A Tangible Chronology

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Abstract

A common task when trying to understand pieces of architecture inside a site is to spot, document and depict changes over time. Quite often successive *states* of an artefact are then represented using emergent, screen-based computer technologies (Virtual reality, Augmented reality, haptic interfaces, etc.). In this contribution we wish to investigate whether some tasks – both communication in workgroups or reasoning tasks – would not be better tackled once freed from the screen as unique interface. We introduce a proof-of-concept prototype, called “tangible chronology” developed in order to represent changes that occurred on Krakow’s market square over a period of 750 years. The paper presents the development and its evaluation, before discussing in what tangible models could serve content holders or academics *specifically in historic sciences,* and in what their making *there* calls specific attention and methods.

Keywords

Architecture, Interfaces, Reasoning, Edutainment, Rapid prototyping

1 Introduction

A common task when trying to understand pieces of architecture inside a site, whatever scale you choose to privilege, is to spot, document and depict their changes over time. This task pulls together different actors, with different agendas, and covers a rather heterogeneous set of challenges. For instance, from the point of view of scholars in historic sciences, the identification of a chronology means inputs, and inputs mean uncertainties, context, etc. On the contrary, content holders, magnetized by what they suppose are the expectations of the wide public; rather tend to minor doubts and to focus on communication tasks. But beyond these possible conflicts, there is a common issue: finding appropriate means to represent something that occurs, develops, and changes in time, and in space.

Ever since XIXth century pioneering works like Minard’s figurative cartography, or Marey’s graphic method, we are entitled to believe that depicting dynamics of change requires specific means and devices - in other words that the analysis of changes implies rethinking traditional visual tools like cartography, plans and section, *etc*. In the “information age” too, notably in *visual analytics*, innovative graphic solutions are put to the fore that renew our capacity to analyse and make decisions on spatio-temporal data sets (see for instance Keim et al 2011).

However, when talking specifically about architecture, focus is still usually put on representing a *state* (“my building in 1605”), rather than changes. Readers probably came through historic edifices, sites, museums, exhibiting either coloured plans or virtual / tangible models showing various stages of development of the edifice. Naturally tangible models may ***now*** appear as “communication old timers”. And it is true that the development of computer applications (GIS, CAD, VR, the internet) and related technologies (LIDAR, laser scanning / 3D displays), have driven most actors to adapt their work methodologies. Seemingly, a time came (two decades ago?) when actors stopped thinking “what can you do with a virtual model that you can’t already do with a tangible plaster or wooden model”. Numerous investments in computer-based solutions later, it might appear rather absurd to consider there can be an alternative to screen-based communication.

Yet, our claim is that, with mature computer technologies and related devices (touch screens, smartphones, *etc.*), with records of successes and failures, it might be time today to re-think this over calmly. In this contribution we intend to turn the question around: “what can we do with a tangible model that we can’t do with a virtual model”? In other words, we wish to demonstrate that maybe there are tasks – including reasoning tasks - that are best tackled once freed from the screen as unique interface. This paper therefore focuses on a clear research question: can physical models over-perform traditional screen-based virtual models (and naturally in which conditions, for which tasks)?

Our contribution introduces a proof-of-concept prototype, called “tangible chronology”, developed in order to represent changes that occurred on Krakow’s market square over a period of 750 years. The prototype combines a master board, 3D physical models of the artefacts, with a coding of their position on the board and in ordinal time, and a tangible timeline for each artefact.

