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Co-creating together: Ibero-American emergent collaborations in architecture and digital manufacture

Cocriação: colaborações emergentes ibero-americanas em arquitetura e manufatura digital

Cocreación: Colaboraciones iberoamericanas emergentes en arquitectura y en fabricación digital

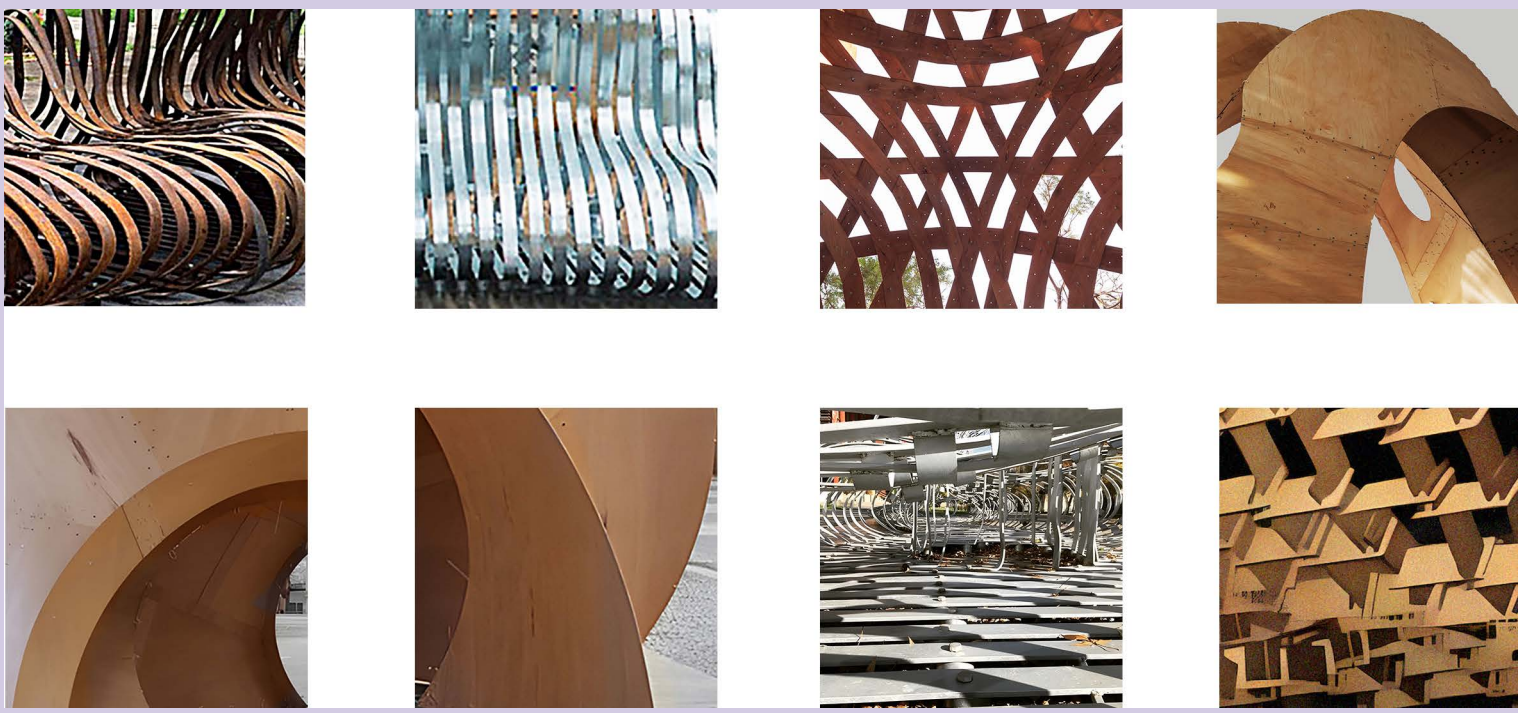

Figure 0 Geometric pattern maps generated by parametric design and digital fabrication corresponding to cases analysed in the article. Source: Mauro Chiarella 2022.

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RESUMO

As novas tecnologias de design e fabricação digital difundidas com a globalização, potenciam ferramentas e processos inovadores para a arquitetura. Estas novas tecnologias abrem diferentes oportunidades profissionais, forjando relações alternativas com a sociedade, especialmente em gerações e países emergentes. Este artigo pretende refletir sobre estas novas experiências colaborativas, entre universidades ibero-americanas, contando com o uso intensivo de tecnologias digitais na arquitetura. Para superar as lacunas tecnológicas, descrevemos os esforços colaborativos para produzir construções na escala real, mediante a colaboração em rede, que resulta na hibridização dessas "novas mídias" adaptadas aos seus contextos locais e culturais. Estas iniciativas surgem da tentativa de superar a escassez de recursos das Universidades locais e seus processos institucionais rígidos. Além disso, anseiam promover a conectividade global junto das novas gerações, por meio de ações informais e coletivas que rompem com o ensino tradicional, aplicando técnicas avançadas em processos criativos coletivos. Estas experiências revelam uma autoria arquitetônica distribuída entre todos os participantes que colaboram na conceituação, programação, gestão e execução do projeto, com diversas práticas híbridas e uma poderosa sinergia coletiva; que também resultam em novas propostas ampliadas que desdobram novas relações com o meio ambiente e a comunidade. Assim, essas ações tendem por si mesmas a integrar e projetar novos horizontes na colaboração arquitetônica. Este artigo tem como objetivo mapear essas ações espácio-temporais em arquiteturas do sul global (Santos 2014).

