SIGraDi 2022
Critical Appropriations

Proceedings of the XXVI Conference of the Iberoamerican Society of Digital Graphics (SIGraDi) 2022

7-11 November, 2022
School of Architecture

EDITORIAL UPC
Universidad Peruana de Ciencias Aplicadas

Pablo C. Herrera
ORCID: 0000-0001-8535-2029

Cristina Dreifuss Serrano
ORCID: 0000-0001-6540-3167

Luisa Fernanda Arris Calderón
ORCID: 0000-0003-4561-5992

Paula Z. Gómez
ORCID: 0000-0003-3455-5445

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Edición:	Pablo C. Herrera, Cristina Dreifuss-Serrano, Luisa Fernanda Arris Calderón y Paula Gómez Z.
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Editado por:
Universidad Peruana de Ciencias Aplicadas S.A.C.
Av. Alonso de Molina 1611, Lima 33 (Perú)
Teléfono: 313-3333
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Edited by

Pablo C. Herrera
Cristina Dreifuss-Serrano
Luisa Fernanda Arris Calderón
Paula Gómez Zamora

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Welcome to SIGraDi 2022

Miguel Cruchaga Belaúnde, Dean
Universidad Peruana de Ciencias Aplicadas, Perú

17 years ago, we had the privilege of hosting a SIGraDi Conference. Both institutions were going through our founding years, and we had the privilege of sharing experiences with those who consolidated, for Architecture and Urbanism, the enormous contribution of new technologies that would take the development of graphic representation to great levels of improvement.

During those days, our campus was full of dynamism and students of all careers were equally interested in the themes and the promises of revitalization and opening of new horizons to the university world.

We promised to help them enter the Andean territory, and to spread their great value in the Subcontinent, as they had been doing and promoting with great success. Our relationship has grown stronger and our interest in the subject has kept us in touch.

We await the start of SIGraDi 2022 with expectation and enthusiasm. We want to know your progress, what your new goals are and what insights the fields of research and teaching offer us.

Welcome SIGraDi!

Bem-vindo a SIGraDi 2022

Miguel Cruchaga Belaúnde, Dean
Universidad Peruana de Ciencias Aplicadas, Perú

Durante 17 anos tivemos o privilégio de sediar um Congresso SIGraDi. Ambas as instituições atravessavam os nossos anos de fundação e tivemos o privilégio de partilhar experiências com quem consolidou, para a Arquitetura e o Urbanismo, o enorme contributo das novas tecnologias que levariam o desenvolvimento da representação gráfica a grandes níveis de melhoria.

Durante esses dias, nosso campus estava cheio de dinamismo e estudantes de todas as carreiras estavam igualmente interessados nos temas e nas promessas de revitalização e abertura de novos horizontes para o mundo universitário.

Prometemos ajudá-los a entrar no território andino e difundir seu grande valor no Subcontinente, como vinham fazendo e promovendo com grande sucesso. Nosso relacionamento se fortaleceu e nosso interesse pelo assunto nos manteve em contato.

Aguardamos o início do SIGraDi 2022 com expectativa e entusiasmo. Queremos conhecer seu progresso, quais são seus novos objetivos e quais insights os campos de pesquisa e ensino oferecem a você.
Bem-vindo SIGraDi!

Bienvenidos a SIGraDi 2022

Miguel Cruchaga Belaúnde, Dean
Universidad Peruana de Ciencias Aplicadas, Perú

Hace 17 años tuvimos el privilegio de ser anfitriones de un Congreso de SIGraDi. Ambas instituciones recorríamos nuestros años fundacionales y tuvimos el honor de compartir experiencias con quienes consolidaban, para la arquitectura y el urbanismo, el enorme aporte de las nuevas tecnologías que llevarían el desarrollo de la representación gráfica a grandes niveles de superación.

Durante esos días, nuestro campus estuvo lleno de dinamismo, y los estudiantes de todas las carreras se interesaron por igual en los temas y las promesas de revitalización y apertura de nuevos horizontes al mundo universitario.

Nos comprometimos a ayudarlos a introducirse en el territorio andino y a extender su gran valor en el subcontinente, tal como lo venían haciendo e impulsando con mucho éxito. Nuestra vinculación ha crecido cada vez más y nuestro interés por el tema nos ha mantenido en contacto.

Aguardamos el inicio de SIGraDi 2022 con expectativa e ilusión. Queremos conocer sus avances, saber cuáles son sus nuevas metas y qué intuiciones les suscitan los terrenos de la investigación y la enseñanza.

¡Bienvenido SIGraDi!

Preface

Pablo C. Herrera, Chair SIGraDi 2022
UPC, Perú

The School of Architecture of the UPC was created in 1994. In 1999 it participated in the initiative of the Virtual Workshop of the Americas directed by architects Guillermo Vásquez de Velasco and Antonieta Angulo from Texas A&M University. Thanks to Guillermo's interest in promoting SIGraDi, we began to participate in the congresses in 2003 in Rosario, Argentina. Since then and consecutively, 20 years have passed, and UPC has hosted the Congress of the Ibero-American Society of Digital Graphics in its IX version, in 2005, and this 2022 its XXVI edition.

Participating in the gestation process of different initiatives that SIGraDi has promoted allowed us to ensure technology implementation paths in our School of Architecture. From mandatory courses on BIM and digital fabrication starting at the fourth semester, to elective courses on photorealistic visualization, audio visual storytelling, infographics, and computational design. Precisely, living the differences of adopting computerized technologies and the evolution of the first computer workshops that we promoted in the region since 2006, together with the Homo Faber exhibitions on digital fabrication since 2015 and the edition of the book for the twenty-five years of SIGraDi, continues to motivate us to grow. This within a community and participatory culture that assimilates disruption and prepares us to coexist and appropriate technologies, understood as allies of our processes, which emerge from the context of exploration and curiosity to solve real problems.

Critical Appropriations, the theme that we promote at SIGraDi 2022, becomes a call to reflection on the origin and process of the actions of a transformative design and its possibilities, from the role of technology and its effect on the social, cultural, material, and educational spheres.

SIGraDi 2022. Critical Appropriations was organized into 7 topics and 30 subtopics: Programming Cultures (Agent-Based Systems, Data Analytics, Generative Design, Machine Learning, Parametric Analysis, Predictive Modeling and Shape Grammars); Manufacturing & Industry 4.0 (Robotics, Digital Fabrication, Internet of Things, Blockchain and Decision Making); Interactions & Collaborations (User Experience, Mixed Realities, Virtual Reality, Codesign, BIM Adoption and Interdisciplinary Design); Special Topics (Digital Heritage, Inclusive Design, Media Art and COVID-19); Life Long Learning and Digital Education (Hybrid Education and Online Learning);

Design, Nature and Ecosystems (Smart Cities & Environments, Sustainable Design, Building Performance, Bio-Inspired Design and Living Things).

These topics prompted the generosity of 20 instructors and their twelve connected workshops from 10 countries in a call for 170 participants, which take place between November 7 and 8.

Between November 9 and 11, Philip F. Yuan (China), Shelby Elizabeth Doyle, Daniel Cardoso, Sandra Manninger, Matias del Campo (USA), Felipe Ferrer and Benito Juárez (Peru) present their appropriations in Metaverse, Robotic Fabrication, Computational Feminism, Other Computations, Regenerative Manufacturing, Digital Biology, Neural Networks, Artificial Intelligence, Low-High Tech, and Glocalism.

In these three days, SIGraDi 2022 presents the research of 267 authors from Argentina (4), Brazil (40), Chile (8), China (2), Colombia (5), Costa Rica (1), Denmark (2), Germany (2), Hong Kong (1), Italy (1), Mexico (4), Peru (1), Portugal (4), Singapore (1), Taiwan (1), Turkey (5), United Kingdom (7), USA (13) and Uruguay (2). 19 countries with works in English (46), Portuguese (35) and Spanish (23) that make up this volume of 104 articles in 24 sessions organized by language.

SIGraDi 2022 shares different appropriations as triggers for dialogue with others, from which new reinterpretations will continue to create a digital culture that promotes its own agendas towards other geographies.

This XXVI SIGraDi 2022 Conference is inspired by the intensity of everyday life and society, with the enjoyment and appropriation of technologies in their different forms.

From Lima, Peru, we are immensely grateful to each of the local and international teams that allow us to be here, connected, sharing, and enjoying our appropriations with the hope of meeting in person very soon.

Welcome to SIGraDi 2022.

Prefacio

Pablo C. Herrera, Chair SIGraDi 2022
UPC, Perú

A Faculdade de Arquitetura da Universidade Peruana de Ciências Aplicadas (UPC) foi criada em 1994. Em 1999 participou da iniciativa do Workshop Virtual das Américas dirigido pelos arquitetos Guillermo Vásquez de Velasco e Antonieta Angulo da Texas A&M University. Graças ao interesse de Guillermo em divulgar a SIGraDi, começamos a participar dos congressos em 2003 em Rosário, Argentina. Desde então, e consecutivamente, 20 anos se passaram, e a UPC sediou o SIGraDi em 2005 e agora em 2022, o XXVI Congresso da Sociedade Ibero-Americana de Gráfica Digital.

Participar no processo de gestação das diferentes iniciativas que a SIGraDi tem promovido, permitiu-nos garantir caminhos de implementação da tecnologia na nossa Faculdade de Arquitetura. Desde cursos obrigatórios sobre BIM e fabricação digital do quarto ciclo, até cursos eletivos sobre visualização fotorrealista, narrativa audiovisual, infografia e projeto computacional. Precisamente, vivendo as diferenças da adoção de tecnologias computadorizadas e a evolução dos primeiros workshops de informática que promovemos desde 2006 na região, juntamente com as exposições Homo Faber sobre fabricação digital desde 2015 e a publicação do livro do vigésimo quinto ano da SIGraDi, continua nos motivando a crescer dentro de uma cultura comunitária e de participação. Isso assimila a disrupção e nos prepara para conviver e apropriar-nos das tecnologias, como aliadas de nossos processos, que emergem do contexto de exploração e curiosidade para resolver problemas reais.

Apropriações Críticas, tema que promovemos no SIGraDi 2022, torna-se um chamado à reflexão sobre a origem e o processo das ações de um design transformador e suas possibilidades, a partir do papel da tecnologia e seu efeito no social, cultural, material e educacional.

