N. Gu, S. Watanabe, H. Erhan, M. Hank Haeusler, W. Huang, R. Sosa (eds.), *Rethinking Comprehensive Design: Speculative Counterculture, Proceedings of the 19th International Conference on Computer-Aided Architectural Design Research in Asia CAADRIA 2014,* 317–326.

THE ROLE OF THE RECORD AND THE PARADOX OF THE ORIGINAL

Implications for the re-construction of historic buildings affected by earthquakes in Chile

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Abstract. Earthquakes have progressively destroyed the Chilean built heritage over the years, not only due to the initial devastation they produce, but also as a result of the applied reconstruction approaches that follow. The design of reconstruction projects has usually aimed to re-establish the previous built form of historic buildings; generating new 'heritage' constructions that try to imitate only the appearance of previous ones rather than understanding that heritage, in the case studied, includes a sustainable mode of construction. This issue occurs in places where previous records are sometimes non-existent, which poses the question of authenticity. Considering the regularity of earthquakes in Chile, the role of accurate recording technologies, such as 3D laser scanning, becomes relevant. Their implications for new and existing architectures in the re-construction process include being a virtual database for demolition, retrofitting, intervention or replica. This paper examines the survey of the church of *San Lorenzo* de *Tarapacá* obtained in January 2013, and discusses how this, in conjunction with previous records, might impact on what is considered heritage and the design of future reconstructions.

Keywords. Earthquakes; 3D scanning; heritage intervention; replica; *Tarapacá.*

1. The 2005 earthquake and the record

In June 2005 an earthquake of 7.9 on the Richter scale affected the northern area of Chile. *Tarapacá* was one of several affected historic areas in the region. It was the most destructive event that had happened in the area since 1987.

The village of *Tarapacá* dates from 1717, and its church from 1720. Both are recognized for their historical significance: the church was declared a 'National Monument' in 1951 and the village, a 'Typical Zone' – or traditional area- in 1973. Both categories are defined by the Council of National Monuments of Chile to protect built heritage and regulate built intervention.

Old records of these areas are dispersed and show mainly isolated buildings, and as such they do not allow us to form an idea of how the village used to look like at specific historical moments. Additionally, available records are usually produced after a destructive event has occurred; it is almost impossible to find a record of a heritage building that has not been affected by any earthquake in some way, as earthquakes happen regularly in Chile.

> On average, one earthquake above eight in magnitude is produced every ten years in a different part of the Chilean territory. (Madariaga, 1998)

In this context, accurate recording technologies might play an important role for future conservation, intervention, reparation and re-construction of historic buildings.

2. 3D laser scanning

3D laser scanning can be a powerful tool for an accurate recording, as it combines laser measurements and photographs to build a colour, measurable 3D model of the reality in a short period of time. The application of this tool has been used before in post-earthquake assessment, but has not yet been used to question the nature of the reconstruction, whereby a series of paradoxes can be identified. This paper will focus on the paradox of the original and its implications in the design process after the earthquake (1).

3D laser scanning is not a new technology, but it has become more accessible in recent years, as it is *"(...) quicker, more efficient and more cost effective than ever before"* (ScanLAB Projects, 2012). Current 3D scanning technology varies according to the application. The terrestrial laser scanner, which is the one used in this study, is designed for data collection using a tripod and changing its position after each scan, in order to obtain the complete 3D data of a building or area. Currently, there are even more improvements to this technology: the new environmental scanners can capture a better range of data in less time; they can do the post processing automatically;

and some of them are made even more portable by including handheld lasers to capture the data as the person walks (2).

As a result, 3D laser scanning can be used as powerful damage survey tool considering the amount of data that can be obtained in the limited time frame available in a post-earthquake situation before changes or demolition take place. In order to test this hypothesis, two practitioners (see acknowledgments) recorded the declared heritage area of *Tarapacá* over three days using the terrestrial Scanner Faro Focus 3D, obtaining 178 scans. The scans were taken mainly from the streets, but also from some interiors spaces as a sample, including the church of *San Lorenzo* (Fig.1), the main building of the village.

Figure 1. Transversal section of San Lorenzo's church from 3D data. Source: B.Devilat

It is probable that this technology can play a central role in post-earthquake situations, as it allows us to record, strategically assess, repair, re-construct and speculate about the nature of heritage in a dramatically changing environment.