Palavras-chave: Cocriação, Fabricação Digital, Sul Global, Superação Criativa.

ABSTRACT

Innovative technologies for digital design and manufacture have spread with globalization, providing improved working tools and processes for architecture. These technologies open up different professional opportunities, forging alternative relations with society, especially for new generations and emerging countries. This article reflects on novel collaborative experiences between Ibero-American Universities, accounting for the intensive use of digital technologies in architecture. To bridge technological gaps, the authors describe collaborative efforts to produce full-size constructions, using networking, which results in a hybridization of these "new media" adapted to local and cultural contexts. These initiatives arise from an attempt to overcome the lack of resources at local Universities and their rigid institutional processes, along with their concerns about promoting global connectivity for new generations, leading to informal and collective actions that break with traditional teaching, applying advanced techniques in unseen collective and creative processes. These experiences reveal an architectural work distributed among all the participants that collaborate in the conceptualization, programming, management, and execution of the design, with diverse hybrid practices, and a powerful collective synergy. This also results in new expanded proposals that unfold new relationships with the environment and the community. Thus, these actions tend, by themselves, to integrate and project new horizons in architectural collaboration. This article aims at mapping these spatial-temporal actions in Architecture from the global south (Santos 2014).

Keywords: Co-creation; Digital Manufacture; Global South; Creative Problem-solving

RESUMEN

Las tecnologías innovadoras disponibles para el diseño y la fabricación digital se han difundido con la globalización, entregando mejores herramientas y procesos para la arquitectura. Estas tecnologías abren diferentes oportunidades profesionales, creando relaciones alternativas con la sociedad, especialmente para las nuevas generaciones y para los países en vías de desarrollo.
La intención de este artículo es intentar reflexionar sobre experiencias colaborativas innovadoras entre las universidades iberoamericanas, dando cuenta del uso intensivo de tecnologías digitales en la arquitectura. Para cerrar las brechas tecnológicas, se describen esfuerzos colaborativos para producir construcciones de tamaño real, usando la colaboración en red, que resulta en una hibridación de estos "nuevos medios", adaptados a los contextos locales y culturales. Estas iniciativas surgen de un intento por superar la falta de recursos de las universidades locales y sus rígidos procesos institucionales, junto con sus preocupaciones sobre la promoción de la conectividad global para las nuevas generaciones, lo que lleva a acciones informales y colectivas que rompen el molde de la enseñanza tradicional, aplicando técnicas avanzadas a procesos creativos colectivos. Estas experiencias revelan un trabajo arquitectónico entre todos los participantes que colaboran en la conceptualización, programación, manejo y ejecución del diseño, con diversas prácticas híbridas y una poderosa sinergia colectiva. Esto también resulta en nuevas propuestas expandidas, que resultan en nuevas relaciones con el medioambiente y la comunidad. Así, estas acciones tienden, por sí mismas, a integrar y proyectar nuevos horizontes en la colaboración en la disciplina de la arquitectura. Este artículo busca mapear estas acciones espacio-temporales en la arquitectura del sur global (Santos, 2014)..

Palabras clave: co-creación; fabricación digital; sur global; superación creativa.

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Figure 1 Muro-Pixel and Casa G experiences. First examples of digital design and fabrication collaborations in Ibero-America. Source: Rodrigo García-Alvarado.

INTRODUCTION

The changing conditions, due to the accelerated technological dissemination of digital media, place the same type of concerns at the same time, but in different contexts, with different degrees of industrialization (Kieran and Timberlake, 2004). This change in architectural context was behind the creation of SIGraDi - Sociedad Iberoamericana de Gráfica Digital - in 1997, with a debate that reflects an uneven impact of the fourth industrial revolution, in the Ibero-American context, without the consolidation of previous industrial revolutions (such as serial mass production) in technological and social aspects. In this context, the difficulty to access autonomous funding and dedicated resources to update and produce knowledge at an academic level, through project and construction practice, poses a challenge to overcome (Monedero, 2003). This challenge encourages dialogue, collaboration, and the exchange of human and technological resources as a way of integrating and sharing knowledge in a context that stretches beyond borders (Davis, 2019). Just as with the ELEA initiatives in 1983, Supersudaca emerged in 2001, and Plataforma Arquitectura (now ArchDaily), in 2008. However, the "SIGraDi" effect took time to expand, and a decade after its creation, the authors of this text, from Chile, Brazil, and Argentina, met, beginning collaboration under this context, with the desire for a collective improvement that continues until today.