SIGraDi 2022. Apropriações Críticas foi organizado em 7 tópicos e 30 subtópicos: Programming Cultures (Agent-Based Systems, Data Analytics, Generative Design, Machine Learning, Parametric Analysis, Predictive Modeling e Shape Grammars); Manufacturing & Industry 4.0 (Robotics, Digital Fabrication, Internet of Things, Blockchain e Decision Making); Interactions & Collaborations (User Experience, Mixed Realities, Virtual Reality, Codesign, BIM Adoption e Interdisciplinary Design); Special Topics (Digital Heritage, Inclusive Design, Media Art e COVID-19); Life Long Learning and Digital

Education (Hybrid Education e Online Learning); Design, Nature and Ecosystems (Smart Cities & Environments, Sustainable Design, Building Performance, Bio-Inspired Design e Living Things).

Esses temas motivaram a generosidade de 20 instrutores e seus 12 workshops conectados de 10 países em um chamado para 170 participantes, que acontecerá entre 7 e 8 de novembro.

Entre 9 e 11 de novembro, Philip F. Yuan (China), Shelby Elizabeth Doyle, Daniel Cardoso, Sandra Manninger, Matías del Campo (EUA), Felipe Ferrer e Benito Juárez (Peru) apresentam suas apropriações em Metaverse, Robotic Fabrication, Computational Feminism, Other Computations, Regenerative Manufacturing, Digital Biology, Neural Networks, Artificial Intelligence, Low-High Tech, e Glocalismo.

Nestes três dias, o SIGraDi 2022 apresenta a pesquisa de 267 autores da Argentina (4), Brasil (40), Chile (8), China (2), Colômbia (5), Costa Rica (1), Dinamarca (2), Alemanha (2), Hong Kong (1), Itália (1), México (4), Peru (1), Portugal (4), Cingapura (1), Taiwan (1), Turquia (5), Reino Unido (7), EUA (13) e Uruguai 2). 19 países com trabalhos em inglês (46), português (35) e espanhol (23) que compõem este volume de 104 artigos em 24 sessões organizadas por idioma.

O SIGraDi 2022 compartilha diferentes apropriações como gatilhos para o diálogo com os outros, a partir das quais novas reinterpretações continuarão a criar uma cultura digital que promova suas próprias agendas para outras geografias.

Este XXVI Congresso SIGraDi 2022 é inspirado na intensidade do cotidiano e da sociedade, com a fruição e apropriação das tecnologias em suas diferentes formas.

De Lima, Peru, somos imensamente gratos a cada uma das equipes locais e internacionais que nos permitem estar aqui, conectados, compartilhando e desfrutando de nossas apropriações com a esperança de nos encontrarmos pessoalmente muito em breve.

Bem-vindo ao SIGraDi 2022.

Prefacio

Pablo C. Herrera, Chair SIGraDi 2022
UPC, Perú

La Facultad de Arquitectura de la UPC se creó en 1994. En 1999, participó en la iniciativa del Taller Virtual de las Américas, dirigido por los arquitectos Guillermo Vásquez de Velasco y Antonieta Angulo desde la Universidad de Texas A&M. Gracias al interés de Guillermo por promover SIGraDi, empezamos a participar en los congresos desde 2003 en Rosario, Argentina. A partir de entonces, y de forma consecutiva, han transcurrido 20 años, y la UPC ha sido sede de SIGraDi en 2005 y, en 2022, del XXVI Congreso de la Sociedad Iberoamericana de Gráfica Digital.

Participar en el proceso de gestación de las distintas iniciativas que SIGraDi ha promovido nos permitió asegurar caminos de implementación de tecnologías en nuestra Facultad de Arquitectura, desde cursos obligatorios sobre BIM y fabricación digital a partir del cuarto ciclo hasta cursos electivos en visualización fotorrealista, narración audiovisual, infografía y diseño computacional. Precisamente, vivir las diferencias de adoptar tecnologías computarizadas y la evolución de los primeros talleres computacionales que promovimos desde el 2006 en la región, junto a las exhibiciones Homo Faber sobre fabricación digital desde el 2015 y la edición del libro por el vigésimo quinto año de SIGraDi, nos sigue motivando a crecer dentro de una cultura comunitaria y de participación. Esta asimila la disrupción y nos prepara para convivir y apropiarnos de las tecnologías, como aliados de nuestros procesos, que emergen desde el contexto de la exploración y la curiosidad para resolver problemas reales.

Apropiaciones Críticas, el tema que impulsamos en SIGraDi 2022, se convierte en un llamado a la reflexión sobre el origen y proceso de las acciones de un diseño transformador y sus posibilidades, desde el rol de la tecnología y su efecto en el contexto social, cultural, material y educativo.

SIGraDi 2022. Critical Appropriations se organizó en 7 tópicos y 30 sub tópicos: Programming Cultures (Agent-Based Systems, Data Analytics, Generative Design, Machine Learning, Parametric Analysis, Predictive Modeling y Shape Grammars); Manufacturing & Industry 4.0 (Robotics, Digital Fabrication, Internet of Things, Blockchain y Decision Making); Interactions & Collaborations (User Experience, Mixed Realities, Virtual Reality, Codesign, BIM Adoption y Interdisciplinary Design); Special Topics (Digital Heritage, Inclusive Design, Media Art y COVID-19); Life Long Learning and Digital Education (Hybrid Education y Online Learning); Design, Nature and

Ecosystems (Smart Cities & Environments, Sustainable Design, Building Performance, Bio-Inspired Design y Living Things).

Estos tópicos impulsaron la generosidad de 20 instructores y sus doce talleres conectados desde 10 países en una convocatoria para 170 participantes, que tienen lugar entre el 7 y 8 de noviembre.

Entre el 9 y 11 de noviembre, Philip F. Yuan (China), Shelby Elizabeth Doyle, Daniel Cardoso, Sandra Manninger, Matías del Campo (EE.UU.), Felipe Ferrer y Benito Juárez (Perú) presentan sus apropiaciones en Metaverse, Robotic Fabrication, Computational Feminism, Other Computations, Regenerative Manufacturing, Digital Biology, Neural Networks, Artificial Intelligence, Low-High Tech, y Glocalismo.

En estos tres días, SIGraDi 2022 presenta las investigaciones de 267 autores de Argentina (4), Brasil (40), Chile (8), China (2), Colombia (5), Costa Rica (1), Dinamarca (2), Alemania (2), Hong Kong (1), Italia (1), México (4), Perú (1), Portugal (4), Singapore (1), Taiwan (1), Turquía (5), Reino Unido (7), EE.UU. (13) y Uruguay 2). 19 países con trabajos en idioma inglés (46), portugués (35) y español (23) que conforman este volumen de 104 artículos en 24 sesiones organizadas por idiomas.

SIGraDi 2022 comparte distintas apropiaciones como detonantes del diálogo con otros, a partir de los cuales nuevas reinterpretaciones seguirán creando una cultura digital que impulsa sus propias agendas hacia otras geografías.

Este XXVI Congreso SIGraDi 2022 se inspira en la intensidad de la vida cotidiana y la sociedad, con el disfrute y apropiación de las tecnologías en sus diferentes formas.

Desde Lima, Perú, agradecemos inmensamente a cada uno de los equipos locales e internacionales que permiten que estemos aquí, conectados, compartiendo y disfrutando de nuestras apropiaciones con la esperanza de reunirnos muy pronto de manera presencial.

Bienvenidos a SIGraDi 2022

SIGraDi President's greetings

Marcelo Bernal, President
Sociedad Iberoamericana de Gráfica Digital, SIGraDi

This Book of Proceedings gathers the body of work presented at the XXVI Congress of the Ibero-American Society of Digital Graphics, SIGraDi, organized by the UPC, Lima, Perú.

This year the call for "Critical Appropriations" questions the tension between the regional and the global research agendas. How do we cultivate our identity and originality while being influenced by global research trends? Or how do we influence back those trends from our regional experiences? This bidirectional question is particularly important considering the languages and territorial distribution of our international community. While actively connecting new researchers, educators, practitioners, and institutions within the boundaries of our territory, increasingly we attack members from all over the world that every year chose SIGraDi to share their work. Our challenge is not only the Iberoamerican integration but becoming a platform for global discussions.

This publication is possible thanks to the generous contribution of our members through different committees and roles, starting with our global community, who, for one more year, chose to submit their original work to SIGraDi.

The Local Organizing Committee, besides leading the overall organization of SIGraDi's major event, the international congress, organized two parallel events: "Homo Faber," an exhibition of the Latin American Fablabs, and the workshops on the first two days of the congress.

The Scientific Committee, including one hundred forty-seven members from twenty-five different countries, reviewed and validated the quality of the research endeavors presented here through a rigorous double-blinded peer review process.

The Executive International Committee during the last year has been focused on updating the internal procedures and platforms, developing the new venue handbook to guide new institutions in the process of organizing the annual congress, inviting new members to the scientific committee, working on the indexation of our proceedings, and editing two journals, the International Journal of Architectural Computing (IJAC) and Gestão & Tecnologia de Projetos (GTP) that publish extended versions of selected work of the SIGraDi members every year.

Finally, special thanks to the Leaders of the twelve workshops from Greece, Brazil, Japan, the United States, the UK, Chile, Peru, Argentina, Mexico, and Iran, who generously share their knowledge and expertise to move our community forward.

Saludos del presidente de SIGraDi

Marcelo Bernal, presidente
Sociedade Iberoamericana de Gráfica Digital, SIGraDi

Este Livro de Atas reúne o conjunto de trabalhos apresentados no XXVI Congresso da Sociedade Ibero-Americana de Gráfica Digital, SIGraDi, organizado pela Universidade Peruana de Ciências Aplicadas, UPC, Lima, Peru.

A chamada deste ano para "Apropriações Críticas" questiona a tensão entre as agendas de pesquisa regional e global. Como cultivamos nossa identidade e originalidade enquanto somos influenciados pelas tendências globais de pesquisa? Ou como influenciamos essas tendências a partir de nossas experiências regionais? Essa questão de mão dupla é particularmente importante considerando os idiomas e a distribuição territorial de nossa comunidade internacional. Enquanto conectamos ativamente novos pesquisadores, educadores, profissionais e instituições dentro dos limites de nosso território, cada vez mais visamos membros de todo o mundo que a cada ano escolhem o SIGraDi para compartilhar seu trabalho. Nosso desafio não é apenas a integração ibero-americana, mas tornar-se uma plataforma de debate global.

Esta publicação é possível graças à generosa contribuição de nossos membros através de diferentes comitês e funções, a começar pela nossa comunidade global, que, mais uma vez, optou por submeter seus trabalhos originais ao SIGraDi.

O Comitê Organizador Local, além de liderar a organização geral do comgresso mais importante do SIGraDi, o congresso internacional, organizou dois eventos paralelos: "Homo Faber", exposição dos Fab Labs latino-americanos, e as oficinas dos dois primeiros dias do O congresso.

