob-

lem faced by the publishing of books refers to their distribution, which is also expensive. High investments are necessary so the books get to the book store's shelves to be purchased by readers. Therefore, when all of the difficulties of producing books have been surpassed, the problem of low circulation of the piece is faced, although the propagation over the Internet is also an alternative.

Given all these issues, it should be considered that the research presented in this paper is not exhaustive, but it proposes to bring to light some of the main publications and their authors. The effort to

make a literature review reveals evidence of the ways of thinking from each period of time, consolidating the developed intellectual production and laying the basis for future connections.

The SIGraDi Conferences (since 1997), as well as the eCAADe (since 1983), disclosed papers that present thematic analysis based on bibliography. Therefore, this paper justifies itself by the importance of reviewing only published books, in order to provide a new panorama that includes some of the topics related to those recommended by Industry 4.0.

It should be noted that the history of publications by members of SIGraDi has had a very close relationship with eCAADe, in part due to the friendships of its founding members, such as Arturo Montagú and Thomas Maver. Thus, in the year of 2001, SIGraDi presented at the 19th eCAADe the history of its region (Montagú et al. 2001) where different authors reviewed the scenario of their countries. The experiences developed coincided with the first eCAADe round table led by Earl Mark, Bob Martens and Rivka Oxman (2001). Yet, in 2019, when SIGraDi and eCAADe hold their conferences together, actualizing collaboration and exchange of experiences between the two fellow societies, we present a review of the books published in Latin America.

Towards the end of the 20th Century, at the 17th eCAADe, Mark Clayton and Guillermo de Velasco (1999) presented a review of texts, which highlights the intense presence of Computer Programming. This review allowed the identification of 12 new topics in architectural computing education. Some years later, on the 20th eCAADe, Regiane Pupo and Gabriela Celani published *Trends in Graduate Research on IT & Architecture: A Qualitative Comparison of Tendencies in Brazil and abroad*. With 19 themes, they compared the trend of topics in digital technologies in Master thesis and PhD dissertations from Brazil and other countries between 1999 and 2006. Comparing it with the work of Clayton and Vásquez de Velasco, both coincide with the little production of Programming, Algorithms and Math Models topics.

In recent years, it has been seen the mapping of

topics and conferences papers related to Computing Architecture, such as the work of Tassia de Vasconcelos and David Sperling which analyzes the teaching strategies supported by architectural digital techniques and produced by the Latin American community between 2010 and 2015 (Vasconcelos and Sperling 2016). Months later they set a retrospective from 2006 to 2015 (Vasconcelos and Sperling 2017) considering a systematic review of CumInCad database.

Thus, it can be verified that one of the main contributions of the literature review is the establishment of panoramas, which can provide the comprehension of the ways of thinking that have been consolidated over time. Therefore, the main objective of this paper is to evidence the panorama of the books published in Latin America in the almost twenty years of our century, pointing out their main topics.

## MATERIALS AND METHODS

Our analysis takes as its starting point the work of Clayton and Vásquez de Velasco (1999) which seeks to answer the question from educators in Architectural Computing: “What do we need to teach our students now to be ready for this future?”, in order to identify “the topics that we have taught in the past can help to identify those that should be continued and those that should be abandoned to make way for new topics”. Likewise, this research seeks to recognize the topics proposed by the authors in the reference set.

Clayton and Vásquez de Velasco proposed 16 topics in the Architectural Computing education: *Design methods, Knowledge systems, Computing theory, Future (speculation on future systems), CAAD Theory, Computer literacy, Business applications, Programming, General computer graphics, CAD management and practice, 2D modeling applications, 3D modeling applications, Hypermedia, Animation, Communications, World Wide Web*. In their projections they have proposed five trends: *Distributed computing and electronic commerce, Convergence of telecommunications and computing, Real-time navigation through spatial simulations* and, finally, *Time-scaled animation phe-*

*nomena* that we have also included in our analysis list.

In addition, for the analysis of the books, it was included a list of trends associated to the Fourth Industrial Revolution, that were not identified in previous researches for this sort of analysis: *BIM, Robotics, Personal fabrication, Additive manufacturing, Big Data, Cloud computing, Blockchain, Nanotechnology and Internet of Things*.

This way, this work is the result of a qualitative research, based mostly in a literature review. At first, the CumInCAD database was sought in an effort to bring up papers that came up with a wider review of the Latin American bibliography production. It was found that there were a thesis survey (Pupo and Celani 2007) and a database of scientific papers (Vasconcelos and Sperling 2016, 2017), however, the book-based analysis had not been previously addressed, as proposed in this study.