This article outlines a brief cartography of a set of collaborations between different countries, institutions, but most of all collectives – co-creating together- that progress both in terms of scientific interest, as well as in friendship among peers, projecting new professional perspectives for architecture and society. This, with the hypothesis, that these experiences evidence a socio-technical dialogue and co-creation procedures, and with the specific objectives of recognizing their characteristics, conditions, and potentialities.

This type of collaboration in Ibero-America, involving design and digital fabrication, was previously addressed in publications such as those by Sperling et al, 2015; Scheeren et al, 2018; and Wallisser et all, 2019. These works record many initiatives and participants, providing a panorama and trends, but without in-depth analysis on

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the resulting artifacts. Moreover, recent reviews like Scheeren and Sperling, 2019; Herrera et al, 2020 and Celani, 2020, show the historical development and diversity of technological emergence in Ibero-America for architectural education, pointing to digital fabrication and implementation models. In addition, Davis, 2019, reveals practical cases that demonstrate the potential of co-creation in architectural education.

METHODOLOGY

The article gathers and describes the co-creation design process using digital media and digital manufacture (as defined by Kolarevic 2003; Stacey, 2004; Gramazio & Kohler, 2008), starting from the experiences in each university and community, but with a special focus on the joint experiences developed collaboratively. The technologies used are 3D-modeling, digital rendering, parametric and generative design, Laser cutting, CNC-machining, and Steel bending. The chronological sequence establishes a relationship between these activities, as well as analysis and discussion of their characteristics, framing both the technological and creative aspects involved, as well as the social and architectural limitations that these tried to overcome. The methodology thus combines operational and institutional descriptions, as well as reflections about their particularities and interrelations. This report is also based on the authors' academic experience, how they were taught and worked, according to disciplinary conventions, and seeks to explore new ways and possibilities of acquiring advanced technologies in other countries, adapting them to expand local abilities adapted to the Ibero-American reality, highlighting a cultural crossroads, and the transformation of professions.

Our cartography focuses on nine experiences, three in each institution with the leadership of each of the three authors (including one carried out jointly by two of them), and a final one that the three authors led jointly. We describe the itinerary of these activities with the technical procedures used following institutional terminology but, fundamentally, reviewing their pedagogical implications. The analysis concludes in three main facets on the disciplinary horizon, which seek to expand upon the projections of these experiences in the face of cultural assumptions.

SHARED EXPERIENCES

The authors met for the first time in 2009, at the SIGraDi Conference in Sao Paulo, Brazil, where they had the opportunity to talk and share experiences. This congress coincided with the introduction of visual programming, associated with digital fabrication, in a course, taught by Gonçalo Henriques and Ernesto Bueno. This three-day course introduced the South American participants to programming and began a series of experiences that would intensify with the congress. Mauro Chiarella and Rodrigo Alvarado worked together on a postgraduate program abroad and began to think about how to apply the experiments back in their countries. The second author migrated from

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Europe to Brazil and had the challenge to adapt his knowledge in a new context. The three authors collaborated in 2011, in Santa Fe, Argentina, working with new technologies and design approaches with local students. Since then, their collaborations have benefited from remote communication media, which the authors began to use more often to work remotely. On not being activities with predetermined dates or actions, the collaboration took place with spontaneous temporary exchanges, remotely exchanging experiences, within a framework of the congresses where they met (among these SIGraDi São Paulo, Fortaleza, Florianópolis), and with some teacher exchange periods (Chile> Brazil 2010, Argentina> Chile 2013, Chile + Argentina> Brazil 2020).

Muro-pixel (Pixel-wall) and Casa G (House G) (2008, 2010)

2008 and 2010 saw the first collaboration on digital fabrication and parametric design. This was the "Muro Pixel" at Bio-Bio University in Chile in 2008, with the arrival of the first laser cutter that allowed cutting and assembling plates, forming variable envelopes, such as temporary installations in the university grounds **(Figure 1, left).** Through the collaboration of a Chilean and Brazilian researcher, and developing a parametric design that allows them to assemble different versions. The experience is disseminated online, and several Ibero-American countries replicate it, as an introductory exercise in parametric design and digital manufacture, using different materials and manufacture strategies considering their local contexts. This led to a new experience in 2010 at Universidade Federal do Rio Grande de Sul, in Brazil, with the Chilean researcher and local faculties collaborating in the installation of a CNC machine at the Faculty of Architecture to show its building potentialities, developing a housing system with embedded panels, called "Casa G". This focused on self-managed social housing (Garcia Alvarado, Turkienicz, 2010), building a full-scale basic prototype **(Figure 1, right)**. The experience was based on two intensive workshops, where Brazilian, Argentinian, and Chilean students participated together, developing a generative urban program, scale models, and a real-size housing prototype with the support of a local industry, which was then exhibited at construction fairs.