O Comitê Científico, que inclui cento e quarenta e sete membros de vinte e cinco países diferentes, revisou e validou a qualidade dos esforços de pesquisa aqui apresentados por meio de um rigoroso processo de revisão por pares duplo-cego.

O Comitê Executivo Internacional durante o último ano se concentrou na atualização de procedimentos e plataformas internas, desenvolvendo o novo manual da sede para orientar novas instituições no processo de organização do congresso anual, convidando novos membros para o comitê científico, trabalhando na indexação de nossos anais e editar duas revistas, International Journal of Architectural Computing (IJAC) e Gestão &

Tecnologia de Projetos (GTP) que publicam anualmente versões estendidas de obras selecionadas de membros do SIGraDi.

Finalmente, um agradecimento especial aos líderes dos doze workshops da Grécia, Brasil, Japão, Estados Unidos, Reino Unido, Chile, Peru, Argentina, México e Irã, que generosamente compartilham seus conhecimentos e experiências para levar nossa comunidade adiante.

Saludos del presidente de SIGraDi

Marcelo Bernal, presidente
Sociedad Iberoamericana de Gráfica Digital (SIGraDi)

Este libro de actas reúne el cuerpo de trabajo presentado en el XXVI Congreso de la SIGraDi, organizado por la UPC, Lima, Perú.

Este año la convocatoria de "Apropiaciones críticas" cuestiona la tensión entre las agendas de investigación regional y global. ¿Cómo cultivamos nuestra identidad y originalidad mientras nos vemos influenciados por las tendencias de investigación globales? ¿O cómo influenciamos esas tendencias desde nuestras experiencias regionales? Esta pregunta bidireccional es particularmente importante considerando los idiomas y la distribución territorial de nuestra comunidad internacional. Mientras conectamos activamente a nuevos investigadores, educadores, profesionales e instituciones dentro de los límites de nuestro territorio, atacamos cada vez más a miembros de todo el mundo que cada año eligen SIGraDi para compartir su trabajo. Nuestro desafío no es solo la integración iberoamericana, sino convertirnos en una plataforma de debate global.

Esta publicación es posible gracias a la generosa contribución de nuestros miembros a través de diferentes comités y roles, comenzando por nuestra comunidad global, quienes, un año más, optaron por enviar su trabajo original a SIGraDi.

El Comité Organizador Local, además de liderar la organización general del evento más importante de SIGraDi, el congreso internacional, organizó dos eventos paralelos: "Homo Faber", una exposición de los Fab Labs latinoamericanos, y los talleres de los dos primeros días del congreso.

El Comité Científico, que incluye 147 miembros de 25 países diferentes, revisó y validó la calidad de los esfuerzos de investigación presentados aquí a través de un riguroso doble proceso ciego de revisión de pares.

El Comité Ejecutivo Internacional durante el último año se ha enfocado en actualizar los procedimientos y plataformas internas, desarrollar el nuevo manual de sede para guiar nuevas instituciones en el proceso de organización del congreso anual, invitar a nuevos miembros al comité científico, trabajar en la indexación de nuestras actas y editar dos revistas, International Journal of Architectural Computing (IJAC) y Gestão & Tecnologia de Projetos (GTP), que publican versiones extendidas de trabajos selectos de los miembros de SIGraDi cada año.

Finalmente, un agradecimiento especial a los líderes de los 12 talleres de Grecia, Brasil, Japón, Estados Unidos, Reino Unido, Chile, Perú, Argentina, México e Irán, quienes generosamente comparten su conocimiento y experiencia para hacer avanzar a nuestra comunidad.

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SIGraDi 2022: Critical Appropriations Conference is hosted by UPC (Lima, Peru) School of Architecture and supported by the SIGraDi Executive International Committee (CEI) and the SIGraDi Advisory Committee (CA).

A Conferência SIGraDi 2022 é organizada pela Faculdade de Arquitetura da UPC (Lima, Peru) e apoiada pelo Comitê Executivo Internacional da SIGraDi (CEI) e pelo Comitê Consultivo da SIGraDi (CA).

La Conferencia SIGraDi 2022 es organizada por la Facultad de Arquitectura de la UPC (Lima, Perú), y cuenta con el respaldo del Comité Ejecutivo Internacional SIGraDi (CEI) y el Comité Asesor SIGraDi (CA).

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Miguel Cruchaga Belaúnde | *Dean, School of Architecture* | UPC | **Perú**
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Alcanzando el metaverso: cómo la fabricación une lo virtual y lo real
Philip F. Yuan, China

Aprender haciendo
Learning by Doing
Felipe Ferrer, Perú

Architecture and Artificial Intelligence – Rise of a Paradigm
Arquitectura e inteligencia artificial – El surgimiento de un paradigma
Matias del Campo & Sandra Manninger, United States

A Carrier Bag of Tools for Computational Feminism
Un maletín de herramientas para el feminismo computacional
Shelby Elizabeth Doyle, United States

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Fabricación regenerativa | Más allá de la 4.ª Revolución Industrial
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Benito Juárez, Perú

Keynote Presentation

Touching Metaverse
How Fabrication Bridges the Virtual and the Real

Alcanzando el metaverso
Cómo la fabricación une lo virtual y lo real

Philip F. Yuan
Tongji University, China

Abstract. We live in the era when the subject-object relationship of architectural design needs to be re-pondered and reassembled, the era we usually call posthumanism. Facing global warming, geopolitical upheaval and the pandemic, while confronting the challenge of the mutual development of architecture and society, we need to redefine and rethink the relationship between globalization and locality to reflect the contradictions and the opportunities brought by the current trend of human-machine collaboration and Object-Oriented Ontology. We, as architects, need to take a serious look at the parallel development of virtual and real worlds, and phygital futures presents the challenge of an architectural ontological approach to thinking and design tools. The talk will explore this issue through my research and practice.

Speaker biography

Philip F. Yuan is a professor at the College of Architecture and Urban Planning (CAUP) at Tongji University, Thomas Jefferson professor at University of Virginia (UVA, 2019), the visiting professor at Massachusetts Institute of Technology (MIT, 2019) and Royal Melbourne Institute of Technology (RMIT, 2021). He is also the co-founder of DigitalFUTURES and Editor in Chief of Architectural Intelligence journal, the founder of Archi-Union Architects and Fab-Union Technology, council member of UIA Professional Practice Commission (PPC). Yuan is a pioneer in architectural intelligence and robotic fabrication, making achievements in both academic research and architectural practice. He emphasizes the integration of technological innovation and architectural culture, building environment and ethics, constantly seeking human-machine collaboration in the era of post-humanism.

Keynote Presentation

Learning by doing

Aprender haciendo

Felipe Ferrer
PUCP, Perú

Resumen. Desde nuestro taller y durante varios ciclos, capturamos de diversos lugares del Perú su cultura local y energía, y aprendimos de sus métodos constructivos. Experimentamos con tecnologías digitales y, a través de procesos empíricos, tratamos de amalgamar lo local con lo global. Creemos que el cruce entre tecnologías —*hi tech*— y —*low tech*— es la clave para entender el potencial de donde estamos trabajando. En la ciudad de Lima, uno puede encontrar ciertas paradojas socioeconómicas y políticas con mecanismos muy sofisticados y, a la vez, primitivos. Nos interesa usar tecnologías globales de punta, pero trabajamos con las técnicas locales de construcción y procesos artesanales. Apuntamos a responder de una manera muy local a problemas globales. Investigamos la intersección entre la arquitectura y lo artesanal, lo digital y lo físico, y el proceso de fabricación y su construcción. Aprender cómo hacer, cómo construir es entender los materiales y cómo transformarlos, comprender cómo se vinculan los diferentes elementos entre sí; es explorar sistemas constructivos y ver cómo operan a diferentes escalas; es afrontar cómo hacer realidad lo que diseñamos.

Speaker biography

Felipe Ferrer Cárdenas (Lima, 1978). He is a registered architect and founder of V.Oid. He is a professor at the PUCP where he has taught courses on Digital Fabrication, Final Degree Projects, and Experimental Workshop V on experimental design. He has a master's degree in Advanced Architectural Design from Columbia University where he was also a professor of the advanced design master's degree (2005-2006). He worked with Diller Scofidio + Renfro (2005-2010). In Italy they awarded him the Gold A' Award and he was nominated for the Mies Crown Hall Americas Prize Award in Chicago with the AGP eGlass Factory project in Lima. Felipe was selected as Curator for the Peruvian Pavilion at the Venice Biennale 2020-21 where he resignifies bars in public spaces to turn them into artifacts to interact with.

Keynote Presentation

Architecture and Artificial Intelligence
Rise of a Paradigm

Arquitectura e inteligencia artificial
El surgimiento de un paradigma

Matías del Campo
University of Michigan, United States

Abstract. We are currently experiencing the emergence of a new design methodology based on the application of artificial intelligence. The rise of a new paradigm in architecture design. In this lecture, Dr. Matias del Campo and Dr. Sandra Manninger offer an insight into a wide spectrum of possible applications within this new design ecology. The lecture, based on the book “Neural Architecture”, approaches the problem from two specific directions: the theoretical underpinnings of design methods that are capable of interrogating the deep layers of the history of our discipline, and the implementation of AI as a practical tool. Painting a picture of an architecture design ecology that includes nonhuman players, estranged architectural objects, and a posthuman ethos regarding agency and authorship, the lecture provides an opportunity to interrogate an environment that is already a reality, surrounding us on a daily basis. How will the discipline adapt to this rapidly changing landscape? How can we, as architects, contribute to the ongoing dataset building and avoid the pitfalls of cultural and racial bias? Will it change the way we as architects work in the future? This and more will be discussed in the keynote lecture 'Architecture and Artificial Intelligence - Rise of a Paradigm'.

Speaker biography

Dr. Matias del Campo is a registered architect, designer, and educator. He is an Associate Professor at Taubman College of Architecture and Urban Planning, University of Michigan (UoM), director of the AR2IL – The Architecture and Artificial Intelligence Laboratory at UoM, and affiliate faculty member of Michigan Robotics and MIDAS the Michigan Institute of Data Science. Most recently he published the AD Machine Hallucinations – Architecture and Artificial Intelligence with Wiley, and his book Neural Architecture – Design and Artificial Intelligence with ORO editions.

