Transcultural Languages: 3D Reconstruction of the Wampo Canoe, and Its Interpretation Through Intelligent Technologies on Digital Fabrication

Luis Garcia, Catholic University of Temuco, Chile
Ignacio Bugueno, University of Chile, Chile

The Barcelona Conference on Arts, Media & Culture 2022
Official Conference Proceedings

Abstract
The heritage rescue promoted since 2003 by Unesco in its convention for the safeguarding of the Intangible Cultural Heritage is the foundational basis of our research group, which focuses on the generation of new cultural expressions with the integration of state-of-the-art intelligent technologies. Our objective is to rescue, transcribe/translate and create new expressions based on cultural based raw material and elements. Housed as a project exercise of the Innovation and Territory Laboratory of the Design Department of the Catholic University of Temuco, this work proposes to explore new cultural/artistic experiences. For this purpose, we have identified and selected symbolic elements of the native peoples that inhabited the current Chilean territory, specifically the Mapuche nation, located in Araucanía region. In this case we do a photogrammetry process of one of this canoes and start to thinking about its re-construction with new methods of fabrication, and also propose new materials for the speculative propose. At the end of this work we can offer a several approximations of a new ways of reconstruction, not necessary based on functional approach, but also in a perspective of give some point of discussion about the new technologies and its ethical role.

Keywords: Digital Humanities, Inmaterial Cultural Hertitatge, Mapuche, Lafkenche, Wampo

iafor
The International Academic Forum
www.iafor.org

Introduction

From the Laboratory of Innovation and Territory housed in the Department of Design of the Catholic University of Temuco we have been proposed to perform the crossing between emerging technologies and the registry material of the native peoples who inhabited the current Chilean territory, all with the primary purpose of giving value to the native peoples and ancestral practices, in a sufficiently broad scope from which we can observe and promote correct and restorative eco-social practices [5]. It is under this premise that the FAAD Research Group is currently being developed, a research group open to the faculty, from which we will broaden the spectrum of the proposed research to the arts and architecture.

The pre-Hispanic native peoples that developed on the current Chilean geography moved freely through the territory[1], a territory of abrupt morphology, configured by the Andes mountain as a physical-perceptual limit to the east, and from which are born a significant number of rivers that cross the geography, from its highest elevation, tributaries fed by winter ice, which after the spring thaw flow to the lowest elevation in the west where they flow into the Pacific Ocean, a place where freshwater mixes with salt water.

These native peoples made a conscious reading of the territory, identifying places of passage in the mountain chain where the Mapuche people traveled to the Atlantic Ocean in search of salt, these trips were made at very specific times of the year in which these mountain passes could be crossed. In this drift they also exchanged raw materials and objects such as functional handicrafts with other Mapuche settlements that they encountered on their passage through the territory [44].

The Mapuche people focus their spiritual world around the elements that make up nature, and in this spiritual world they build an arboreal imaginary where they identify some species that make up their spiritual geographic repertoire.

Likewise, this native Mapuche people integrates in their daily actions the consideration of the natural world, this is reflected in daily activities of consideration of the earth and its natural elements. We have witnessed firsthand how the Mapuche communities begin their ceremonial acts by sharing food and drink first with the earth, giving thanks for these and the abundance provided by the soil [37]. In this aspect Hilger [19] highlights how Mapuche children were sent to talk with the soil, the earth, the trees and the animals, in this sort of consideration and horizontality among all of us who are standing on the earth, forming a primordial and necessary part of this interconnected and hyper-influenced ecosystem configuration.

In the shamanic rituals, the Mapuche culture reconnects the local ecology with its ceremonial ritual elements and processes, intertwining its diverse territories or spiritual platforms [16] with man and nature -*Kimün*-, in some of them interpreting the trajectories of birds, imitating their logic of displacement [17] in a surrealist game of activation of the cosmos. All these elements construct the symbolic space of the Mapuche sacred geographic landscape [35], which is evident in their ceremonial rituals.

However, in the southern part of the current Chilean territory there was a significant number of native peoples who designed and built canoes as a means of river transport in both fresh and salt water, of which a significant number of these canoes are still found mainly in European museums [42].

Among them we mention here the Mapuche Lafkenches [36] who occupied the current area of Biobío, Araucanía and the Lakes, as well as the Fuegians in the extreme southern part of the territory, the land of fire, being the Yaganes, Onas, Kaweskar, Alacalufes and Selk'nam [30].

For this specific work we have taken as a reference the Mapuche Lafkenches and their canoe -*wampo*- monoxilo [11].

This Mapuche canoe -wampo- is an element that can, eventually, respond to two different situations between them, but that nevertheless, conceptually possess a common thread, this common thread is the drift or the journey. This is how the -*wampo*- can certainly be used to be transported on fresh water, at the same time that it can be the funeral urn that transports the body in this change of states in the direction of the -*wenumapu*-[13]. Also important is the spiritual consideration of water for the Mapuche culture, water as a transforming element of nature, water as a basic element for human life on which we all depend and which is certainly not an inalienable element or transferable as a consumer good [32], but rather as an element that is part of life [38].