Bancapar (2012-14)

Bancapar, which won the design prize, Clap Platinum, in 2015, is a parametrically designed bench, conceived as an object of Public Art. The project was self-proposed for the front of the Industrial Engineering Faculty of the Bio-Bio University in Chile, and required a joint initiative, with shared management and authorship, involving interdisciplinary work between students and professors of the university and a teaching research group from the National University of Litoral, Argentina. This collaboration resulted in an unprecedented project that merged regional art, technology, and manufacture in the region. The experience left with questions when compared with the traditional ways of doing

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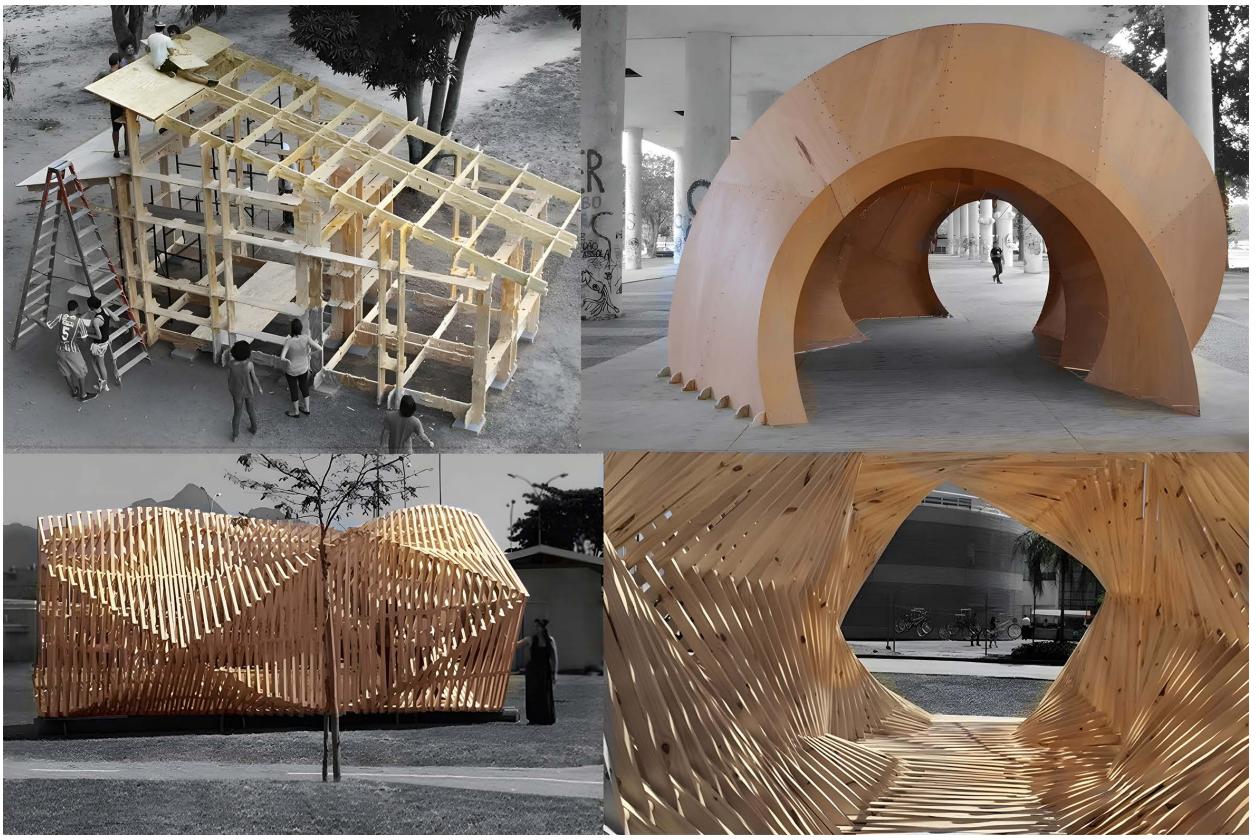

Figure 2 Wiki-House, Helicoidal Surfaces, Tornado Pavilion (2014, 2015, 2017), Source LAMO archive.

and thinking in project disciplines (Chiarella and Garcia-Alvarado 2015). In Bancapar, the use of parametric formulas has a prefiguration characterized by Collaborative Design between teams from two universities and Ibero-American countries, where the concept of Author(s) and their work was broken down due to the manipulation of an initial dynamic formula, regardless of a single, predefined formal result. The emergence of new domains of collective creativity led to the use of the initial designers' own inventiveness to expand and enhance the imagination of the other subjects involved in the process (Chiarella et all, 2020). Parametric formulas acted as tools for universal language communication, enhancing that creativity, allowing the initial designer to lose control of the design process while maintaining shared objectives and guidelines **(Figure 2).**

Wiki- House (2014), Helicoidal Surfaces (2015), Tornado Pavilion (2017)