Speaker biography

Dr. Sandra Manninger is an architect, researcher, and educator. Born and educated in Austria, she co-founded SPAN Architecture together with Matias del Campo in 2003. SPAN Architecture's research highlights how to go beyond beautiful data to discover something that could be defined voluptuous data. This coagulation of numbers, algorithms, procedures, and programs uses the forces of thriving nature and, passing through the calculation of multi-core processors, knits them with human desire. Her award-winning projects have been published and exhibited internationally, e.g., at La Biennale di Venezia 14/16/18/21, MAK, Autodesk Pier 1 and have been included in the permanent collections of the FRAC, Design Museum in Munich, or the Albertina in Vienna. Sandra Manninger has taught internationally at, e.g., the TU Vienna, University for Applied Arts, DIA Bauhaus in Dessau, UPenn, Tongji and Tsinghua Universities, at the University of Michigan, and the Royal Melbourne Institute of Architecture.

Keynote Presentation

A Carrier Bag of Tools for Computational Feminism

Un maletín de herramientas para el feminismo computacional

Shelby Elizabeth Doyle
Iowa State University, United States

Abstract. This lecture will share work from the first six years of the ISU Computation & Construction Lab (CCL). The CCL is a physical space that houses digital fabrication machines and robotics – as well as a home to pedagogical experiments, fabricated objects, and theoretical ambitions collected under the hypothesis that computation is informed by and productive of architectural cultures. Or said differently: the CCL is a 'carrier bag' to hold the tools for constructing a feminist future for technology (See Le Guin). The CCL gathers these strategies for architecture and computation under the term computational feminism, operating relentlessly upon the cultures of architecture and computation using disciplinary tools: writing, teaching, coding, drawing, making, and building. Projects from each of these categories will be presented as methods for reflecting on how architect and designer's make-with, attribute, and historicize computational knowledge and labor.

Speaker biography

Shelby Elizabeth Doyle, AIA is an Associate Professor of Architecture and Stan G. Thurston Professor of Design Build at the Iowa State University College of Design, co-founder of the ISU Computation & Construction Lab (CCL), and director of the ISU Architectural Robotics Lab (ARL). The central hypothesis of CCL and Doyle's work is that computation in architecture is a material, pedagogical, and social project; computation is both informed by and productive of architectural cultures. This hypothesis is explored, through the fabrication of built projects and materialized in computational practices. The CCL is invested in questioning the role of education and pedagogy in replicating existing technological inequities, and in pursuing the potential for technology in architecture as a space of and for gender equity. Doyle received a Fulbright Fellowship to Cambodia, a Master of Architecture from the Harvard Graduate School of Design, and a Bachelor of Science in architecture from the University of Virginia.

Keynote Presentation

Other Computations

Otras computaciones

Daniel Cardoso Llach
Carnegie Mellon University, United States

Abstract. A growing body of architectural and design scholarship seeks to understand, for example, computational design methods' manifold effects on the design professions, their historical origins, pedagogical implications, as well as their potentials for both creative design and managerial efficiency. However, the bulk of these efforts has focused on practices and institutions of the global North. As a result, our understanding of the role of digital technologies in architecture and design is framed by historical and theoretical armatures that closely reflect concerns, and interests, native to these locations —chiefly the United States, UK, and Europe— and thus carry with them assumptions that, when unchecked, can occlude important questions and domains of analysis. How might we articulate other accounts of digital design and construction that do not place regions outside of the global North on the receiving end of technology and innovation? How might we dismantle the conceptual past that condemns entire regions and peoples to perpetually catch up with a seemingly pre-determined future? This talk will explore these questions through a series of recent investigations in the field of "other computations.".

Speaker biography

Daniel Cardoso Llach is Associate Professor of Architecture at Carnegie Mellon University, where he chairs the Master of Science in Computational Design and co-directs CodeLab. He is the author of publications, exhibitions, and artifacts exploring the nexus of design and computation through sociotechnical and historical lenses, including the book Builders of the Vision: Software and the Imagination of Design, and the forthcoming Designing the Computational Image, Imagining Computational Design, with Theodora Vardouli. Cardoso Llach's work has been supported by the Graham Foundation for Advanced Studies in the Fine Arts, Canada's Social Science and Humanities Research Council, Google's Artists + Machine Intelligence program, among others. He is also a 2021-22 Pennsylvania Manufacturing Fellow and founding co-editor of the Design, Technology, and Society Routledge book series. Daniel holds a Ph.D. and a MS (with honors) from MIT, and a B. Arch. from Universidad de los Andes at his native Bogotá.

Keynote Presentation

Regenerative Manufacturing | Beyond the 4th Industrial Revolution

Fabricación regenerativa | Más allá de la 4.ª Revolución Industrial

Benito Juárez
Fab Lat, Perú

Abstract. Unlike the exponential increase in digital information, every year we lose globally the bio-information contained in the DNA of the multiple species that become extinct due to human actions, specially by activities such as construction, agriculture, transport, and manufacturing, that directly affect the increase of global warming. The digital information vs. bio-information appear to travel on opposite growth curves. The loss of biodiversity in our planet is the consequence of a predatory economic model, which extracts raw materials and gives back contamination. How to strengthen the development of a regenerative and collaborative economy, based on the co-creation of value from bio-information, which stimulates and encourages the increase of local and global biodiversity? Regenerative Manufacturing | Beyond the 4th Industrial Revolution is a space to reflect on the opportunities offered by bio and digital technologies to develop a new generation of design and manufacturing models that increase the biodiversity of the planet.

Speaker biography

Benito Juarez is pioneer in digital manufacturing technologies in Peru and Latin America. Co-founder of the Latin American Fab Labs Network. Creator of the Floating Fab Amazon project, selected by the United Nations for the global launch of the 17 SDG (NYC, 2015) as “the World’s most disruptive project on Sustainable Manufacturing and Climate Change” (Summit Solutions, UN 2015). Creator of the SimbioCreación methodology, which promotes the culture of Exponential Collaborative Creativity. Co-founder of NUTRIGENE (Singularity University 2016), a company dedicated to eradicating malnutrition in the world through a nutrient printer. Director of Supernodo Latinoamérica (Fab Lat) from where he works for technological democratization through the creation of inclusive projects and avant-garde products based on digital fabrication, revaluing the riches in biodiversity and multiculturalism of Latin America.

Workshops Presentation
Apresentação dos Workshops
Presentación de talleres

The workshops will take place on November 7th and 8th. SIGraDi 2022 workshops will occur online via Blackboard Collaborate or similar video conferencing platform. The workshops at SIGraDi are an opportunity for students, teachers, and professionals from Latin America to explore the possibilities of digital technologies as allies of the design process, sharing their experience with their peers from different parts of the planet. As in every year, we are sure that it will be an enriching and knowledge space that promotes appropriations.

Os workshops acontecerão nos dias 7 e 8 de novembro. Os workshops do SIGraDi 2022 ocorrerão on-line via Blackboard Collaborate ou plataforma de videoconferência similar. Os workshops da SIGraDi são uma oportunidade para estudantes, professores e profissionais da América Latina explorarem as possibilidades das tecnologias digitais como aliadas do processo de projeto, compartilhando sua experiência com seus pares de diferentes partes do planeta. Como em todos os anos, temos a certeza que será um espaço enriquecedor e de conhecimento que promove apropriações.

Los talleres se llevarán a cabo los días 7 y 8 de noviembre. Los talleres de SIGraDi 2022 se realizarán en línea a través de Blackboard Collaborate o una plataforma de videoconferencia similar. Los talleres de SIGraDi son una oportunidad para que estudiantes, docentes y profesionales de América Latina exploren las posibilidades de las tecnologías digitales como aliadas del proceso de diseño, compartiendo su experiencia con sus pares de diferentes partes del planeta. Como cada año, estamos seguros de que será un espacio enriquecedor y de conocimiento que promueva apropiaciones.

Workshops Presentation*

WS1.
Biomimetic Design and prototyping: A digital toolkit for designers
Alexandros Efstathiadis & Ioanna Symeonidou
University of Thessaly, Greece

WS2.
Torres paramétricas a tectônica da concepção algorítmica à fabricação digital
Ana Carolina Santos Vicente & Wallace Dornelas
Universidade Federal de Viçosa, Brazil

WS4.
Optimizing into the Probable Future. Predictive Models of Sustainable Building Performance
Marcelo Bernal, & Victor Okhoya
Perkins&Will Design Process Lab, United States
Tyrone Marshall & Cheney Chen
Perkins&Will Energy Lab, United States
Mohamed Imam
Perkins&Will Vancouver, Canada

W5.
AR + Design: Augmented Reality Immersive Design Method
Yang Song
University of Liverpool, United Kingdom

W6.
Get Your Ph.D. Done
Paula Gómez Z.
Georgia Tech Research Institute, Atlanta, United States

* For reasons beyond our reach, the instructors of Workshops W3 and W8 had to cancel their calls at SIGraDI 2022.

W7.
Architectural Intelligence: Multimodal ML applications in Design
George Guida & Indrajeet Halder
Harvard University, Graduate School of Design, Cambridge, United States

W9.
Diseño 3D a partir de modelos basados en inteligencia artificial
Michael Hurtado
UPC, Perú

W10.
Diseño de exoesqueletos en productos
Patricio Rabus
Universidad de Buenos Aires, Buenos Aires, Argentina

W11.
Ibrida: Metodologías de dibujo desde la fabricación digital e inteligencia artificial aplicada al bocetaje para la producción de arte contemporáneo
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Ciudad de México, México

W12.
ML Plugin: Develop a Machine Learning plugin for Grasshopper
Mohammad Pourfooladi
Art University of Isfahan, Iran

Workshop Presentation W1

Biomimetic Design and Prototyping: A digital toolkit for designers

Workshop in English

Alexandros Efstathiadis & Ioanna Symeonidou
University of Thessaly, Greece

Biomimicry is the interdisciplinary science that studies nature's models and draws inspiration from them to solve contemporary design challenges. However, processing, evaluating, and imitating biological systems can be a daunting task for designers and architects. For this reason, specialized methodological tools have been developed to assist the biomimetic design process and bridge the existing knowledge gap. Furthermore, advancements in parametric, generative CAD software enable the extraction and emulation of complex biological structures. Algorithmic design allows for the generation of unlimited design permutations through a series of interactive parameters that can be altered by the user on-demand and in real-time, according to design requirements. Intricate biomimetic structures surpass the technical capabilities of traditional fabrication technologies. However, progress in additive manufacturing (AM) technologies like fused filament fabrication (FFF), enables the production of complex topologies. In nature, the information that guides the building process is stored in the DNA of organisms. Similarly, the data that dictates the 3D printing of a model is stored in the form of a G-code created by specialized slicing software. Biomimetic design combined with 3D printing is driving a paradigm shift in sustainable design. The workshop will provide an analytical strategy that will enable designers to extract, emulate and prototype biomimetic structures. Initially, the concept of biomimicry will be introduced. A variety of biological structures will also be presented along with specific biomimetic tools and databases. Afterwards, a series of algorithmic and parametric modeling tools and plug-ins will be explored in Rhinoceros 3D and Grasshopper 3D. In the end, the models will be transferred to the slicing program Cura where the.G-code for the AM process will be generated. The intricacies of 3D printing complex biomimetic geometries will be analyzed.