> The rehue (sacred place) is composed of various plants such as maqui (Aristotelia chilensis), canelo (Drymis winteri), quila (Chusquea quila), apple tree (Pyrus malus) and ampe fern (Lophosoria quadripinnata). In the middle of these branches a stick with steps is placed (the rehue strictly speaking) so that the machis can be enraptured in it. They dig a hole, throw in pesos and silver beans and plant the rehue (stick) on these coins (Pascual Coña, Moesbach, 1930, p. 342) [27].

The tree possesses a whole spiritual significance [31][34] for the Mapuche as a configuring element of their -*kimün*- and their -*newen*-, among the identified species that possess a high symbolic significance we find the maqui, the laurel, the araucaria, the eucalyptus, the cinnamon tree and the oak. The latter is used in the construction of the -*chemamüll*- [33], the -*rewe*- and the -*wampo*-, all these elements concentrate the energies they symbolize [18]. The oak (Nothofagus oblicua) is characterized by its stages of growth and evolution, also receiving different names in Mapudungun for each stage, so the young oak is called -*coyan-, coyam*- or -*hualle*- and the mature oak is called -*pellin*-. In their spiritual dimension, some of them are characteristic for their sensorial participation in the daily living, and others are characteristic used in a discursive and ritual dimension [31]. Thus also the oak specifically is used also in the construction of musical instruments Pifilka, louse and the bark for the dyeing of wool [22].

Context

Forests and wood play a fundamental and essential role in Mapuche culture. They consider the tree as a symbolic element endowed with a spirit -*Ngen*-[4][14], as well as a functional element that, as a last resource, serves to heat the house in the form of firewood. The Mapuche concept -itrofil mongen- supports a naturalistic conservationist view of the territory and its abundance. In its functional role it forms part of the construction of elements of diverse scales, furniture, architectural structural elements as well as the symbolic role in the construction of the -*rewe*-, the -*chemamüll*- [47] and the -*wampo*-. This is how we have witnessed the deforestation of native forests at the hands of the forestry industry[20], this industry currently has a negative ecological impact not only on the soil, but also on the immediate surroundings, as well as the consumption of water from the mountain tributaries.

The effect of monocultures and pest control to improve forest production using chemicals has generated such a magnitude of deterioration of the ecosystem [28], eliminating complete links in the food chain, insects, earthworms that are the food of birds and other animals in danger of extinction [3][23][28], modifying and deteriorating this Mapuche spiritual geography, the same effects of the deterioration produced by global warming with its most immediate effect climate change [9], which is modifying and favoring the displacement of tree species and soil use, drying wetlands with the advance of desertification [39].

The Mapuche peoples define the hydrographic basins as the delimitation of territorial occupation [40], considering fluvial transport through these canoes -*wampo*- of the native peoples, mainly for the crossing of people over the rivers [10][46]. According to Lira, these vessels were used in different navigability contexts, and the different shapes of the monoxila canoes developed were verified in these contexts [41]. It is also interesting to note that these navigation techniques were already well established prior to the invasion and domination of Araucania [6] by European plunderers.

> La otra embarcación muy usada en este reyno es de canoas: derriban un árbol grueso y alto, devastan el tronco o plan que ha de servir de quilla, caban el corazón hasta dexar el plan de cuatro dedos de grueso y los costados poco más de dos, y acomodan el güeco para buque, la extremidad más delgada para proa, y la mas gruesa para popa, donde se asienta el que gobierna con una pala que llaman canalete, y quando es grande sirven otros dos de remeros a los lados y reman en pié sin estribar en el bordo de la canoa, con que la trahen tan ligera que apenas toca al agua. Pero como son redondas son celosas y suelen trastornarse. Son moderadas, y la mayor que he visto fué en Tolten, capaz de treinta personas[...].
>
> No son en Chile los árboles tan gruesos, ni tienen los indios instrumentos con que labrar los palos que no alcanzan, sino un toqui o una azuelilla del tamaño de un formon que la encaban como martillo, y con su flema van cabando un arbol gruesso, gastando mucha chicha en tres tiempos, uno al cortar el arbol, otro al desvástarle y otro al concabarle, y otro gasto y fiesata al echarla al agua. Y antes que tubiessen instrumentos de ierro, y los que oy no los tienen en las provincias cercanas al Estrecho de Magallanes, hazen las canoas con gran trabaxo y caban un arbol muy gruesso con fuego, y con unas conchas del mar le van raiendo, aplicando el fuego moderadamente al rededor del arbol, atendiendo a que no gaste sino aquella parte necesaria para derribarle, y con lentas llamas le trozan, sucediendo las conchas, que ni tienen mas achas ni azuelas para descortezarle, pulirle y darle la perfeccion. Y con el mismo trabaxo y faltas de erramientas abren el buque, quemando a pausas el corazon del arbol y raspando con las conchas lo que labra el fuego; y aunque tarde y espaciosamente, vienen a sacar su embarcacion tan bien labrada como si tubieran los instrumentos necesarios; y hazen mas que nuestros artifices, pues sin instrumentos obran a fuerza de industria y de paciencia lo que ellos con ayuda de azerados instrumentos. Tan ingeniosa es la necesidad y la naturaleza en los mas rusticos para su conservacion, como en los mas politicos el arte.
>
> Con estas, aunque debiles canoas, se arroxan al mar a pescar, como lo hazen los de la Imperial en la pesca de las corbinas, que es muy copiosa, y tambien a dar asalto a los enemigos, como lo hizieron en la punta de la Galera, que navegando por el mar en silencio de la noche con diez canoas, salieron a la mar por el rio de Chaguin y desembocaron en las tierras de sotabento del puerto de Valdivia a maloquear a los

> indios amigos de los españoles; pero sentidos de ellos fueron rechazados, y despues de una gran batalla en que quedaron muertos muchos indios, los demas dexaron sus canoas y se echaron al monte, que es alli muy espeso, y de palos secos hizieron balsas y se volvieron a sus tierras (1877) [29].