In Brazil, digital fabrication experiences began at Universidade Federal do Rio de Janeiro, perhaps with a subliminal influence (Casa-G). Local experiences began with the development of construction systems in the final architecture graduation project by Clarice Rohde, and a collective effort to produce the first Wiki-House in Ibero-America in 2014 (Passaro and Rohde 2016), as a prototype for regular housing **(Figure 2, top left).** In 2014, Gonçalo Henriques migrated from

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Portugal to Brazil to join efforts to apply digital integration, regarding computational design and manufacture, to expand local expertise to the local Laboratory – LAMO, and to the University. At that time, a paradigm shift began for the students, combining architectural practice with digital media and manufacture. A further project using Helicoidal surfaces, namely the Butterfly Galleries Pavilion (2015), was installed in the university courtyard **(Figure 2 top right)**, with a Spanish architect, Andres Pastor -Invited by Maria Angela Dias, involving local professors, students, and LAMO team for the digital fabrication and construction support - who later went to Argentina and Chile, to build in collaboration with the other authors, 3 other pavilions using digital fabrication, namely, HS-BG 2015, SSFS 2015, Bio-dune 2018 (Pastor,-Alvarado 2019). Since then, the local LAMO laboratory organizes a series of annual activities, such as seminars and workshops, to link theory and practice, with students from Argentina taking part in 2017 (Henriques, Bueno, Lenz, & Sardenberg 2019). The construction of the Tornado Pavilion in 2017 marked a period of collaboration between local groups, resonating remotely with the others (Passaro, Henriques, Sansão, Tebaldi, 2019), also as a full-scale construction **(Figure 2. down)**. In 2011, the Argentinian professor Mauro Chiarella continued his postdoctoral studies in Chile, and visited Porto, and thus, the intersections of knowledge, cultures, and mixed experiences began to intensify.

Pavilions SSFS (2015) and Flexoinform (2019)

The SSFS "Same Slope - Folded Surface" Pavilion was the winner of Silver Emporia 2016 for Innovative Ephemeral Architecture, selected for its ecological, reusable, and recyclable stand. This low-cost canopy is a self-supporting 8 x 8 m skin made of a single 5 mm layer of wood **(Figure 3. left)**. The use of algorithms and parametric design enabled unfolding a complex surface into a planar set of flat parts cut with CAD-CAM technology. The assembled parts are like a great puzzle, using cold bending to acquire shape and final strength. It was ecological, reusable, recyclable, and sustainable. The geometric shape, materials, and its tension-cable mounting system enable reuse of the installation, which rests on the ground without perforations, respecting the existing pavement of the public place where the group installed it. The SSFS experience verified the use of Collaborative Design, where the strategic use of developable equal slope geometries nourished the initial design (University of Seville) to achieve the manufacture and assembly (FADU-UNL) of a temporary folded pavilion. Andres Pastor and the FabLab of the Spanish University, started the design process, and then students from Master's Degree in Argentina tested two of its modules. The team from Seville built the final pavilion completely in Seville for the European Night of Researchers in September 2015.

The recently built Pavilion has the goal of using the active bending behaviour as a design tool, having as reference the

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Figure 3 SSFS (Same Slope - Folded Surface) Pavilion (2015) and Flexoinform (2019). Source Chiarella, RILAB UNL.

geometry of structures based on the elastic deformation of initially flat elements **(Figure 3 right)**. Active Flexion (AF) is defined as the instrumentalization of one of the –"new"- capabilities inscribed in Digital Materiality (DM) from a Performance-Based Parametric Design (PBPD) Approach -and not as a predefined structural typology-. The methodological proposal uses analogue-digital "form-finding", as a PBED (Performance Based Ecological Design). In instrumental terms, parametric modelling -of algorithmic mathematical logic-, digital simulation -for the prediction of physical behaviour-, computational numerical calculation evaluation, and finally, CNC manufacture, were used to combine the different ideation, simulation, analysis, and manufacturing instances to a continuous logic that re-informs the model from the data obtained at each moment. In this sense, the empirical-analytical experimentation is digitally amplified through Integrative Processes (IP) that constitute a new procedure and approach to geometry, to rethink the ideation processes and open multiple possibilities to emancipate -from the modern paradigm- the material condition in architecture. Flexoinform looks to produce an approach to DM in architecture as an alternative proposal that challenges "conventional" design and construction methods in architecture, by developing a parametric design algorithm aimed at optimizing the operational relationship between geometry, material, and structure in curved laminar envelopes to Active Flexion (AF).