3. Alternative Approaches to Reconstruction

Although reconstruction and restoration are different concepts, reconstruction is commonly considered within restoration. Issues concerning restoration of historic buildings and monuments had been addressed over the years by many authors, leading to different theories of restoration (Capitel, 1988). For Ruskin, for example, restoration could only be understood as the total destruction of a building, viewed as an act that would inevitably render the building a falsehood (Ruskin, 1849). Other authors have addressed these assumptions, proposing a wider concept of heritage so as to understand its intervention as a creative aesthetic operation (Solá-Morales, 2006)

Currently there is an international consensus concerning intervention into historic buildings, evident in the guidelines defined by the restoration charters, published throughout 20th century (Devilat, 2008). These publications indicate that: interventions must be made in order to consolidate the structure when needed; they must be reversible and recorded; they have to differentiate the new and old elements through materiality, in order to avoid distorting historical evidence; and they must consider the different historical phases of time of the building, among other principles. In this context, the record plays an interesting role. Thus far, it has been successfully used to document the intervention process. However, the existence of such records sometimes produces that no physical traces of those interventions are left visible in the building, which may lead to misunderstanding in the general public.

3D laser scanning, by virtue of its immediacy and universality allows us to speculate about the nature of the reconstruction. The fact of having a 3D scanning record can be seen as an oxymoron when referred to pre and post-earthquake contexts. Imagine a destroyed building that had been 3D scanned prior to an earthquake. We shall assume, in the context of Chile, that the prior scan has taken place as a result of an earlier earthquake where the building in question has largely remained standing. The existence of an accurate record allows for the production of a replica of the previous building. However, the existence of such record could also be used as the justification to knock down what is left and build something completely different in that place, since the 3D record would allow for the exploration of the previous building digitally, and also physically through 3D printed models.

4. The record throughout time

Figure 2 (left) Poirot, F. Aerial view of Tarapacá in 1978-1979. Source: http://www.panoramio.com/photo/1536741 / Figure 3 (right): Same view as before but obtained using the 3D point cloud from the scans taken in 2013. Source: B. Devilat

This leads us to a more complex question. It is already possible to see partial records of buildings over time. As time goes on this record will become increasingly complete. The question is, which previous state of a building should be replicated at 1:1 in the event of irreparable destruction? Some of the issues involved will be now demonstrated, by referring to the history of the rebuilding of the church of *San Lorenzo* de *Tarapacá* as a case study.

The church of *San Lorenzo* de *Tarapacá* was built in 1720 with one nave. The construction of the second one started in 1760, which coincided with an economic growth of the area due to the extraction of minerals nearby (Council of National Monuments, 2013) - although Montandón indicated that the second nave was built in 1878 after the 1987 earthquake while reconstruction works were carried out in the main nave (Montandón, 1990). In any case, it is clear that the church has gone through several changes in its history, most of them related to interventions for its repair and reinforcement after fires and seismic events (Figure. 4).

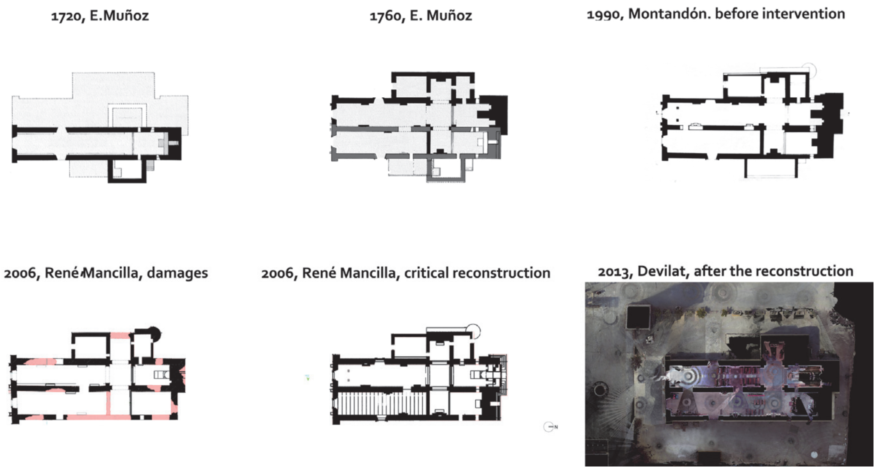

Figure 4: Sequence of available plans of the church, from a hypothetical version in 1720 to the 3D scanning record in 2013. Source: drawings by B. Devilat from authors indicated

The first earthquake recorded occurred in 1877, and is described in the literature as a very strong one. A fire followed in 1879, and then another one in 1887, but the reparation did not happen until 1891 (Salazar, 2012). The church of *San Lorenzo* de *Tarapacá* was declared National Monument in 1951, but that classification did not produce any known conservation or intervention to its structure. In 1955, an earthquake and a fire affected the church and another earthquake in 1976. After all these events, it was the earthquake of 1987 that left the church severely damaged, producing the collapse of some walls and the roof. The tower was repaired one year before that, so it was not affected (Salazar, 2012).