Likewise, in order to give context to the above, it seems relevant to us the testimony of Mr. Guillermo Reucán, which we present below:

> About its use, my grandfather had a canoe here, because he used to drive it in the lowlands there, on the other side in Tralahuapi, down here, on the beach that goes down to the edge of the road, there was the port. And there they would go out in canoes, they would go to Tralahuapi, to the other side, Curihue, all that. When there were emergencies [...] when a family member died, the telephones they had were the smoke. They had a part where they could build a fire and make smoke. The others on the other side, when they saw the smoke, they would go over here to see what was going on (it took them two hours, sometimes a little more [...] they were heavy, for the rowing, for everything. Because they were not well built, and they were thick. They were four, five inches thick. But the waves didn't move them [...] They made some dowels so that the paddle would hold there [...] Well, here they had a canoe that weighed about five hundred kilos [15].

To summarize, we would like to establish this context in which this work is developed, a complex context configured by an original cultural heritage with its symbolic, territorial and also functional considerations. An original cultural heritage of great value and that through various approaches we put in value through new interpretations, initially digital, which will later become material.

Methodology

In this section we will describe the methodology described to address the issues previously discussed.

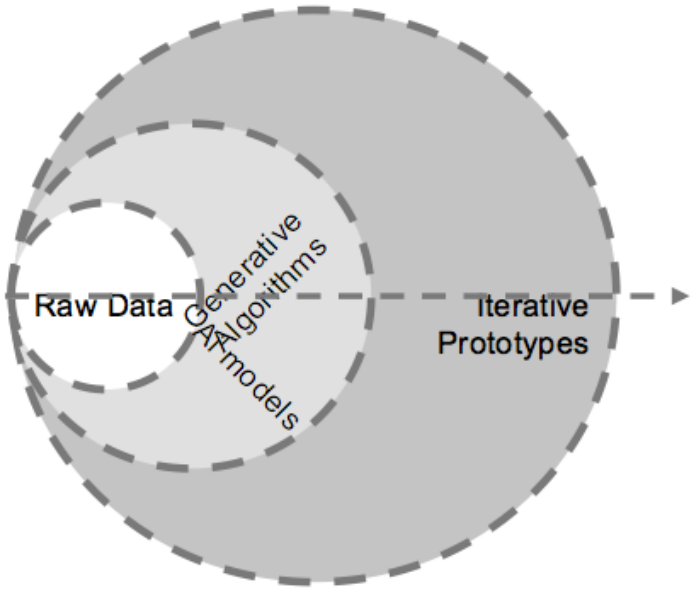

Figure 1: General approach, by the authors.

Figure 1 corresponds to the general graphic that defines our methodological approach based on prototypes, from which, rather than posing a question, we propose digital processes, which after several iterations, we obtain findings that facilitate the formulation of the research question. This iterative process is less conceptual and reflexive, and is based on experimentation as a search process. Certainly here our methodology based on doing sets us apart from traditional methodologies based on scientific research, and brings us closer to the development of both digital and physical prototypes.