Then, a literature review was made within books published by professors and researchers working in the field of Architecture and Urbanism in the countries covered by SIGraDI. Therefore, the books found were taken as an empirical object.

To select the books, a search was made among the papers published at the Conferences of SIGraDI since 2001. The collected data was complemented by searches over the Google Books database. Therefore, the period from 2001 to the present time is taken as the time frame of the study.

As a total, as shown in Table 1, 33 references were selected among books (22, marked in black) and catalogs (11, marked in white), in chronological order between 2002 and 2018, representing 5 countries: Argentina (10), Brazil (16), Chile (3), Colombia (1) and Mexico (1) and Uruguay (1). Spain (Álvarez and González 2017) is represented by two workshops held by the Architectural Association in Havana (Cuba, 2012) and Valparaíso (Chile, 2011). From there, after its reading and analysis, not only it brings up to the panorama understanding of the Latin American publishing developed over the last 20 years, but also it turns able to identify the authors and the themes pushed by them, as well as the countries

that historically developed these initiatives and make them sustainable.

It is worth mentioning that, in this paper, we do not contemplate Proceedings, although they constitute a bibliographical material of extreme relevance, such as the Proceedings of SIGraDI Conferences, whose works can be accessed both by SIGraDI website [1], as well as directly by the CumInCAD database website [2], or, still, by Blucher Proceedings platform [3]. We have neither included in our literature review dissertations, thesis or research reports, not even scientific magazines or journals. At last, books that present a purely theoretical approach were also excluded, being directed to the teaching of certain software, for example, some titles of the brazilian publisher ProBooks, or manuals of a more pragmatic nature, such as the book published in 2015, in Peru, by Umberto Roncoroni, entitled as *Manual de diseño generativo*.

We privileged only the books approaching themes related to digital technologies predominantly linked to the universe of Architecture and Urbanism. Thus, the books focusing on the field of Communication were out of this study scope, such as books of Lucrécia D'Alessio Ferrara (*Cidade, entre mediações e interações*, 2016) and Lucia Santaella (*A ecologia pluralista da comunicação: conectividade, mobilidade e ubiquidade*, 2010), both brazilian, and also the books organized, in Brazil, by André Lemos (*Cibercidade: as cidades na cibercultura*, 2004; *Cibercidade II: Ciberurbe. A cidade na sociedade da Informação*, 2005; *Cidade Digital: portais, inclusão e redes no Brasil*, 2007).

Also not included were the books linked more specifically to the universe of Arts and Design, such as the book organized by Artur Matuck and Jorge Luiz Antonio, in 2008 (*Artemídia e cultura digital*), *Desorientação e colaboração no cotidiano digital*, organized in 2014 by Rejane Spitz, brazilian, and *Design: do virtual ao digital*, published in 2002, by Álvaro Guillermo Guardia Souto, or thoughts on the impact of the informatics on culture, such as Alejandro Piscitelli (*Ciberculturas*, 1995, and *Ciberculturas 2.0: en la Era*

Table 1  
Computing  
Architecture books  
published between  
2002 and 2018

Country	Authors	Year
Brasil	Duarte	2002
Brasil	Celani	2003
Argentina	Combes	2003
Argentina	Montagú et al.	2004
Argentina	Rodríguez	2004
Chile	Parra et al.	2004
Brasil	Piazzalunga	2005
Brasil	Prestes	2006
Argentina	Rodríguez	2006
Argentina	Rodríguez	2007
Chile	R. García	2007
Chile	Astudillo et al.	2008
Colombia	Patiño & Arbeláez	2009
Brasil	Da Silva	2010
Argentina	Muñoz	2010
Brasil	Kowaltowski	2011
Argentina	Muñoz	2011
Brasil	Arantes	2012
Argentina	Rodríguez et al.	2013
Brasil	Scheer et al.	2013
Argentina	Muñoz	2013
Brasil	Celani	2013
Brasil	NOMADS	2013
Uruguay	F. García	2014
Brasil	Sperling et al.	2015
Brasil	Braida et al.	2016
Argentina	Muñoz	2016
España	Alvarez et al.	2016
Brasil	Cordeiro & Costa	2017
Brasil	Celani	2018
Brasil	Belmiro	2018
Brasil	Schereen et al.	2018
México	Anzalone et al.	2018

Type of reference ☒ Book ☐ Catalog

de las máquinas inteligentes, 2009), and *As teorías da cibercultura: perspectivas, questões e autores* (Rüdiger 2013). Texts of a predominantly philosophical nature were also not included, such as the book by Umberto Roncoroni, peruvian, *Filosofía y software: la cultura digital detrás de la pantalla* (2012).