Keywords. Design, Nature and Ecosystems, Bio-Inspired Design, 3D printing

Topics. Day 1. Introduction to biomimicry; Presentation of biological structures, biomimicry tools and databases; Exploration of modeling tools in Grasshopper; Participant work in groups. Day 2. Introduction to 3D printing; 3D printing and biomimicry; Participant work in groups; Feedback and guidance; Final presentations

Workshop Presentation W2

Torres paramétricas a tectônica da concepção algorítmica à fabricação digital

Workshop em Português

Ana Carolina Santos Vicente & Wallace Dornelas
Universidade Federal de Viçosa, Brazil

Esse Workshop pretende aplicar os entendimentos acerca da tectônica digital, assim como a manipulação de seus elementos fundantes, desde a fase de concepção paramétrica, através do Grasshopper, até a de fabricação digital. Para isso, inicialmente será dada uma introdução teórica à tectônica digital, com foco nos principais autores que trataram do tema, e dos seus elementos (Estrutura, Manipulação, Material, Construção e Interação), propostos por estudos recentes. Em seguida, a fim de possibilitar o desenvolvimento de torres paramétricas, será ministrado um tutorial utilizando Rhinoceros + Grasshopper (e o plug-in Lunchbox), cujo foco será explorar componentes como a estrutura, pavimentos, envoltória, manipulação formal e materialidade das torres, considerando os fundamentos da tectônica e as possibilidades de fabricação digital (impressão 3D ou corte à laser). Para isso. Espera-se que os participantes possam compreender como considerar os elementos da tectônica nos processos de projeto computacionais, aliando de maneira declarada as dimensões funcionais e artísticas da arquitetura.

Keywords. Manufacturing and Industry 4.0, Digital Fabrication, Digital Tectonics, Computational Design Processes.

Topics. Day 1. Introdução teórica ao tema da tectônica digital. Tutorial Rhino + Grasshopper (torre paramétrica). Apresentação e início da atividade (divisão em grupos e desenvolvimento das torres). Day 2. Continuação do desenvolvimento das torres (acompanhado pelos ministrantes). Preparação dos arquivos para fabricação (orientado pelos ministrantes). Apresentação e discussão dos resultados

Workshop Presentation W4

Optimizing into the Probable Future. Predictive Models of Sustainable Building Performance

Workshop in English

Marcelo Bernal, & Victor Okhoya
Perkins&Will Design Process Lab, United States
Tyrone Marshall & Cheney Chen
Perkins&Will Energy Lab, United States
Mohamed Imam
Perkins&Will Vancouver, Canada

We aim to lead a hands-on discussion that asks how we might consider and anticipate the impact of climate change on buildings and the environment to speculate, imagine, and innovate new models of design intervention that can modulate better performance outcomes in an uncertain future. Although parametric analysis is an emergent data-driven approach to building performance analysis, few practitioners understand effective methods of evaluating parametric analysis data. Furthermore, even fewer understand predictive models and how to estimate uncertainties. In these two days' workshops, the participants will learn how to simulate performance models based on weather files that represent different scenarios for climate changes (current, 2050, and 2080) and then generate design alternatives, analyze the performance of large design spaces, sample large design spaces, interpolate simulated data using machine learning predictive methods, visualize data for qualitative data exploration, and perform sensitivity analysis for quantitative assessment and estimation of the contribution of individual parameters in the overall performance.

Keywords. Climate Change; Design Space; Machine Learning; Data Visualization; Sensitivity Analysis.

Topics. Day 1. Climate Model Scenarios; Generative Design; Parametric Analysis: Data Visualization. Day 2. Sampling the Design Space; Sensitivity Analysis; Predictions-based Machine Learning; Decision Making.

Workshop Presentation W5

AR + Design: Augmented Reality Immersive Design Method

Workshop in English

Yang Song
University of Liverpool, United Kingdom

W5 aims to introduce the knowledge of exploring immersive parametric design through the Augmented Reality (AR) environment. As the quintessential 3D-4D design field, architectural design has been limited throughout its history by 2D or cumbersome 3D representation. Even though computer-aided architectural design and modelling software is widely used to produce digital 3D models, the conventional screen-based visualization methods for design and analysis are restrictive to how well the user understands the space on a computer screen, as the design is done outside the building site, hence there might be disparities between the design and final. This limitation may be eliminated by AR technology, which has become readily available, together with tools facilitating the easy creation of 3D-4D models as holograms onsite. Furthermore, with its interactive input features, AR can increase the potential for interaction between humans and data. As we immerse ourselves into rapidly developing AR, this technology can also radically change how one interacts with and experience the built environment, enhancing or altering or adding a new layer of information to the surrounding environment. This workshop explores how AR technology can change the ways of architectural design. Ideas like immersive design, as well as real-time modification experience and interaction with the built environment and the metaverse, will therefore actuate as the central core for the research streams.

Keywords. Interactions and Collaborations, Mixed Realities (AR), Immersive Design.

Topics. Day 1. AR introduction; Basic AR interactive functions for design inputs; Design algorithm development. Day 2. AR immersive design workflow demonstration; Structural stability simulation; Participant design algorithm development and final outcome.

Workshop Presentation W6

Get Your Ph. D. Done!

Workshop in English

Paula Gómez Z.
Georgia Tech Research Institute, Atlanta, United States

Finish your Ph.D. in a defined period of time. This is a participatory, non-specific topic workshop. It will cover techniques to get your Ph.D. done by understanding the drivers of your progress. It requires active participation, teamwork and sharing your academic experiences with the instructors and other participants. The outcomes are two. First, a deep understanding of a set of techniques to be able to finish the dissertation, and second, an implementation plan for the milestones: Qualifying paper and exam, topic proposal, dissertation writing, Ph.D. defence, and graduation!

Keywords. Lifelong Learning, Ph.D., Education, Decision Making.

Topics. Day 1. Why haven't you finished? Time management, Decide in advance. Day 2. Owning (your topic), Writing (your dissertation), Becoming (a Ph.D.).

Workshop Presentation W7

Architectural Intelligence: Multimodal ML applications in Design

Workshop in English

George Guida & Indrajeet Halder
Harvard University, Graduate School of Design, Cambridge, United States

We have now reached a historical moment of convergence between text and image processing, bringing forward new multimodal creative processes. Dalle2, StableDiffusion, and Midjourney are challenging current cultural practices of architectural production where a single text input can generate thousands of novel images. This workshop will reposition the role of language and semantics within architecture and introduce students to the opportunities of text-image models and 3D form generation for early design stages. Generated through a combination of the latest machine learning (ML) models, students will be taught how to generate images from text inputs and use these to inform a computational process of 2D to 3D reconstructions. The parameters behind each model and semantics specificity of each text input establish a new creative exchange between human and machine, where human agency finds new meanings. Following an introduction to ML applications architectural design, students will develop three sequential exercises related to 1) envelope making; 2) plan making; 3) a quasi-architectural or metaverse proposals to challenge the first two assignments. The course thus engages ways to reposition language within the design process through new methods and design metrics and considered these practices as challenging current cultural practices of architectural production.

Keywords. Programming Cultures, Machine Learning, Generative Design, Neural Networks, Metaverse

Topics. Day 1. Students will develop three sequential exercises related to 1) envelope making; 2) plan making; 3) a quasi-architectural or metaverse proposals to challenge the first two assignments. Day 2. The third step focuses on creating constructible and discretized forms that hybridize the 2D image outputs. The two primary workflows that we shall delve into are a NURBs based creation of forms in Rhino and several Grasshopper plugins (Monolith, Pufferfish, MeshEdit, Human, Python etc) and vozelized space-based methods using Houdini.

Workshop Presentation W9

Diseño 3D a partir de modelos basados en inteligencia artificial

Workshop en español

Michael Hurtado
UPC, Perú

Since the appearance of image generation models, there has been a growing interest in their use in areas such as art, design, and architecture. More recent are the text-to-image generation models that have shown the importance of choosing the right terms in the prompt to produce an image, this is known as prompt engineering. In this workshop, two 3D computational design methods will be presented, based on the use of image generation using AI. The first is based on the GAN generation model, specifically we will use the StyleGAN algorithm, which allows us to train the network from images chosen in a database, and the second method is based on the use of modifiers from a model. text-to-image generation model known as diffusion model, for this work we will use Stable Diffusion. Finally, through the Grasshopper plugin we will convert the resulting 2D image into a 3D model that can be used within the architectural computational design process.

Keywords. Manufacturing and Industry 4.0, Artificial Intelligence, 3d models, AI design.

Topics. Day 1. Artificial Intelligence fundamentals, diffusion models of text-to-image generation and GAN models, Grasshopper and how to convert a 2D image to 3D.

Workshop Presentation W10

Diseño de exoesqueletos en productos

Workshop en español

Patricio Rabus
Universidad de Buenos Aires, Buenos Aires, Argentina

Gracias a las posibilidades que ofrecen los actuales métodos de fabricación digital en simbiosis con los *softwares* 3D generativos, la estética resultante se convierte en un conductor en el diseño que llevó a la aplicación de las técnicas de diseño arquitectónico a escala de productos. El modelado 3D y las técnicas de impresión 3D han cuestionado las prácticas de diseño y fabricación, las cuales han liberado a los diseñadores de la estética anterior, y, sobre todo, han permitido recrear, visualizar y producir estructuras sustraídas de la naturaleza ya no como un recurso estético, sino funcional. Cuando una trama 2D, en una superficie, se utiliza como eje para una forma tubular se obtiene una estructura espacial. Si el punto de partida es una trama de crecimiento orgánico, el resultado será extremadamente poderoso en términos estructurales. El exoesqueleto es la forma en que está compuesto el hueso humano y animal. No se refiere tanto a una trama específica, sino a un tratamiento o forma de concreción. Se pueden obtener exoesqueletos de múltiples maneras: desde trama triangular a geometrías Voronoi, desde bordes de volúmenes poliédricos a dibujo de segmentos manualmente.

Keywords. Manufacturing and industry 4.0, digital fabrication, generative design, design, nature and ecosystems, bio-inspired design.

Topics. Day 1. Generative design, digital fabrication, bio-inspired design. Day 2. Generative design, digital fabrication, bio-inspired design.