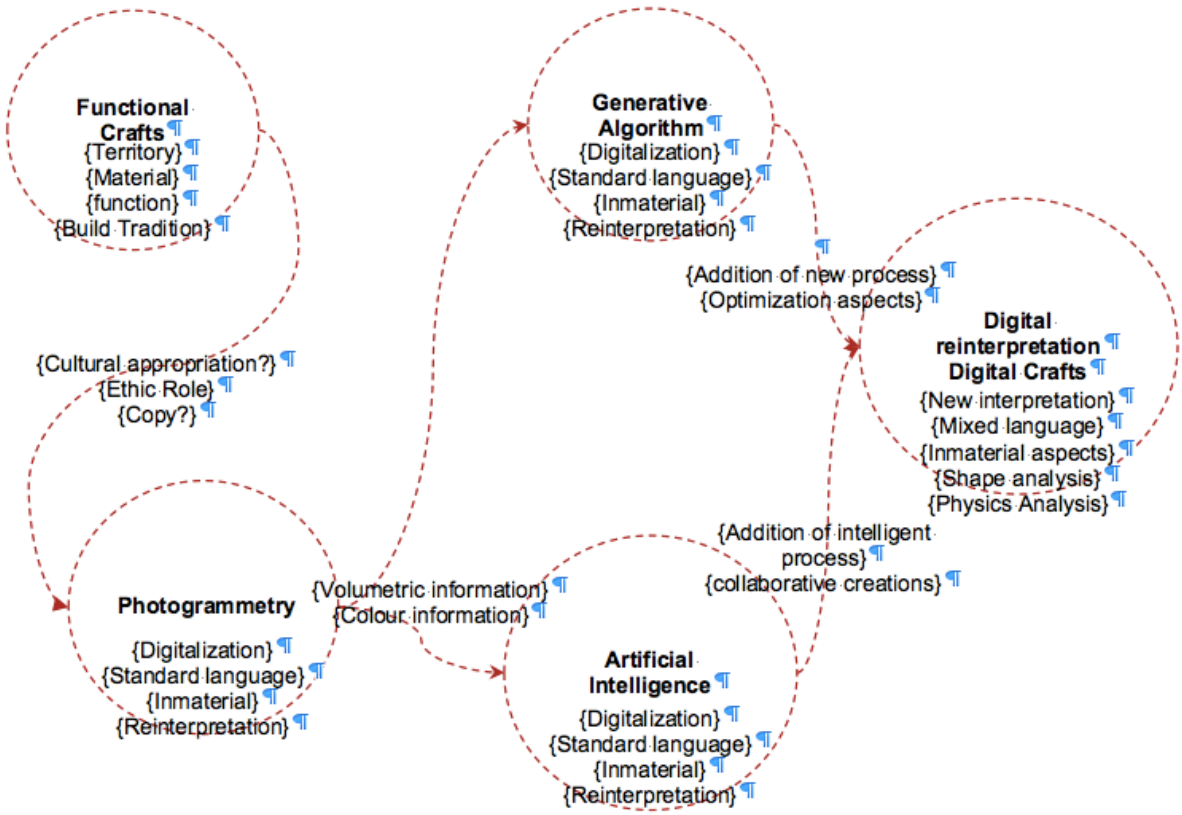

Figure 2: Approach to functional crafts, by the authors.

In figure 2 we present the methodological graph through which we approach the experimental development of prototypes with input data coming from functional crafts, classification that corresponds to our current object of study: the Mapuche -wampo-. In it the work begins with the identification of the material corresponding to the intangible cultural heritage, its classification, the role that this has fulfilled culturally in its original pre-Hispanic environment, mainly, to define our ethical role after this bibliographical review, with respect to our performance. After these previous steps, we point out the process through which we will carry out the digitization of the element, in this case the Mapuche -wampo-. For this particular case we have used photogrammetry with the free software Meshroom [2]. This exercise was proposed within the Design workshop of the third semester of the design career of our university. In this particular case, students David Bustamante and Pablo Sandoval were responsible for making the various photographic sweeps of the element and compile the photographic information that then served as the basis for the development of the prototype. The students' work resulted in a digitally reconstructed assembly of the *-wampo-*, which through an augmented reality application was represented on the lagoon of our campus.

Figure 3: Meshroom[2] results by David Bustamante & Pablo Sandoval.

Figure 4: Final students presentation, by David Bustamante & Pablo Sandoval.

Figure 5: Augmented Reality, students final presentation,
by David Bustamante & Pablo Sandoval.

Although the work of the students could be exposed in the results, we present it here because it is a derivative of our research methodology based on prototypes, with a clear output of application and dissemination, but for the particular case of this work we prefer not to deepen.

Well, for our work we have used the three-dimensional mesh obtained from this photogrammetric process and from this we have made several digital processes for its recomposition and volumetric re-interpretation, which gives us the opportunity to rethink some manufacturing processes.

Discussion

We start the digital prototyping process from the mesh provided by the photogrammetric survey. The first process we perform is the adaptive remeshing from the original. This process of adaptive remeshing allows us to establish a better distribution of the points that determine the definition of the three-dimensional mesh, in this we have defined some values with respect to the original definition, among them we determine the maximum and minimum distance between the new points and the variability that the remeshing process can offer us, This value is relevant because the original field has flat areas, in which the defined points of the mesh can be at a greater distance, and also because of its manual construction, it has areas of greater curvature in which it is necessary to concentrate the points that define the mesh.

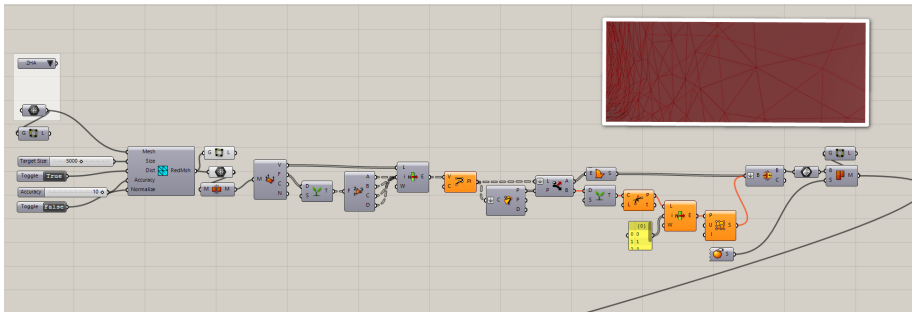

Figure 6: Grasshopper definition, remeshing process, rebuild process Mesh-Surface-Mesh. By the authors.

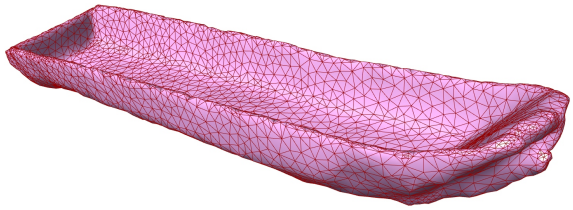

Figure 7: Initial mesh.