RESULTS AND DISCUSSION

Background: Books from the end of the 20th Century

It is emphasized that, unlike the constant bibliographical production of the Northern Hemisphere, Latin America had little specialized production on book format. However, SIGraDi, since its foundation, has brought authors together, creating milestones on the situation of the region.

Adapted from Clayton and Vásquez de Velasco (1999:154), Table 2 shows in black the relation between the distinct topics regarding the computing architecture and the bibliographical production between 1975 and 2000. The Table 2. was adapted to relate it to the only Latin American books published in the 1990s. This decade precedes our research and points out 5 books published in two of the twenty countries that compose Latin America: Argentina (2) and Brazil (3). Unlike the Northern Hemisphere, this production meant, for Latin America, self-managed efforts promoted by public universities, in research

spaces such as the *Laboratorio de Técnicas Avanzadas en Diseño*, in Venezuela, (created in 1974), which organized the first venezuelan conference about the application of computers in architecture (1999). Another references are the School of Architecture and Urbanism of University of São Paulo, which organized the International Seminar: *Computação: Arquitetura e Urbanismo* (Dantas, 1992), and the *Centro de Creación Asistido por Ordenador* (CAO) in Argentina (created in 1989) which was organized in 1997 the *1º Seminario de la Sociedad Iberoamericana de Gráfica Digital* (SIGraDi) in the School of Architecture, Design and Urbanism of the University of Buenos Aires.

Arturo Montagú was the main impeller of the foundation of SIGraDi. He also was very influent and left a great legacy. Some of his published works, at the late 20th Century, are *Aporte de la Informática en la Arquitectura, el Diseño y el Urbanismo* (in 1993, in partnership with Mario Nariño and María Igarabal) and *DatArq 2000 base de datos de la arquitectura moderna y contemporánea* (1999). Also in 1999, in Brazil, Fábio Duarte published a short book entitled *Arquitetura e Tecnologias de Informação: da Revolução Industrial à Revolução Digital*. In this book, Fábio Duarte, within a historical perspective and with references to projects of several architects, approached some topics related to electronic and digital architecture, among which are issues about models and simulations, immersion in virtual environments and de-

Authors	Topics															
	Design Methods	Knowledge Systems	Computing Theory	Future	CAAD Theory	Computer Literacy	Business Applications	Programming	General Computer Graphics	CAD Management and Practice	2D Modeling Application	3D Modeling Application	Hypermedia	Animation	Communications	World Wide Web
1975	Negroponite															
1977	Cross															
1977	Mitchell															
1987	Radford & Stevens															
1987	Mitchell et al.															
1987	Reynolds															
1988	Schmitt															
1988	Crosley															
1991	Mitchell et al.															
1991	Jacobs															
1993	Von Woodtke															
1993	Montagú et al.															
1995	Mitchell et al.															
1995	Brown & Charles															
1996	Sanders															
1997	Woodward & Howes															
1997	Bertol															
1997	Romeiro Filho															
1998	Kolarevic															
1999	Duarte															
1999	Montagú															
2000	Menegoto et al.															

Table 2  
Computing  
Architecture  
references between  
1975 and 2000

materialization. And, in 2000, Jose Luis Menegotto and Tereza Cristina Malveira de Araujo published the book *O Desenho Digital: Técnica e Arte*.

These books, published near to the transition from the 20th Century to the 21st, might be considered pioneers in Latin America, especially since they brought the first regional approaches to the incorporation of digital technologies in the scope of Architecture and Urbanism, even presenting books published outside the Latin American geographical space to a larger audience.

21st century: Computing Architecture books in Latin America

In 2002, Fábio Duarte presented as another contribution the book entitled *Crise das matrizes espaciais*, in which he explored, among other themes, the multimedia city, the technological culture and cyberspace, the trans architecture of Marcos Novak, the fluid architecture of Nox and the hybrid spaces. In 2003, in Argentina, Leonardo Combes was the editor of the book *Contribuciones a los sistemas de diseño*. In Brazil, on that same year, Gabriela Celani published the book *CAD Criativo*, as a result of “a series of CAD educational experiments held in different architecture and engineering programs” (Celani 2003, p. XIV, translated by the authors).