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Mutable Surfaces (2020)

The Mutable Surfaces workshop took place in Rio de Janeiro from 9th to 15th February 2020. This workshop was jointly organized by 4 universities, from 4 countries, Federal University of Rio de Janeiro (Brazil), Bio-Bio University (Chile), National University of the Litoral (Argentina), and the University de Costa Rica (Costa Rica) with students and tutors from 3 countries, a mixed Portuguese-Spanish language, with most participants being "digital natives", and teachers having classical training, but digital enthusiasts. To organize the workshop, the organizers applied for state funds but did not get support. To make the workshop possible, a shorter version was prepared, seeking mutual assistance between local and external participants, seeking to share the research and knowledge of the participating universities, limiting the physical development to an intermediate scale, leaving the initial goal of a 1:1 pavilion for future development. The participants were undergraduate, master's students, and professors from the Faculty of Architecture FAU-UFRJ (8 participants), Engineering COPPE-UFRJ (2 participants), Fine Arts EBA-UFRJ (2 participants), Bio-Bio University (6 participants), Costa Rica University (6 participants).

The authors organized a 3-day training schedule, with lectures and tutorials on visual programming in the morning, and practical exercises in the afternoon, followed by three days in the applied project. This hybrid teaching and project model followed previous LAMO experiences, but now in an extended version. Andres Passaro gave the welcome speech and the opening lecture (day zero). On the first day, Rodrigo Alvarado and Carolina Vargas gave lectures, followed by practical experiences in the afternoon with Alexis Salinas and Paula Ignacio Ulloa. The second day saw lectures by Mauro Chiarella and Rebeca Duque Estrada and in the afternoon continued with physical-digital form-finding with Pedro Engel, Adriane Ossaille, remotely supported by Luciana Gronda and Martin Veizaga from Argentina. Finally, on the third day, Gonçalo Henriques and Juarez introduced participants to gridshells and pre-stressed structures. In the afternoon, the participants designed gridshell structures with form-finding methods and structural analysis.

After three days of theoretical and practical training, we recommended the students to work in groups of three, with participants from different countries, resulting in seven groups designing proposals for the theme introduced beforehand. After a brainstorming and rapid development session, each group presented its project. From all the projects, all the participants jointly selected the four with the most potential to combine projects with complementary affinities and ideas. Finally, in the last two days, the groups conceptually developed four projects in-depth using form-finding models on an intermediate scale, ending with presentations of each group and an intensive dialog of experiences and projections.

In this workshop group, collaboration allowed overcoming financial difficulties and to achieve a joint project, exchanging human, technical,

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Year	Name	Technologies	Institutions	Countries
2009	SIGraDI SP Workshops	Parametric Design and CNC machines	Mackenzie	Portugal, Chile, Argentina
2009-10	Muro-Pixel	Parametric Design and Laser-cutter	UBB-UNISINOS	Chile & Brazil
2010	Casa-G	Parametric Design and CNC machines	UBB-UFRGS	Chile & Brazil
2011	Santa Fe Workshop	Parametric Design and Laser-cutter	FDU-UNL	Argentina, Chile & Portugal
2012-2014	Bancapar	Parametric Design and Steel bending	UBB-UNL	Chile & Argentina
2014	Wiki-House	Parametric Design and CNC machines	UFRJ	Brazil
2015	SSFS	Parametric Design and CNC machines	UNL-US	Argentina & Spain
2015	Helicoidal Surfaces	Parametric Design and CNC machines	UFRJ-US	Brazil & Spain
2017	Tornado Pavilion	Parametric Design and CNC machines	UFRJ	Brazil
2018	Bio-Dune Pavilion	Parametric Design and CNC machines	UBB	Chile & Spain
2019	FlexoInform	Parametric Design and CNC machines	UNL	Argentina
2020	Workshop Mutable Surfaces	Parametric Design and Laser-cutter	UFRJ	Brazil, Chile, Argentina & Costa Rica

Table 1 Summary of the experiences analysed

and cultural knowledge. The development of a project introducing three themes, revealed the need for greater coordination beforehand, as in this case, there was a short preparation time. One of the biggest challenges was working with participants with different skills and cultures, in a short period; and although it is felt that they made interesting progress, further development would require more time for the groups to work together. In this sense, the idea to develop the project for an intermediate scale was suitable, although the group is always looking for the opportunity to build something together at full-scale. The authors would like to say thank you to all those who participated in person and the others who took part remotely in this Ibero-American task force.

Table 1. These experiences show a growing and diverse chronological sequence **(Table 1),** but share several similar conditions (in addition to the same academics having participated in several of them). Firstly, it constitutes progress in the use of new digital design and manufacturing technologies for architecture, which university curricula usually do not accept, but which students, professionals, and researchers consider relevant to get to know. Secondly, these correspond to circumstantial activities, to collective initiatives self-managed by the participants, sharing knowledge through practical activities, instead of teaching processes with foreign guests. Thus, making an early adaptation of technologies,