The initial mesh is the result obtained from the photogrammetry, to obtain this more than 40 photographs of the object were taken, images that have been shared as a repository in our research group FAAD.

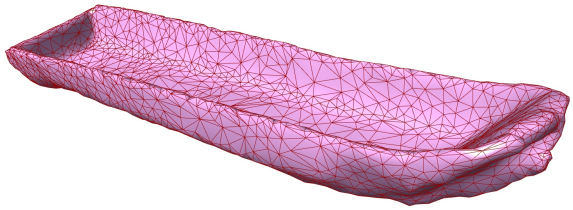

Figure 8: First result from the simplified mesh reduced.

In this process we remove polygons randomly to obtain an adequate amount of points and meshes, this adequate amount is also determined by the amount of data that the hardware is able to compute, so the polygon drop directly affects the computational speed that the hardware is able to offer. We then explode the mesh, extract the points and reconstruct the mesh from these points in a process that simplifies the result.

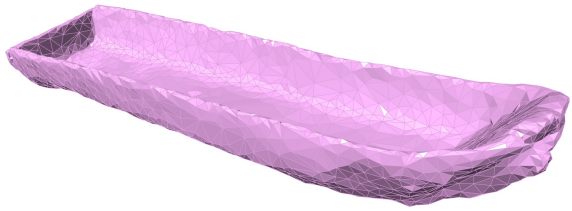

Figure 9: Explode and reconstructed mesh-surface-mesh.

Result of the explosion of the mesh previously reduced and reconstructed on the basis of surfaces.

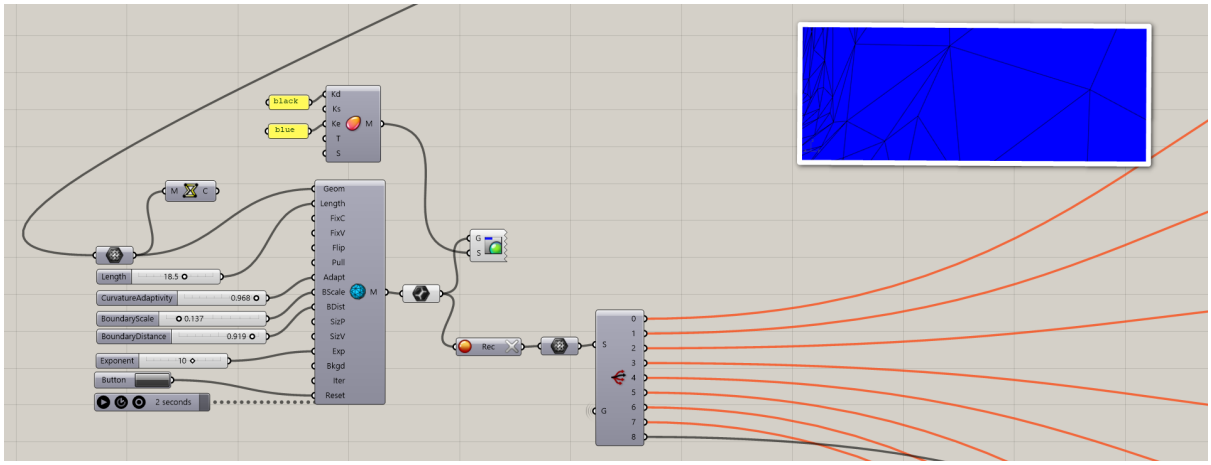

Figure 10: Last remeshing adaptive process. Grasshopper[12] & Meshmachine[26].

In Figure 10 we perform the last remeshing, this time an adaptive remeshing that allows us to control the disposition of the points that define the final mesh.

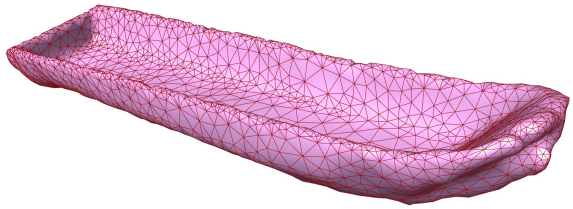

Figure 11: Last result from the adaptive curvature remesh.

Last result of the adaptive remeshing, in this one we verify the separation of points in the flat areas and the accumulation of points for a better definition of the curved areas.