In 2004, Montagú, Pimentel and Groisman published *Cultura Digital: comunicación y sociedad* with prologue by Thomas Maver, presenting the societies’

Figure 2  
Cloud of words  
from books titles  
raised in research



role with a regional view of how technology was applied in architecture and design. In Argentina, Diana Rodríguez published *Hipermedios y modelos virtuales de fragmentos urbanos* and, in Chile, Juan Parra, Rodrigo García and Iván Santelices published the second edition of *Introducción Práctica a la Realidad Virtual*. In 2005, Renata Piazzalunga, Brazilian, published *A virtualização da arquitetura* problematizing the reflections of the virtual in architecture, in its processes of perception and representation.

In 2006, Diana Rodríguez Barros from the Editorial Board from SIGraD published *Experiencia digital: Usos, prácticas y estrategias en talleres de arquitectura y diseño en entornos virtuales*. It concerns of a text with critic reviews of 37 co-authors and regional cases. In Brazil, was also published the book *Cidade digital: infoinclusão social e tecnologia em rede*, by Evandro Prestes Guerreiro. On that same year, a thematic project was started with the permission for Gabriela Celani to translate the book *The Logic of Architecture* (in 2008, look for Mitchell, 2008) and it finished with the publishing of *O processo de projeto em arquitetura: da teoria à tecnologia* (Kowaltowski et al. 2011).

In 2007, Diana Rodríguez, once more presented another contribution by editing the book *URBAMEDIA: base de datos urbanos de áreas centrales, casos de ciudades argentinas y latinoamericanas*, while Rodrigo García, Chilean, published *Animaciones Arquitectónicas*. In 2008, in Chile, Claudio Astudillo and Mariapaz Velázquez (editors) published *Propagaciones. Exploración de nuevos escenarios y campos de investigación tecnológica*.

In the following year, in 2009, Ever Patiño and Elsie Arbeláez published, in Colombia, *Generación y transformación de la forma: Morfología, geometría, naturaleza y experimentación*. The book *Urbanismo paramétrico: parametrizando urbanidade*, by Robson Canuto da Silva, Brazilian, was launched in 2010, presenting a reflection and practical applications of parameterization in urbanism and spatial syntax. In 2012, Pedro Fiori Arantes, in Brazil, published *Arquitetura na era digital-financeira: desenho, canteiro e*

*renda da forma*, which focus on issues on subjectivity and experience in postmodern architecture, electronic drawing board and hybrid construction site.

In 2013, once more on behalf of SIGraDi, the Editorial Committee published *Didáctica Proyectual y Entornos Digitales: prácticas y reflexiones en escuelas Latinoamericanas de Arquitectura y Diseño*. It's a book organized by Diana Rodríguez, Maria Tosello and David Sperling, which is composed of texts written by 51 co-authors and is divided in three sections that gathers experiences of five countries of the region (Argentina, Brazil, Chile, Perú and Venezuela). On this same year, Scheer et al. (2013) in Brazil, published *Modelagem da informação da construção: uma experiência brasileira em BIM*.

In 2016 the book *101 Conceitos de Arquitetura e Urbanismo na Era Digital* was published, edited by Frederico Braida et al. (2016), with a prologue by Gabriela Celani, which brought together 46 co-authors working in Brazil and Portugal with the aim of presenting some of the most relevant words and concepts of the contemporary universe of digital architecture. Aristóteles Lobo de Magalhães Cordeiro and Germana Costa Rocha organized, in 2017, in Brazil, the book *Modelos em arquitetura: concepção e documentação*.

In 2018 the book *Arquitetura contemporânea e automação: prática e reflexão* was launched, edited by Gabriela Celani and Maycon Sedrez, emphasizing aspects such as digital manufacturing, generative systems and evolutionary algorithms. The book brings texts from 13 authors and 14 interviewees exponents with of digital architecture in Brazil and abroad.

In addition to these books that bring a more consistent theoretical discussion, there are also some booklets published in a more independent way by research laboratories, such as the books by Muñoz (2010, 2011, 2013 and 2016), Celani (2013), *NOMADS - Núcleo de Estudos de Habitares Híbridos* (2013) and Passaro et al. (2017). These books and exhibition catalogs, also contribute to the establishment of the reflection panorama on the topics present in Latin

American scenario of computing architecture.