Workshop Presentation W11

Ibrida: metodologías de dibujo desde la fabricación digital e inteligencia artificial aplicada al bocetaje para la producción de arte contemporáneo

Workshop en español

Fernanda Olivares & Eduardo Ramírez
Ciudad de México, México

Este taller está dirigido a artistas contemporáneos, *makers*, diseñadores y a la comunidad creativa para experimentar la traducción de métodos de dibujo a las herramientas de fabricación digital como escaneo e impresión 3D, modelos anatómicos e inteligencia artificial. Ibrida tiene como objetivo construir puentes hacia la hibridación de lo análogo y lo digital. Mediante el rescate de principios de dibujo anatómico y nuevas posibilidades de producción artística desde un enfoque multidisciplinario, el participante enriquecerá diversas exploraciones y alcances para crear un proyecto phygital a través de herramientas tecnológicas.

Keywords. Digital craft, life long learning and digital education, phygital artificial intelligence.

Topics. Day 1. Digital Anatomy, AI and phygitality, traditional drawing methods translated to the digital, AI and new image conceptions, figure model and pose with 3D scan, contemporary art, and hybridization.

Workshop Presentation W12

ML Plugin: Develop a Machine Learning plugin for Grasshopper

Workshop in English

Mohammad Pourfooladi
Art University of Isfahan, Iran

In 1950, Alan Turing asked, “Does a machine think?” A simple question that was the beginning of research on machine learning. Today, “Artificial Intelligence” (AI) is used in most fields of everyday life and learning it can greatly help in the development of new technologies. “Machine Learning” (ML) is one of the parts of artificial intelligence that must be learned to work in this field. The learning process in machine learning begins with data as input until the machine uses them to find the patterns in that data set and make better decisions based on the discovery of their patterns and the insights gained. Machine learning and how to use it for scientific research can be a powerful tool for architects. This workshop aims to provide a basic learning platform for entering the field of machine learning and how to write code for architecture, as well as building the tools desired by the architect for research and design with the help of artificial intelligence tools. In this workshop, students learn how to use the machine learning libraries in the Rhino software to create a plugin that is customized according to their needs.

Keywords. Programming Cultures, Generative Design, Machine Learning, Artificial Intelligence, Develop a Digital Tool.

Topics. Day 1. Basics of programming with C#, Basics of machine learning, Examples of using ML for architectural goals, Generative design using ML, Design evaluation with ML. Day 2. How to develop a plugin, Using ML Libraries, Building the customized plugin.

PhD Workshop
Workshop para doutorandos
Taller para doctorandos

PhD Workshop Committee

Frederico Braida (Chair)
Universidade Federal de Juiz de Fora, Brazil
Fernando Lima
Belmont University, United States
Maria Elena Tosello
Universidad Nacional del Litoral, Argentina
Paula Gómez
Georgia Tech Research Institute, United States
Rodrigo Martín-Iglesias
Universidad de Buenos Aires, Argentina
Silvia Patricia Hernández
Universidad Nacional de Córdoba, Argentina

The SIGraDi PhD Workshop is a unique opportunity for PhD students to present and discuss their research proposals in the CAAD field and related topics. The workshop aims to promote interaction between doctoral students and more experienced researchers and collaboration between doctoral students working on similar topics. Student enrolments at any stage of the work are welcome. The workshop will take place on November 7th and 8th from 9am to 11:30am (GMT -3:00). It is planned to discuss up to 10 proposals. In the case that more than 10 proposals are approved in the review process, the ones that represent the diversity of topics in the area will be selected for presentation. The remaining candidates are welcome to attend the workshop as listeners. The Committee will select the best presentation, whose author will receive a certificate and a SIGraDi Conference attendee registration (or reimbursement), which includes one year's membership of the society. In addition, the best presentations could be selected for the Global PhD Workshop.

Exhibition
Exposição
Exhibición

Homo Faber 3.0
Appropriation of Digital Fabrication from Latin America
Apropriação da Fabricação Digital pela América Latina
Apropiación de la fabricación digital desde Latinoamérica

Curators

Pablo C. Herrera
UPC, Perú
Rodrigo Scheeren
Universidade Federal da Bahia, Brazil
David Moreno Sperling
Universidade de São Paulo, Brazil

Homo Faber 3.0: Appropriation of Digital Fabrication from Latin America is inspired by local challenges, vulnerable communities, and semi-peripheral geographies, from the creative strategies that drive pioneers, developers, and end-users in our region with digital fabrication, as an ally of their processes of design, in any of its forms. For this version, the following categories are promoted: Artistic/Hacking; Bottom up / Community / Craft; Construction Components; Low-High Technologies; Robotic Strategies; Pedagogical Elements and Mobile Fab Labs. Homo Faber 3.0 explores the domestication, interpretation, and application of digital fabrication in the region, which stimulates the logic of technological appropriation of Homo Faber, beyond simple curiosity, automation, and personalization, to distance itself from the modest technological manipulation of Homo Fabricatus. Appropriation as a critical practice makes visible processes that create the foundations of a digital culture that establishes local agendas for other geographies, implementing technical solutions in synergy with situated ecosystems. This invitation to Homo Faber 3.0 hopes to reveal inspirations and synthesize thoughts from making objects, spaces, and environments.

Exhibition

Homo Faber 3.0. Categories and Laboratories
Homo Faber 3.0. Categorias e Laboratórios
Homo Faber 3.0. Categorías y laboratorios

Low-High Technologies

Superlimão, *São Paulo, Brazil*
Dum Dum LAB, *Valparaíso, Chile*
RILAB | UNL, *Santa Fé, Argentina*
Taller 1:1 | PUCP, *Lima, Perú*
FabLab U. de Chile, *Santiago, Chile*
LEFAD | PUC Minas, *Belo Horizonte, Brazil*
DATLab, UNaM, *Misiones, Argentina*
Laboratorio Bio, *Medellín, Colombia*
UNICAP ICAM-TECH, *Recife, Brazil*
MicroUtopias Lab, *Medellín, Colombia*

Pedagogical elements

IEH | UBA, *Buenos Aires, Argentina*
FabLab Belas Artes, *São Paulo, Brazil*
LAMO | UFRJ, *Rio de Janeiro, Brazil*
Fab Lab Tech Mx, *México DF, México*
Robot_Lab, *Bogotá, Colombia*

Artistic/Hacking

Morfolab | UPB, *Medellín, Colombia*
1maginari0 | UFMG, *Belo Horizonte, Brazil*
Estudio Trujillo-Pisanty, *México DF, México*
Vestibles, *Santiago, Chile*
Plasma | UNICAMP, *Campinas, Brazil*
WE-Labs, *Lima, Perú*

Mobile Fab Labs

FabLab Unal, *Medellín, Colombia*
FabLab Austral, *Puerto Williams, Chile*

Tracks
Sessões
Sesiones temáticas

Programming Cultures
Agent-Based Systems
Data Analytics
Generative Design
Machine Learning
Parametric Analysis
Predictive Modeling
Shape Grammars

Interactions and Collaborations
User Experience
Mixed Realities
Virtual Reality
Codesign
BIM adoption
Interdisciplinary Design

Special Topics
Digital Heritage
Inclusive Design
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COVID-19

Manufacturing and Industry 4.0
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Life Long Learning and Digital Education
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Sustainable Design
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Living Things

Other Computations
Digital Craft

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Special Topics:
Media Art

Drawing with bare hands: a hand-gesture based drawing experience with motion sensors.

Alekos Diacodimitri[1], Federico Rebecchini[1]

[1] Department of Department of History, Representation and Restoration of Architecture, Sapienza University of Rome, Rome, Italy
alekos.diacodimitri@uniroma1.it; federico.rebecchini@uniroma1.it

Abstract. One of the features that makes analog drawing so fascinating is its manual component. The path of a graphite line on the sheet, the different pressure of the stroke, the texture described by an entropic movement, the unexpected residues of dirt, each of these things virtually refers to the intervention of a hand. This research unfolds around the idea of using the movement and gestures of the hands as a basis for the generation of forms for architectural design. Not three-dimensional models, but flat shapes, two-dimensional digital drawings generated by the author's gestures. Through a Leap Motion sensor and a digital drawing program, all the various forms of freehand drawing were explored, finding an interesting result in the field of free shape generation linked to hand gestures. The result of this experience is a different way of seeing gestures as a generative tool of architectural forms, to be used into architectural design process.

Keywords: Media art, Digital drawing, Shape generation, Gesture, Motion sensors

1 Introduction

The definition "Architectural Representation" includes within it a varied spectrum of graphic outputs. We can include study sketches, definitive drawings, CAD-produced designs, photorealistic renderings, architectural photographs, and any type of output representing a built or unbuilt architectural space. Within this paper architectural representation has been approached with a very specific approach. Among the many paths of representation, the one that has been traveled starts from the most classical premises: a hand holding an object designed to depict something. A stick on the ground or a pencil on a sheet of paper, there is little difference in the moment when the protagonists of the action lead to the same result, albeit with different graphic style: the description of a space.

Hand drawing was for hundreds of years the only tool that architects had at their disposal to control often insurmountable complexity. The continuous

refinement of drawing techniques led in the late 1900s to a quality in analog representation that has never been equaled. The advent of digital drawing, from CAD to its evolutions in terms of 3-D modeling, have slowly widened the mesh of architectural representation leading to an inflation in terms of styles and quality, expanding a field that to this day is trying to find margins that are getting further and further apart. Within this situation a permanent center of gravity is represented by analog hand drawing. It, though often relegated to the background within the most avant-garde faculties of architecture, continues to maintain unchanged its status as the primal locus of architecture's development and eventual study. Sketching allows an immediacy in recording data that digital still fails to provide. In addition, hand drawing possesses something that digital can never even simulate, and that is gesturality. In it often lies the fascination with analog drawing. The way a pencil is gripped, how its tip comes into contact with the sheet of paper, the pressure of the tip on the roughness of the support, and finally the actual gesture of the performer of the drawing, which between muscle memory and creative darting produces strokes impossible to simulate (Fig. 1).

For who is writing beginning with gestures in representation was therefore a due act, if not the only one possible when approaching drawing. The hand is the performer of the gesture, an irreplaceable appendage that allows one to better control spaces and directions previously only imagined. A human hand is subject to error and contradictions. The gestures of our hands are at the basis of creation through drawing: in order to create they are always in contact with the instrument that mediates our thinking. We inevitably pass from some object (pencil, pen, nib, brush, digital pen, mouse, VR controller) to an output. Each of these instruments interprets the gestures of the hands through their own peculiarities. This consideration introduces the possibilities of gestures in the digital realm as well. Some tools such as CAD software do not provide for it, but new technologies are increasingly moving in this direction. The possibility of interacting in digital environments through tools that detect our gestures is becoming more and more essential year by year for hardware manufacturers and not only. Digital giants such as Meta (formerly Facebook) and their Oculus virtual reality headset are granting increasing space to the enjoyment of their devices through simple hand movements. Gestures, in the specific the motion tracking technology, thus become a tool to humanize and make less mechanical operations limited to the digital environment, with mixed results that not infrequently make one regret the classic mouse and keyboard.