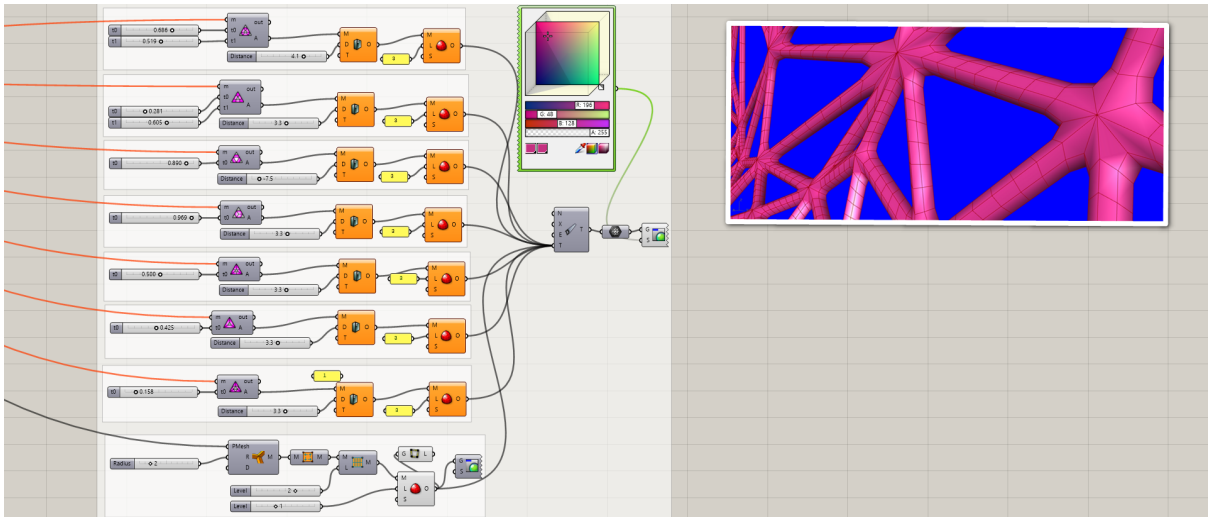

Figure 12: Applying different topological models using Grasshopper[12] & Weaverbird[43].

After the previous steps of optimization of the original mesh, which have been necessary to provide geometric control, we are able to apply topological modifiers which after several processes transform the original mesh into a volume that defines an interior and an exterior, minimum conditions to move to a CAM computerized manufacturing process.

Findings/Results

An unexplored gap for new interpretations of intangible cultural heritage is the proposal of computer-assisted manufacturing processes, these processes should be adapted in terms of materiality and constructive process proposing new discursive and recursive resources in these processes based on the generation of prototypes as a tool for experimental research [24]. At this moment, and based on these results, we are in the definition of the productive processes that we will integrate for this purpose [7] [8] [21]. The validation of this methodology that links the analog world with the digital world, opening the geometric paradigm of the reproducibility of the works in question, seems to us to be relevant.

On the other hand, the models trained in artificial intelligence also offer us the realization of learning with respect to the analogous processes of traditional manufacture, so we could think of training a model in the traditional way of the manufacture of canoes -wampo- mapuche.

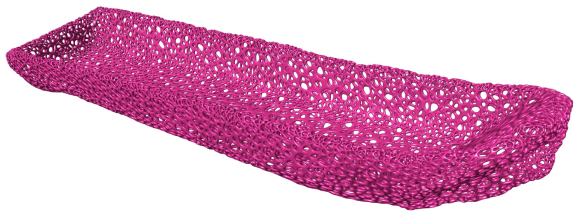

Figure 13: Result 1 of applying topological transformation.

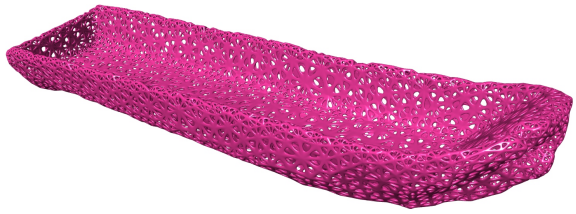

Figure 14: Result 2 of applying topological transformation.

Each of the results proposed by the programming and geometric algorithms solved by the topological modifier offers several areas of customization, openness and other elements.

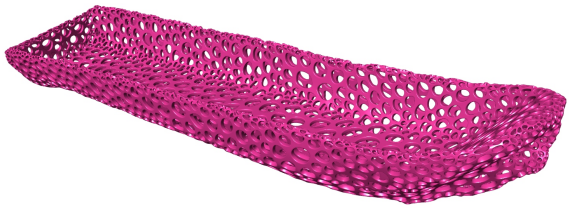

Figure 15: Result 3 of applying topological transformation.

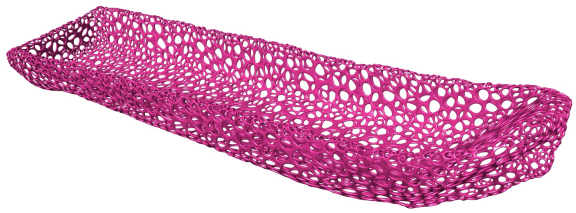

Figure 16: Result 4 of applying topological transformation.

The analysis of these geometrical results thus guides the future development of a geometry adaptable to analogous manufacturing processes for these geometries.

Conclusions

Digital platforms and AI models enable us to build a new computer language of the elements of the functional crafts elements of native peoples, which enables us to use this material for new evolutionary constructions that evolve over time. A new constructive approach also brings with it new tools and possible materialities [25][45], which proposes a research field of interest for our FAAD research group.

With respect to digital humanities, we can at least verify that this work correctly performs an educational task of dissemination of the intangible cultural heritage of the native peoples of the current Chilean territory. This revisit to these elements brings with it new challenges that evolve with technologies, as part of this work we find relevant the descent made by our students regarding the proposed methodology, who finally will be responsible for the recovery and enhancement of these elements, which build our local identity, and that through these project exercises are revitalized and configured raw material rich in meanings.

We would like to stay with some aspects that flutter our development:

1) To redefine these ethical aspects and how they influence the proposed methodology.
2) Prototype these new proposals for the reconstruction of functional crafts elements.
3) Analyze these new elements with a whole new way of perspective.