It was that last earthquake that triggered a restoration project. The intervention was designed in three stages: 1988, 1993 and 1997. It considered the inclusion of a roof, which was missing after the previous earthquakes and fires, and the addition of structural supports built in reinforced concrete

(Muñoz, 1999) (Figures 5-6). Two additional interventions were done afterwards in 2001 and 2003. This is how the church and its intervention is described by the Council of National Monuments:

> Built based on adobe walls of 1.70 m thickness and a structural timber system at the exterior. The roofing, originally a two gabled roof, was changed for a three gabled one, as a characteristic feature from other constructions from the period in the area. The roofing was timber structured covered with canes and a layer of mortar of clay and straw (Council of National Monuments, 2013)


Figure 5 (left): The church in 1988 before the intervention. Source: Salazar, 2012

Figure 6 (right): Same view from the 3D scanning information of 2013. Source: B. Devilat

Ironically, this restoration resulted in more damage to the church during the 2005 earthquake, as the concrete reinforcements contributed to the collapse of the old adobe walls (Council of National Monuments, 2013). In all these events, the tower has been less affected than the rest of the building, because of its independent structure.

The most recent reconstruction was done after the 2005 earthquake using over a million dollars of funding from a copper mining company. As structural records of the previous intervention were not available, two comprehensive surveys were done to the ruined church, which included photogrammetry and laser measurement – no 3D scanning, so the project could be designed using that information. The church was rebuilt using the 'critical reconstruction' approach and contemporary materials, as the specific regulation for the repair of adobe in heritage constructions was not created until after the 2010 earthquake in Chile (in use since 2013). The current building represents a state of the building that had never existed; yet that tries to converge the most representative version of it (Fig. 7).

None of the previous records found as comprehensive as the 3D laser scan done in 2013, which poses the question of the role that this record might have in the future. It will allow for a free exploration of further digital records in forthcoming years, where marks and cracks can be identified later as it is not limited to one point of view, unlike photographs. However, as any other record, 3D scanning can only represent one particular moment in time of the building. In this case, it only represents the church after its latter reconstruction. We can, however, virtually recreate other periods of the building in 3D based on the previous information. Stereo-photogrammetry already allows us to create a 3D point cloud using photos, and it is likely that this technology will improve significantly in future (Fig. 8).

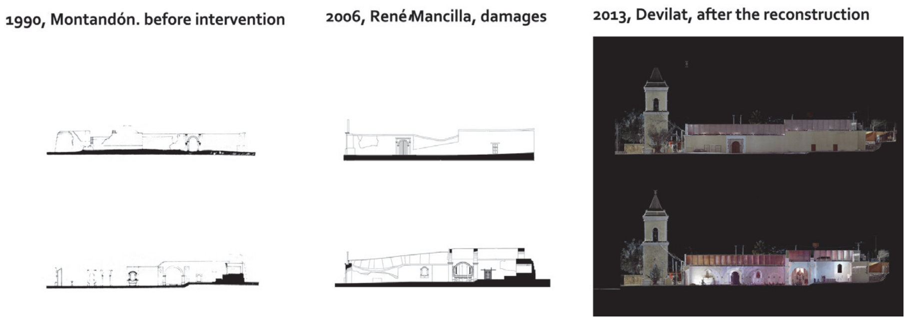

Figure 7: Sequence of the same sections and elevations of the church. From left to right: before the intervention done in the 90's; then, the damage survey done in 2006 after the 2005 earthquake; and finally the 3D scanning information from 2013 after the reconstruction. Source: B. Devilat based on authors indicated

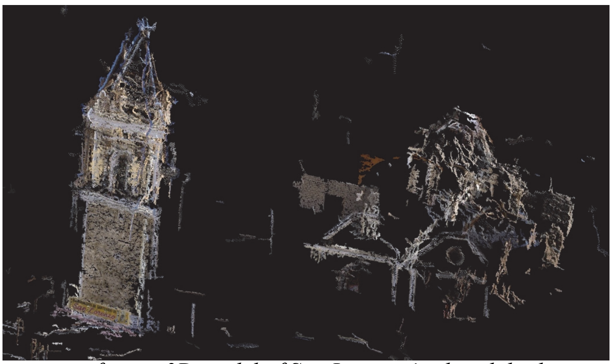

Figure 8. This is view from a 3D model of San Lorenzo's church built using photographs collected from years 2005 and 2006 with vsfm software. It shows the church in ruins after the 2005 earthquake, in a state that will never exist physically again. Source: B. Devilat

5. The paradox of the original

We are led to question whether the rebuilt version of the *San Lorenzo's* church is same building that existed there before and if so, which of the buildings that previously existed. Perhaps the new building is itself an original rather than a copy because it is built in the same place even though most of its elements are new. This is comparable to the paradox of *Ship of Theseus* as described by Plutarch, where the question was if the ship remained the same over time even when almost all of the old planks were replaced. This led to question the authenticity and originality of the reconstructed building. The Cambridge Dictionary defines authenticity as *"the quality of being real or true"***.** In words of Walter Benjamin:

> The authenticity of a thing is the essence of all that is transmissible from its beginning, ranging from its substantive duration to its testimony to the history which it has experienced (Benjamin, 1969).