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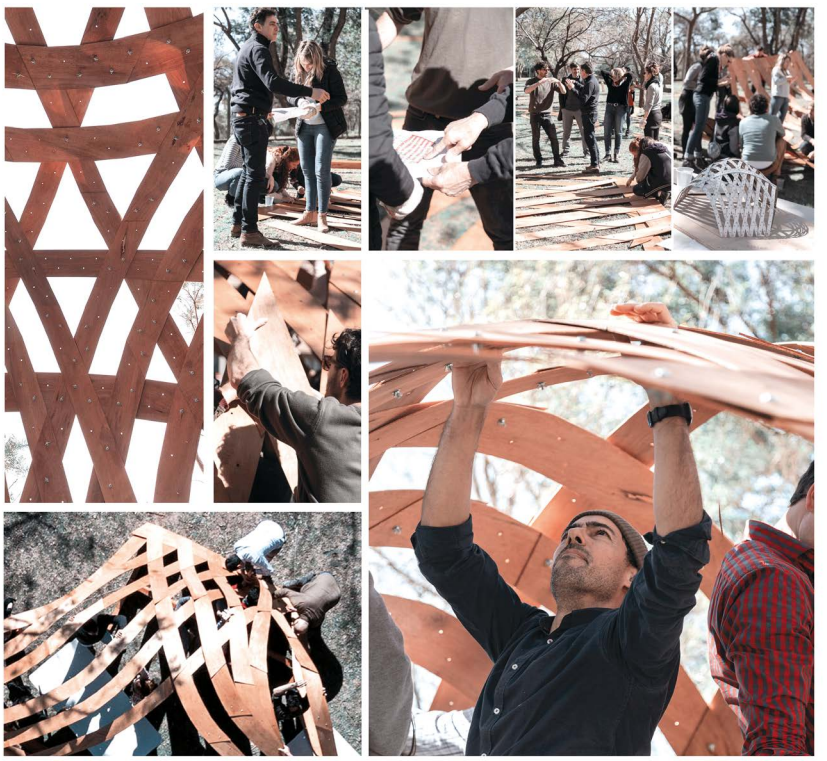

Figura 4 Architecture and digital fabrication. Example of the Methodology and teamwork experiences, with international collaboration. Source Chiarella RILAB UNL.

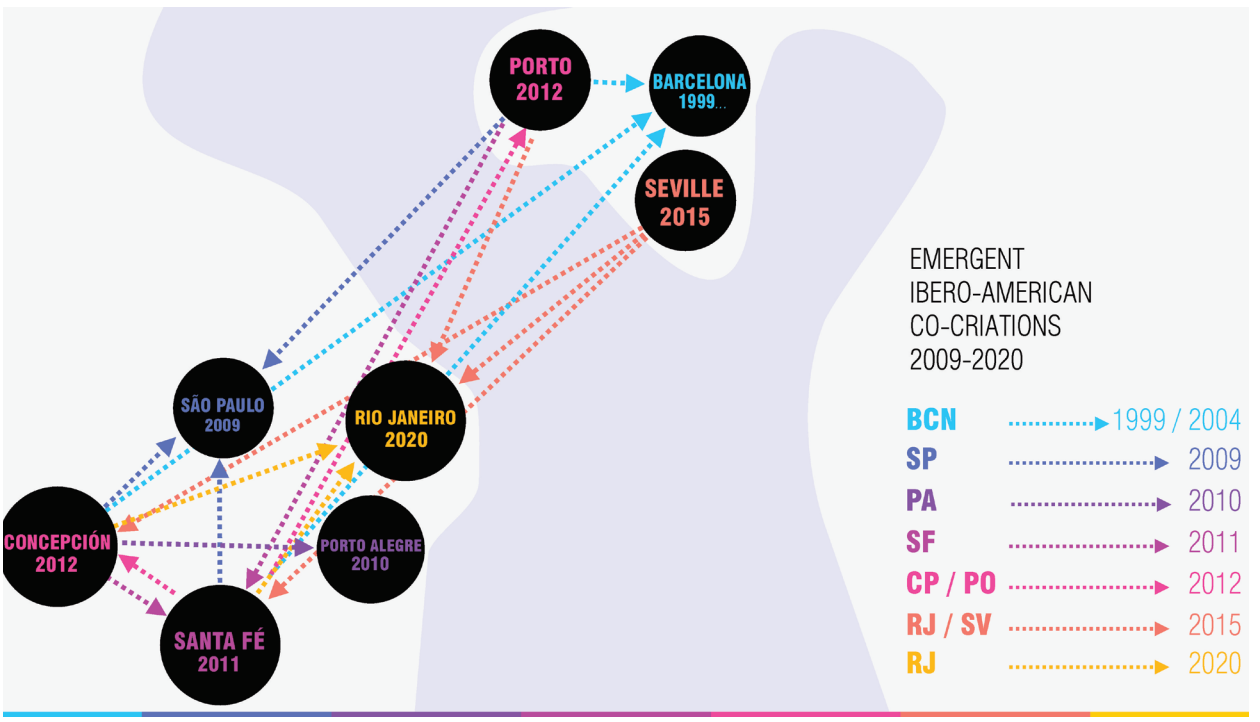

Figura 5 Network diagram - Graph of the interrelations and personal exchange of design and technology between cities/ countries/universities. Source: Gonçalo Castro Henriques 2022.