Acknowledgements

We thank here the deanship of our faculty, for offering the necessary spaces so that this drift, which links intangible cultural heritage and new technologies, has a space from which to plant a seed that we believe will germinate to the extent that each of these proposed perspectives have, certainly, its descent to the undergraduate.

Here we also acknowledge the space provided by the Department of Design of the UC Temuco, who constantly supports these instances of participation in conferences and journals. Likewise, we would like to thank the Research and Innovation Department of UC Temuco for its support, necessary for the confirmation of participation in this congress.

References

[1] Antivil Marinao, Wladimir. (2018). Dibujando la Araucanía: la construcción, la forma y el dominio de un territorio.

[2] AliceVision | Photogrammetric Computer Vision Framework. (2022). Retrieved 24 October 2022, from https://alicevision.org/

[3] Alvarez-Garreton, C., Lara, A., Boisier, J. P., & Galleguillos, M. (2019). The Impacts of Native Forests and Forest Plantations on Water Supply in Chile. Forests, 10(6), 473. MDPI AG. Retrieved from http://dx.doi.org/10.3390/f10060473

[4] Bacigalupo, Ana Mariella. Ngünechen, el concepto de Dios Mapuche. HISTORIA, Vol. 29, 1995-1996: 43-68.

[5] Bejares, Joaquin. (2019). La educación y cocreación como base para la trasmisión de cultura, patrimonio intangible y proyección de identidad. Base Diseño E Innovación, (4), 126-135. Disponible en: https://revistas.udd.cl/index.php/BDI/article/view/313

[6] Carabias Amor, Diego & Chapanoff, Miguel & Adán, Leonor. (2007). Evidencias de navegación en ambientes lacustres precordilleranos andinos: evaluación arqueológica subacuática del sitio "Dos Canoas del lago Calafquén".

[7] Carpo, Mario. 2011. The Alphabet and the Algorithm (Writing Architecture) (Inglés) 1st Edición.

[8] Carpo, Mario. 2017. The second digital turn : design beyond intelligence. Cambridge, MA: The MIT Press.

[9] Cayul Marihuan, O. S., & Quilaqueo Rapimán, D. (2019). Cambio climático en Lonquimay: conocimiento científico y conocimiento local Mapuche-Pehuenche. Revista Austral De Ciencias Sociales, (37), 123–138. https://doi.org/10.4206/rev.austral.cienc.soc.2019.n37-07

[10] Carabias A., Diego, Lira S., Nicolas, & Adán A., Leonor. (2010). Reflexiones en torno al uso de embarcaciones monóxilas en ambientes boscosos lacustres precordilleranos andinos, zona centro-sur de Chile. Magallania (Punta Arenas), 38(1), 87-108. https://dx.doi.org/10.4067/S0718-22442010000100006

[11] Diaz-Vaz, Juan E., & Lira, Nicolás, & Muñoz, Susana (2012). Análisis de conservación y estructura celular de la madera de seis canoas monóxilas del centro sur de Chile. Magallania, 40(1),307-318.[fecha de Consulta 26 de Septiembre de 2022]. ISSN: 0718-0209. Disponible en: https://www.redalyc.org/articulo.oa?id=50623277018

[12] Grasshopper | David Rutten. (2022). Retrieved 24 October 2022, from https://ieatbugsforbreakfast.wordpress.com/

[13] Grebe, M. E. (1993-1994). “El subsistema de los ngen en la religiosidad mapuche”. Revista Chilena de Antropología, 45-64.

[14] Grebe, M. E. (2000). “Relaciones hombre/naturaleza en la cultura mapuche. Los Ngen: sus implicancias y proyecciones socioculturales”. IX Jornada de Alternativas Religiosas en América Latina, (pp. 1-8). Buenos Aires.

[15] Godoy, Marcelo & San Martin, Nicolás. Etnoarqueología para la Comprensión de las Canoas del Lago Calafquen, Panguipulli, Región de Los Ríos, Chile. 6° Congreso Chileno de Antropología, Nov 2007, Valdivia, Chile. pp.1906-1918. ffhal-01984837f.

[16] Guederiaga, Jon. 2010. Drama y Símbolo en la Espiritualidad Mapuche. [Online] https://www.educacion.gob.es/teseo/imprimirFicheroTesis.do?idFichero=%2FVDUjKX1WJc%3D

[17] Gundermann Kröll, Hans. (1985). Interpretación estructural de una danza ritual mapuche.

[18] Gutiérrez Pilquiman, Yessenia Tamar. (2017). Estudio etnobotánico del bosque nativo y su vinculación con cuatro pueblos originarios presentes en el museo de la vivienda tradicional local. Universidad De Chile. Retrieved from https://repositorio.uchile.cl/handle/2250/151408

[19] Hilger, I. (1957). Araucanian child life and its cultural background. Washington: Smithsonian lnstitution.

[20] INFOR - Instituto Forestal, &. (2022). Infor :: Estadisticas Forestales. Retrieved 24 October 2022, from https://wef.infor.cl/index.php/mapa-industria?view=mapa

[21] Jacobs, Jennifer. “Algorithmic Craft: The Synthesis of Computational Design, Digital Fabrication, and Hand Craft – MIT Media Lab.” MIT Media Lab, 2017, https://www.media.mit.edu/publications/algorithmic-craft/

[22] Juan C. Skewes* , Debbie E. Guerra**. On trees and people: The presence of the oak (Nothofagus obliqua) in the Andes mountain life of the Mapuche People in the Valdivia river basin.