Philosophers have offered different approaches to the Ship of Theseus' paradox over time. One of those visions is the one offered by Theodore Sider, called four-dimensionalism. For him, the fourth dimension is time, as most of things are changing over time.

Heraclitus said *"Ever-newer waters flow on those who step into the same rivers",* from where it has been questioned if the river would be considered as the same even though it would never have the same water flowing. Four-dimensionalism vision proposes to solve this issue by using time-slices to analyse this situation, where things would be considered the same if they maintain the similar properties over time (Lewis, 1976). Does *San Lorenzo's* church continue being the same in that context? It might be, considering that in the different time-slices mentioned previously it always has had an element of interpretation, incompleteness and change within its built form.

It is interesting to note that for some cultures this is not a paradox at all. For example, the *Ise Shrine* is, by tradition, rebuilt every twenty years to maintain the building's status as forever new and old at the same time, and as a way to pass on the traditional building techniques to new generations. The very first shrine dates from AD685 (Tange and Kawazoe, 1965). It has been*,* most recently built in 2013, the 62st iteration to date. The old shrine was dismantled and the new shrine is being built in an identical adjacent site based on a post that marks the centre of it. The construction is based on the original blueprints, which might not be in use in any other shrine. The rebuilding process is switching from these two sites in a ceremony called *Shikinen Sengu.* Not only shrines form part of this process of continuous renovation, but also other constructions within the site, such a 100 meter long wooden bridge: the *Uji Bridge*. The timber and other materials form the old shrine are recycled and used in post disaster and post earthquakes areas of Japan and also in other Shrines (Japan National Tourism Organisation, 2013). It is worth noting that the timber used for the buildings comes from the woods that surround the sacred area, which are been renovated and replanted with every shrine iteration, so it is a self-sustainable process.

This is a way of keeping a record of a building: to continue to replicate a replica on a regular basis. This gives us a four dimensional version of authenticity, based on replication. For this, the existence of the original is needed to make the copy, in the same way that the old shrine is dismantled only when the new one is ready: *"The presence of the original is the prerequisite to the concept of authenticity"* (Benjamin, 1969). We are led to wonder whether the existence of a 3D virtual model is a presence of the original in Benjamin's terms.

6. Conclusions and projections

Although historic buildings change over the time, especially after earthquakes, the record of them through time has not been systematic, yet reconstruction claims to be 'the same as before'. But that 'before' is not always something clear, as the revision of the available records has made evident, although it is strongly linked to the latest version of the building previous to an earthquake. There is a case for saying that the design of a reconstruction should take account of more than one previous incarnation of a building.

The 3D record will always be the record of a specific moment of a building. A four dimensional approach to include time becomes important to understand the extents and limits of the technology and its potential impact in the collective memory: the amount and accuracy of the data collected with the 3D laser scanner does not transform it into the truthful and real version that should be preserved in future interventions. However, it can be used as a basis for the construction of a progressive record, as a virtual palimpsest of previous conditions of a building. This record can be the basis of an archaeology of a future reconstruction.

The digital record can also be seen as another form of replication. We now approach technologies that allow us to record the form of an object and we are at a point where we can replicate what the building looks like. When we can similarly record materials, perhaps by means of using techniques developed from medicine like MMR, and record of construction techniques (perhaps as a haptic record that could be used by robots), our record will be as strong as the record embodied in the *Ise Shrine*. We can reconstruct the authentic physical replica at any time that we choose. The cultural and social implications will be examined in further studies in the context of other building types.

Endnotes

1. This is part of the design exploration being pursued in the lead author's PhD thesis. First supervisor: Stephen Gage; second supervisor: Camillo Boano.
2. 3D Imaging Day Seminar. University College London, UK. 18th July 2013.

3. The lead author has translated the quotes that were written originally in Spanish.

Acknowledgements

Thanks to Diego Ramírez who facilitated the 3D scanner equipment for the recording of the heritage area of *Tarapacá* and helped the lead author of this paper in the data collection onsite. Also, to the architect Pablo González who gave some insights about the reconstruction project of the church after the 2005 earthquake, in which he participated as part of a team from the University of Chile. Finally, thanks to Amy Thomas and Felipe Lanuza for revising and commenting this paper.

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