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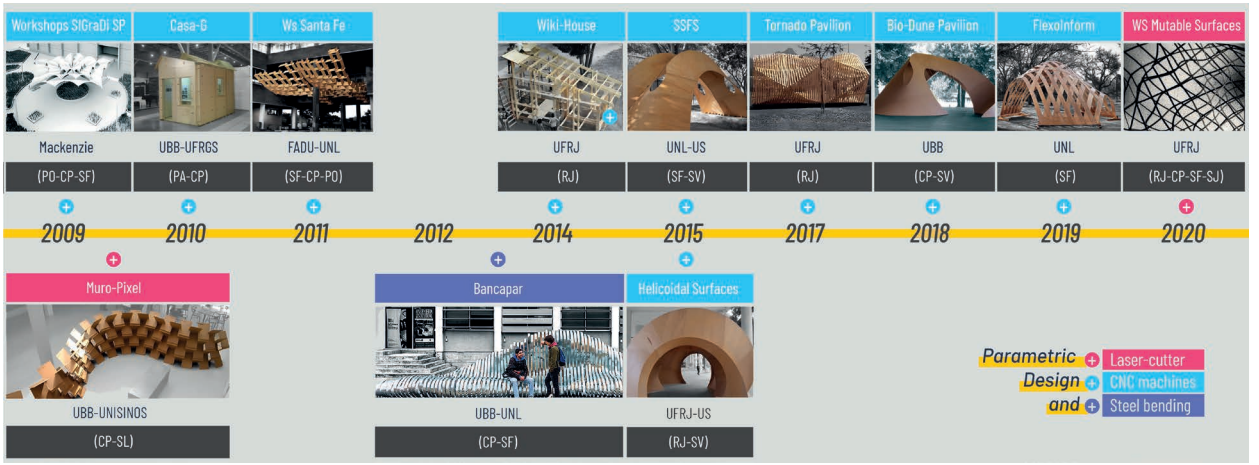

Figura 6 Time-line regarding the projects and the technologies developed through the network collaboration. Source Mauro Chiarella 2022.

and developing a collective physical production, usually testing real-size project and construction possibilities. Third, these experiences also seek new challenges in architecture, social needs that are little covered by traditional construction, in interactive processes, far from the usual work hierarchy in the industry, and even from the distinction between students and teachers. All the participants propose designs and explore their execution together, organizing themselves to solve the difficulties that arise, raising collectively manufactured examples, but rather in an experience of new ways of producing habitable spaces.

The results of these collaborations are mainly the students learning about new technologies, but also the development of new design methodologies and the experience of teamwork, with international collaboration and a broader vision of professional work **(Figure 4).** One can see this evidenced in the group work, the focus of the proposals towards creative contributions with a disciplinary and social impact, and the intense reflection on their role in architecture. In addition to the continuity of these activities, which must address multiple difficulties of organization and implementation, while generating new initiatives and interactions, showing a map of actions in different geographical places and institutions **(Figure 5)**, with an incessant crossing of participants, methodologies, techniques, and study topics **(Figure 6)**. We apply technological tools with a renewed cultural vision regarding different social contexts, which retrofits the professional training.

CONCLUSIONS

This article makes progress in the spatial-temporal cartography of collaborative design and manufacture experiences in Ibero-America. Similar cartographies have been collected in Sperling et al, 2015; Henriques 2017, Scheeren et al, 2018; Chiarella, Bruscato, Henriques & Tortul, 2018; Wallisser 2019. The authors reflect on transitory flows in the digital context of university institutions that usually lack the capabilities to use new technologies. This has sparked collaborative initiatives generally characterized by the following features:

a) Collective authorship and execution, where the role of the designer, of the builder, and of the workers are broken down. All participate in different tasks that collaborate in the design and realization of the models, and usually a full-scale construction.

b) Hybridization of technologies; the use of open-source software, self-learning among peers, global communication, crowd-founding, and concentration of intensive actions over time, with the combination of local materials and state-of-the-art equipment, often addressing the solution of technical difficulties with manual processes, demonstrating a collective synergy.

c) Development of new social solutions; approach to new forms and architectural expressions, proposals for public space and open urban functions, with a distribution of artistic creation, especially suggesting alternatives of temporary or social living, artistic interventions in co-creation, or with neighbours' participation.

These socio-technical characteristics show a learning agenda of new capabilities and cultural commitment with the territory, across all the initiatives and participants in the activities, impelling a particular approach to update the education and vision of architects, as well providing new insights for global knowledge. The properties that emerge in these initiatives reflect a culture of community work and a renewed social vision, supported by new media, but also by open and innovative concepts (Znoinska and Dumitrescu, 2021; Doyle and Senske, 2018). Thus proposing, new modes of architectural collaboration for contemporary challenges.

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