Among the exhibition catalogs, the Homo Faber exhibitions stand out. In 2015, Latin America was for the first time the headquarters of CAAD Futures and, on that occasion, the catalog *Homo Faber: Digital Fabrication in Latin America* (Sperling and Herrera 2015), which was a result from the exhibition that sought to map the development of Fab Labs in Latin America. Participating in the exhibition were 24 Fab Labs from Argentina, Colombia, Brasil, Chile, Uruguay and Perú. In 2018, on the occasion of the XXII SIGraDi Conference, it was published the catalog *Homo Faber 2.0: Politics of Digital in Latin America*, edited by Scheeren, Herrera and Sperling, gathering 37 projects from Mexico, Costa Rica, El Salvador, Colombia, Perú, Brazil, Chile, Argentina and Uruguay. On the same year, within the context of ACADIA 2018, the catalog of the exhibition *Digital Craft in Semi-*

*peripheral Nations*, (Anzalone et al. 2018), was published based on three criteria: Material Systems, Labor Culture and Socio-political opportunities in order to explore the exchange between the technology of the digital and the artisan of the handmade, with projects from Brazil, México, Guatemala and Argentina.

In Table 3, the books are listed next to the topics used in this study. As it can be noticed, there is a greater concentration of publications that approach the *personal fabrication* (15), with a significant recurrence after 2011, while the Fourth Industrial Revolution's themes themselves have not reached the publications in the form of a book yet. Concerning the words present in the titles, those are highlighted by the occurrence: *digital* [digital] (9), *arquitectura* [architecture] (8), *diseño* [design] (6), *arquitectura* [architecture] (5) e *urbanismo* [urbanism] (3). Figure 2 shows

Topics	Type of reference	Authors	Year	2002	2003	2003	2004	2004	2004	2005	2006	2007	2007	2008	2009	2010	2010	2011	2011	2012	2013	2013	2013	2013	2013	2013	2014	2015	2016	2016	2017	2018	2018	2018
				2002	2003	2003	2004	2004	2005	2006	2007	2007	2008	2009	2010	2010	2011	2011	2012	2013	2013	2013	2013	2013	2013	2014	2015	2016	2016	2017	2018	2018	2018	
				Book	Catalog	Book	Catalog	Book	Catalog	Book	Catalog	Book	Catalog	Book	Catalog	Book	Catalog	Book	Catalog	Book	Catalog	Book	Catalog	Book	Catalog	Book	Catalog	Book	Catalog	Book	Catalog	Book	Catalog	Book
Design Methods																																		
Knowledge Systems																																		
Computing Theory																																		
Future																																		
CAAD Theory																																		
Computer Literacy																																		
Business Applications																																		
Programming																																		
General Computer Graphics																																		
CAD Management and Practice																																		
2D Modeling Applications																																		
3D Modeling Applications																																		
Hypermedia																																		
Animation																																		
Communication																																		
World Wide Web																																		
Distributed Computing																																		
Creative Industries and art																																		
Realtime navigation																																		
BIM																																		
Robotics																																		
Personal Fabrication																																		
Additive Manufacturing																																		
Artificial Intelligence																																		
Big Data																																		
Cloud Computing																																		
Blockchain																																		
Nanotechnology																																		
Internet of Things																																		

Table 3  
Computing  
Architecture in  
Latin America  
books in the 21st  
century



the word cloud of the titles in their respective languages, excluding prepositions and articles.

As it can be verified, although the publication of books about this thematic is scarce in Latin America, the big picture analyzed reveals the context in which the discussion on digital technologies in the field of Architecture has taken place in this region. It also might be underlined that, from a bibliographical references analysis, the Latin American authors are in permanent dialogue with the North American and European bibliography, from which they manage to introduce their countries in the discussions carried out in the digital and globalized world scenario, strongly influenced by the Fourth Industrial Revolution.

## FINAL CONSIDERATIONS

As it was shown, this paper enlightens the Latin American intellectual production recorded in the books published in the first years of this new millennium, revealing authors and ways of thinking in Architecture influenced by digital technologies.

The 37th eCAADe and the XXIII SIGraDi Conference coincide in a congress around the Architecture in the Age of the Fourth Industrial Revolution, as a context that reflects the future of technology in the education and practice of Architecture. Therefore, it becomes pertinent and timely, once again as it was in 1999, to review the bibliographic production developed in the first two decades of the 21st Century, in order to map the academic discussions on digital technologies carried out in Latin America.

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