At this point the question that arises is: is gestural drawing something easily translatable into the digital environment? Is analog manual dexterity necessarily the starting point, or at least the ambition, of image production in the digital environment?

This study, starting from the assumptions of the Doctoral Thesis of one of the two authors, unfolds trying to answer these questions, starting from the reduction of the parts involved: it is only the hands that generate the signs. The drawing then becomes bare-handed.

Figure 1. Sketches of architectures from the Ostiense Area in Rome. These sketches were produced in less than 3 minutes each. They are the study sketches produced in order to capture the mood and architectural qualitites of a specific area of Rome. Source: Drawings by F. Rebecchini, 2022.

2 Methodology

2.1 Hardware and Software

Motion tracking systems allow the quantitative study of human body motion. With them it is possible, for example, to calculate the angle between two body segments, the position of a body's center of gravity, or the distribution of forces in the limbs. Originating in the medical field for the study of the pathophysiology of the musculoskeletal system, they now find application in numerous fields, from the design of medical prostheses to sports analysis, to digital animation in film and video games, to virtual reality applications REF.

In this study focused on motion capture graphics, a LEAP motion and a digital painting software were used.

LEAP motion is an optical markerless tracking device produced by the American company Leap Motion Inc. and has been on the market since May 2013, the development of which began in 2008. It is, essentially, a device through which it is possible to interface with a computer by tracking the user's hands. The LEAP motion can track the finger movements of both user’s hands, going so far as to define the position of the individual phalanges of each finger, with a claimed accuracy of 0.01 mm. It is a small USB peripheral that is designed to be placed, facing upward, on a desk between the user and the computer screen. With the presence of two cameras and three infrared LEDs, it can map an approximately hemisphere-shaped area about one meter in diameter. The LEAP software analyzes the objects observed in the device's field of view, recognizing hands, fingers, and any tools being used, while simultaneously reconstructing their position, gestures, and movements.

Corel Painter Freestyle is a graphics software developed by Corel Corporation. It is a version of the more famous Corel Painter program specially designed to work with LEAP motion. The classic version of the software is used

to create artistic images by digitally simulating certain painting techniques: Interfacing with the computer via a graphics tablet, the user can create remarkably realistic images by drawing freehand, thanks to the software's opportunity to simulate a wide selection of classic effects such as watercolor, gouache, oil painting, and many others. In its Freestyle version, this software keeps intact the philosophy behind the classic version about the simulative approach to physical painting and expands the possibilities by allowing the user to relate to the program via LEAP motion.

Today, the software has ended its beta testing phase and is no longer currently available to the public in any form.

2.2 First applications of drawing

In the first phase of the study, our goal was mimesis. We wanted to obtain graphic designs that mimicked the results obtainable from other techniques, whether traditional or digital. By exploiting LEAP motion to process different types of drawings, we came to be able to estimate its effectiveness, its distinctive features, as well as its inevitable criticalities. No attempt was made to elaborate a theory to be later applied to practice: on the contrary, it was the practice itself, experimenting with different graphic solutions, that generated its corresponding theoretical apparatus as a logical consequence of trial and error.

At this stage, our study was developed to recreate the experience of drawing from life that takes place in close contact with architecture, and which has its origin in the architect's notebook and in their ability to analyze buildings through freehand drawing (see also Fig. 1) (Chiavoni, Docci, 2017). An attempt was made to try a similar experience by replacing the classic notebook with a laptop computer coupled with a LEAP motion and using a wooden stick as a virtual drawing tool, emulating real drawing gestures. The real-life drawing experience was conducted using a type of line drawing, thanks to one of the digital graphic tools made available by Corel Painter Freestyle, which simulates the characteristic strokes of graphite and marker pen, configured in such a way as to match variations in hand distance from the screen to the intensity of the mark.

This experience of drawing from life showed all the limitations of instrumental accuracy of LEAP motion: the line drawing is particularly uncertain and shaky. Attempting to reconstruct, for example, the elevation alignments of windows is virtually impossible: the result is a series of flickering, overlapping horizontal lines that are, in the end, meaningless (Fig. 2).

Figure 2. Shaky drawings produced with the aid of wooden stick. The stick was motion tracked by the LEAP Motion. Source: Drawings by A. Diacodimitri on Corel Painter Freestyle, 2016.

2.3 Instrumental accuracy

The degree of instrumental accuracy of LEAP motion has been the focus of several studies, which have established through experimental data its level of reliability. A study (Guna et al., 2014) tested through various procedures the degree of reliability of LEAP motion. A set of static and dynamic measurements was prepared with different tracked objects and varying configurations. For static measurements, a plastic model of a human arm was used, while for dynamic measurements, a special V-shaped instrument simulating two fingers placed at a fixed distance from each other was made. In static measurements, the standard deviation was measured as less than 0.5 mm. Furthermore, this value was shown to increase as the distance of the object tracked by the sensor increased. The results of dynamic measurements revealed poor performance, with a collapse in accuracy for greater distances from the sensor. The conclusions of the research team indicate that:

"The Leap Motion Controller undoubtedly represents a revolutionary input device for gesture-based human-computer interaction. In this study, we evaluated the controller as a possible replacement for a fast and high-precision optical motion capture system in a limited space and with a limited number of objects. Based on the current results and the overall experience, we conclude that the controller in its current state could not be used as a professional tracking system, primarily due to its rather limited sensory space and inconsistent sampling frequency." (Guna et al., 2014)

2.4 The instrumental error betweencontrol and randomness

In addition to aspects related to instrumental accuracy, the main instrumental error issue concerns shadow cones that are created during finger

movement and are referred to as occlusion phenomena. The management of the error related to occlusions is crucial for this study, since, as will be seen, the phenomenon actively participates as a semi casual component in the generation of free form. This phenomenon, by its very nature not eliminable, is generated at the very moment when, during the movement of the fingers of one hand, one finger covers another finger relative to the position of the controller that is tracking its movement. In the short period of time in which this phenomenon occurs, the sensor "loses sight" of the finger, which consequently disappears from the relevant frame, only to reappear again in the next frame, but no longer belonging to the previously traced motion, becoming the starting point of a new motion. This occlusion has strong consequences in terms of the graphic result, since all the shapes that are generated with these procedures will present obvious points of discontinuity, as will be better seen in the paragraphs on the experiences of generating simple and complex shapes, causing on the one hand great difficulties in handling the shape, and on the other hand unpredictable graphic peculiarities worthy of interest. Generally, these occlusions tend to occur more frequently when the hand makes rotational movements.

2.5 Two-dimensional free-form generation

All the described instrumental errors led to the unsatisfactory results described in the section 2.2. This brought to the formulation of a new research path, focusing on the generation of free forms associated with hand gestures. These forms can become tools for architectural design research.

The initial phase of the design process in architecture plays a key role within the compositional process. During this stage, drawings are made so to act within that moment in which the conceptual and spatial complexity of the project is formalized through a quick, jet-like, and (almost always) freehand drawing. The nature of such sketches, from a graphic point of view, is characterized by a very strong level of ambiguity; the meaning of the single sign does not yet have those characteristics of univocity proper to the final drawing, but rather, has precisely in the interpretive variables its greatest strength. The idea is hinted at, is beginning to take shape and will later find substance precisely in its unfolding and unraveling in successive stratifications. In this view, the instrumental imprecision of the analog medium (the pencil, the marker, the paper) plays a fundamental role. In employing these instruments, we take part to a phase of partial randomness, in a still not totally controlled environment that can produce results that are still unexpected. These results almost always require numerous successive iterations before finally coming to fruition.

Instrumental errors, which in other areas have, as we have seen, yielded unsatisfactory results, can here be transformed into a positive quality. At this stage of the study, we focused on investigating the ways in which a free form can be generated through LEAP motion, to understand how controllable this is, how it can be interpreted, and in what ways different movements in hand space

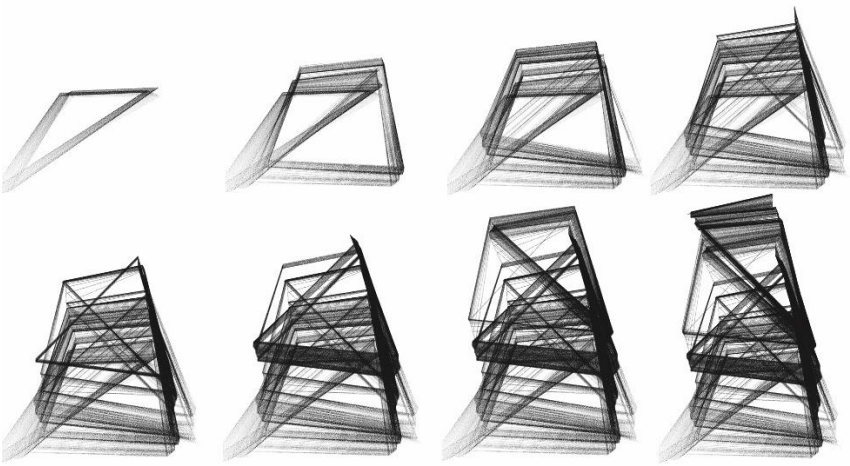

Figure 3. Hand-tracked movements describing a pseudo-axonometric construction. Source: Drawings by A. Diacodimitri on Corel Painter Freestyle, 2016.

are associated with designs that have recurring peculiarities. Within the working environment of Corel Painter Freestyle software, it is possible to act on brush control parameters such as minimum and maximum painting depth, finger spacing, tilt control, and most importantly, it is possible to enable multiple inputs, with 1 or 2 degrees of connection between individual inputs. These possibilities offered by the software make it possible to achieve special graphic results, since they allow several fingers at the same time to collaborate in the realization of the drawing, by tracking the whole opened hand. As a result, compared to single-input operations, the movements that the hand must make are much more organic and complex. This has led to the development of a peculiar graphic language made up of simple 2, 3 and 4-input movements such as translations and rotations, which generate two-dimensional shapes that tend to recur. These forms thus generated were then classified according to the type of gesture that generated them.

When the fingers are made to make movements parallel to each other, a movement is composed, which is here called translation, and which generates simple forms. Such forms develop, of course, according to a single direction. In this case, occlusion phenomena are limited since the fingers all move according to a single direction and thus tend to avoid overlapping one another. This generates shapes that perceptually resemble pseudo axonometric constructions of extrusions along the direction of hand movement (Fig. 3).