[23] Langman, J. (2022). Chile’s threatened forests | Patagonia´s Magazine: Patagon Journal. Retrieved 24 October 2022, from https://www.patagonjournal.com/index.php?option=com_content&view=article&id=4189%3Achiles-threatened-forests-&catid=190%3Aconservation&Itemid=385&lang=en

[24] Mc Cullough, Malcolm. Abstracting Craft The Practiced Digital Hand.

[25] Malé Alemany, Marta. 2016. El potencial de la fabricación aditiva en la arquitectura : hacia un nuevo paradigma para el diseño y la construcción.

[26] MeshMachine | Daniel Piker, . (2022). Retrieved 24 October 2022, from https://github.com/Dan-Piker

[27] Moesbach, E. W. (1930). Vida y costumbres de los indígenas araucanos de la segunda mitad del siglo XIX. Santiago: Imprenta Cervantes.

[28] Noh, Jk., Echeverría, C., Pauchard, A. et al. Extinction debt in a biodiversity hotspot: the case of the Chilean Winter Rainfall-Valdivian Forests. Landscape Ecol Eng 15, 1–12 (2019). https://doi.org/10.1007/s11355-018-0352-3

[29] Rosales, Diego de, 1601-1677. Historia general de el Reyno de Chile: Flandes Indiano: tomo 1 (pp. 174). Disponible en Memoria Chilena, Biblioteca Nacional de Chile http://www.memoriachilena.cl/602/w3-article-8023.html

[30] Gusinde, Martín. 2020. Fueguinos. Una crónica sobre los pueblos australes. Alquimia Ediciones.

[31] Riquelme Maulén, Wladimir. (2019). Árboles y geografías sagradas de la espiritualidad mapuche contemporánea.

[32] Rojas, Massiel & Garcia, Patricia. (2019). Cosmopolitical strategies for the water defense in Mapuche-Huilliche territory. Water and Landscape. 45-56. 10.17561/at.14.4566.

[33] Saavedra, Jose y Salas, Eugenio. (2019). El Chemamüll: Tradición sagrada, pervivencia y símbolo de resistencia cultural mapuche. Mendoza, Argentina. Cuadernos de Historia del Arte – Nº 32, NE Nº 7 ISSN: 0070-1688 ISSN (virtual): 2618-5555. Instituto de Historia del Arte – FFyL – UNCuyo.

[34] Skewes, Juan & Guerra, Debbie. (2015). On trees and people: The presence of the oak (Nothofagus obliqua) in the Andes mountain life of the Mapuche People in the Valdivia river basin. 1. 189-210.

[35] Soublette, Gaston. (2015). Youtube. Entrevista a Gastón Soublette - Parte III: La Cultura Mapuche. Disponible en: https://www.youtube.com/watch?v=N27LAd906yM

[36] Tapia Diego y Martinez, Jorge. (2007). El Newen la fuerza que mueve a la música Lafkenche en el lago Budi.

[37] Vicuña, M. E. G. (1992). El concepto de Ngen en la cultura Mapuche. Revista de lenguas y literatura indoamericanas.

[38] Nacional, B. (2022). Biblioteca del Congreso Nacional | Ley Chile. Retrieved 24 October 2022, from https://www.bcn.cl/leychile/navegar?idNorma=1174443&idParte=10322783&idVersion=2022-04-06

[39] Soto Alvarez, G. (1999?). Mapa preliminar de la desertificación en Chile, por comunas. [La Serena, Chile]: CONAF.

[40] López Huertas, Mario & Valenzuela, Andrea & Carrasco, Claudio. (2017). Propuesta Simbiótica Natural-Cultural en Territorio Mapuche de Arauco. Investigaciones Geográficas. 61. 10.5354/0719-5370.2017.48042.

[41] Lira San Martín, N. (2008).Canoas Monóxilas en el centro-sur de Chile navegando sobre los árboles. Disponible en https://repositorio.uchile.cl/handle/2250/106120

[42] Vila-Mitjà, A., & Estévez Escalera, J. (2022). Fotografías de canoas y modelos de canoas fueguinas en museos europeos. Retrieved 26 September 2022, from https://digital.csic.es/handle/10261/159171

[43] Weaverbird – Topological Mesh Editor | Giulio Piacentino. (2022). Retrieved 24 October 2022, from https://www.giuliopiacentino.com/weaverbird/

[44] Zeballos, Estanislao. (1998). Painé y la dinastía de los zorros. Buenos Aires Argentina. Ediciones el Elefente Blanco.

[45] Zoran, Amit & Buechley, Leah. Zoran, Amit, and Leah Buechley. "Hybrid Reassemblage: An Exploration of Craft, Digital Fabrication and Artifact Uniqueness." Leonardo 46.1 (2013): 4–10. © 2013 The MIT Press.

[46] Mancilla Ivaca, Nastassja Nicole & Valenzuela Sepulveda, Victor Hugo. Reconstrucción del wampo: El reflote de los significados Mapuche como practica resistente.

[47] Saavedra, José y Salas, Eugenio. El Chemamüll: Tradición, pervivencia y resistencia cultural mapuche. pp. 33-103.