By rotating the wrist during hand tracking, the fingers make a rotational movement that graphically transforms into a complex shape. This shape is particularly difficult to read, as the marks tend to overlap without having a chance to develop along a prevailing direction. For this reason, it was preferred to replace the simple rotation movement, which is particularly unmanageable,

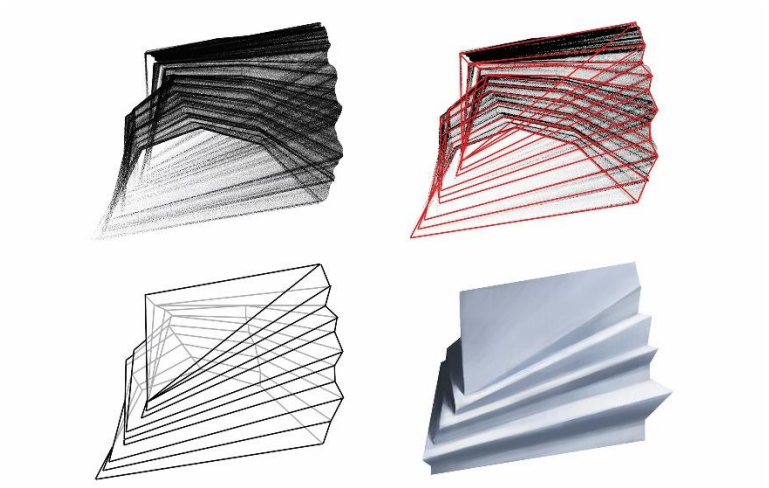

Figure 4. Interpretive process of a form produced by a translation gesture. Source: Elaboration by A. Diacodimitri on Corel Painter Freestyle, 2016.

with a roto translation movement, thus combining the rotation with a linear movement of the whole arm along one direction. In this case the phenomenon of occlusion is particularly present, since at the moment of rotation the fingers tend to create shadow cones and cover each other with respect to the position of the sensor. It has been noted how roto translation movements generate shapes that perceptually recall perspective compositions, probably by virtue of their extreme chaotic nature, within which it is difficult to recognize lines parallel to each other. To this was then added a "modifier gesture," which can be used in both cases, namely finger opening. This distinction between simple and complex forms stems fundamentally from the level of "noise" that the movement generates, caused by the phenomenon of mutual occlusion that is formed between the fingers at the time the gesture itself is performed. As occlusions increase, noise increases and consequently the user's ability to control and manage the form decreases.

This experience can be said to straddle the influences from action painting and those from generative art. Of the former it retains the gestures, the active participation of the body and the transformation of a movement into a representation; with the latter it retains an assonance of results in graphic terms and the fact that the machine, with its errors and imperfections, participates in no small part in the elaboration, although not to the same extent as in generative art.

3 Results

3.1 Interpretation of shapes

It has been said that the shapes elaborated so far undergo a perceptual process by which they are associated with a determined method of representation, although in reality they do not actually respond to any geometrical rules or graphic constructions other than those precedingly described relating to the movements that generated them.

However, indeed, when one observes a shape generated by a translation, it comes naturally to relate it by analysis to an axonometric projection. The reason why this perceptual phenomenon is to be found in several factors. The first factor can be found in the fact that the surfaces that are formed are not graphically pre-sensed as homogeneous and continuous surfaces due to a lag in reception, so a kind of "frame effect" is generated. It allows the entire construction to be seen in transparency and allows all the horizontal sections present on the form to be distinguished. (Fig. 4)

Finally, we must add the component related to the parallelism of the lines: during the translation of the fingers, we obviously tend to keep each finger on a direction vector that (unless there are finger openings) turns out to be always parallel to that of each other finger, because these fingers belong to the same hand. These parallelisms contribute substantially to the perception of the shape as axonometric.

These works remain, as mentioned above, pure suggestions, useful mainly for the advancement of a strongly abstract graphic experimentation. It turns out to be interesting, in this perspective, the component of elaboration linked to the strong randomness of the gesture: in the sphere of artistic expression, the reconnection of such procedures to some aspects of action painting leads to obtaining new and previously not so easily achievable forms. And it is precisely on this principle of "immediacy" of generation that experimentation gains value, aiming at the recognition of gesture and form and free pictorial reinterpretation.

In contrast to what happens with simple forms, where edges and surfaces are clearly visible and exclusively need critical reading, interpretation, and selection; in complex forms this possibility is absent: layered lines, overlaps, intersections and occlusion imperfections are present in such quantity not allowing what in the interpretative process of the simple form took place in the early stages of "polishing" the predominant marks.

3.2 Digital painting over the shapes

By virtue of this, an experimental experience is proposed here that is analogous to the preceding ones in technique but very different in approach, path, and its conclusions, going back to the basic form to a real object that has an extremely elastic connection with that form. Similar to that which a designed architecture may have with one of the first concept sketches that generated it.

Clearly, this implies that the discretionary aspect takes over any kind of analysis in this case: one does not identify lines, surfaces, but rather mass, solid/void ratio and intensity of sign, with the only obligation being to identify each part as being part of a coherent overall perspective representation as far as it can be interpreted.

The initial form worked on Fig. 5 is deliberately extremely complex: it was generated by two particularly articulated rototranslational movements accompanied by a series of finger openings and closings. This shape is first straightened, in order to be able to identify a plausible horizon line and then interpreted as a shape in its entirety. Unlike in the other cases, where the painting operations are "supplementary" to the sign, here the digital pigment becomes preponderant over the original form, and already in the early stages it is possible to see how free the interpreting of the signs is, and how some of them, despite their graphic strength, are not taken into consideration, as they are considered inconsistent with the form that is taking shape. In the subsequent stages, the forms continue to define themselves, seeking a plausible spatial validity: the main triangular forms are configured as covering architectural elements, retaining the spatiality and lines of force of the original form, while other elements are built up for formal coherence until the final elaboration is obtained. Clearly, the representation obtained during this study cannot be defined as a fully designed architecture: too many fundamental elements of the traditional design process are missing to be able to define such forms as architecture, both aesthetically and functionally, constructively and in relation to the context.

3.3 Conclusions

What in the original intentions would have made the difference within this path would have been the variation, induced by the atypicality of the instrument, of the gestuality of the act of drawing.

Almost immediately, these original intentions were contradicted, overturned by the evolution of experimentation, by the realization of the actual potential of these instruments, but also by the instrumental limitations encountered, by the problems that emerged over time, and, why not, by a personal sensibility that led to favoring some solutions at the expense of others, probably just as valid.

The LEAP motion is undoubtedly a valid instrument, fascinating in some ways and with great potential, yet it presents a whole series of problems related to instrumental precision that in fact could easily dilute any easy enthusiasm, especially if one takes into account the fact that, according to its producers, its extraordinary precision should be its workhorse.

Paradoxically, what it should do best, namely the precision design, becomes what it does worst.

In the area of form generation, there are numerous possibilities that new technologies offer, such as parametric modeling; yet, it is precisely here that one can see the decidedly atypical potential of LEAP motion compared to other,

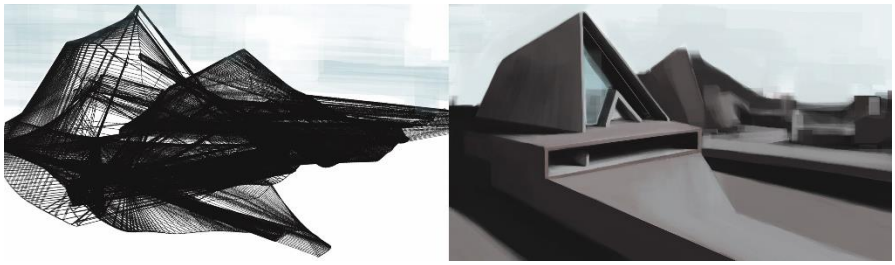

Figure 5. Digital painting over a free form. Source: Elaboration by A. Diacodimitri on Corel Painter Freestyle and Adobe Photoshop, 2016.

more widely used tools: first of all, the figure of the human being, which is "physically" central to the process (and thus not only on an intellectual level), as well as a newfound starring role of drawing as a pure graphic expression of an intention.

The correspondence found between hand gesture and graphic result has in itself a value that relates directly to drawing understood as a material act that performs a certain mental process, thus returning in a sense to the true roots of drawing for design.

Certainly, the results that are obtained with these experimentations are unique, difficult to replicate with other tools (and certainly not with the same immediacy). But their evocative component is still prevalent, especially because of certain cumbersomeness in the process of rationalizing forms.

Further investigation, from a more purely geometric point of view, will be necessary regarding the modalities with which these forms are spatially interpreted, perhaps trying to reconstruct different projection centers that return different patterns of the same projection, in order to hypothesize whether there are some that we are inclined to exclude because they are considered implausible. Precisely the perceptual aspect, which has been addressed here exclusively as a function of the study of the properties of the final products that can be obtained from the two-dimensional forms generated with movement, may become an even more fundamental element of the research, thus necessitating a more reasoned, rigorous, and complete investigation.

4 Discussion

Something as personal and vibrant as the gesture has become the new territory to be colonized by giant technology corporations. Our gestures are increasingly adapted to the tools we are led to purchase, and understanding our movement is just one more attempt to make us familiar with very often unnecessary devices. The example of the Oculus visor from the aforementioned Meta is illustrative in this regard. It is a hardware that has been

constantly implemented (Buckingham, 2021) despite the inevitable problems related to hand tracking (Abdlkarim, …, 2022). The company's CEO Mark Zuckenberg envisions a future where, wearing our headsets, we can meet and work in the Metaverse. Still, everything seems to be extremely vague (Broderick 2022-1). What is implicit is the humanization of a digital space, populated by avatars, that promises endless possibilities. The actual need and usefulness of these digital spaces is all to be proven (Broderick 2022-2), but what this research tries to express is how very often tools born for a certain intent take on completely new connotations.

Experimentation in the field of drawing thus becomes a case study scalable to even very different disciplinary fields. The search for a known and familiar gesture in a novel environment brings to the surface criticalities that are often hidden. Only by changing the point of view, following a trial & error that leads to greater understanding, is it possible to fully understand the possibilities of a tool. What was created for an intent finds through experimentation a new method of expression.

Through the exploration of the possibilities of drawing with bare hands, it is possible to understand how a different gesture, always the result of the human hand, becomes the key to new discoveries. The digital environments in which we will soon move will, hopefully, also find in human gesture a point of reference.

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