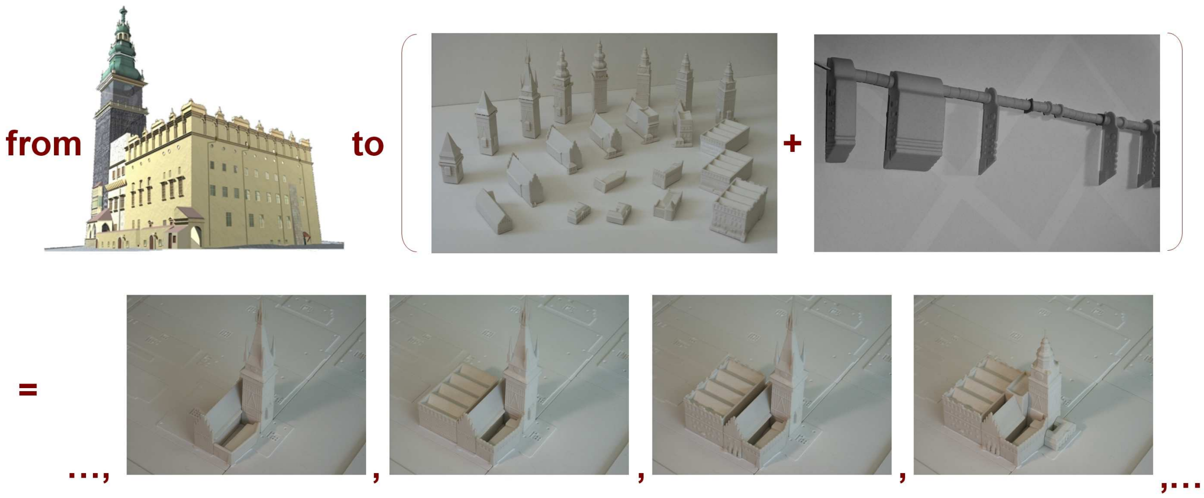

Figure 1 tangible chronology components: experimenting a move from CAD-based virtual environments to tangibility.

Naturally our aim is not to question the usefulness of computers in general: the tangible models we present come out of a fully computer-operated design and production process. Furthermore, tangible interfaces have become a hot research topic within the computer science discipline itself, and limits of the now traditional HCI devices (“mouse/keyboard/screen”) have long been discussed (and exceeded in the gaming industry). We shall therefore not discuss ergonomics on a general ground, but analyse in what tangible models can serve content holders or academics *in historic sciences*, and in what their making *there* calls specific attention and methods. In this paper we shall first comment on this global issue, present the prototype, and conclude with possible future directions.

2 Research context

Over the past 20 years, we have seen the development of a number of technologies that have impacted the way we try to explicit architectural changes over time (changes inside an edifice, changes inside a site). (Mazuryk and Gervautz 1996) or (Novák-Marcinčin et al. 2009) give successive overviews of the some of the most commonly used technologies and CAD-based virtual environments such as VR (virtual reality) and AR (Augmented Reality). Although at start focused on design and analysis tasks, computer-based geometric modelling tools little by little integrated a concern for the visual quality of outputs, with realistic rendering layers introduced within many software packages. In short, what we have seen, notably in applications to historical sciences, is the focus progressively shifting from 3D for analysis to 3D for communication. This is particularly obvious when looking back today on contributions dating of the nineties like (Alkhoven,1993) : her analysis of the evolution of Heusden’s urban fabric, with a consistent classification effort, sheds light on geometric rules & knowledge in an analytical approach that has little to do with some communication-oriented approaches that the rise of technologies has made possible since then.

Under the influence of computer graphics – related fields, of mobile technologies, and of the gaming industry, new ways to deliver the same “virtual world” content have also been introduced – immersive platforms, haptic technology, touchscreen + stylus solutions, mobile devices, etc. It would be irrelevant here to draw the whole history of these technologies, but it appears to us important to state that seemingly, little by little, an idea has made its way inside many circles (wide public, content holders, funding agencies, some scientists, etc.) : *if you want to illustrate how an artefact might have* *been at time t, how it might have been at time t+1, (etc.) , you need comprehensive 3D modelling, and virtual environments (the more the better).* But what if you want to understand time, read & compare densities of changes, durations, overlapping, uncertainties? What if you're interested not only in the effects of time on architectural shapes, but in how the whole story developed over time?

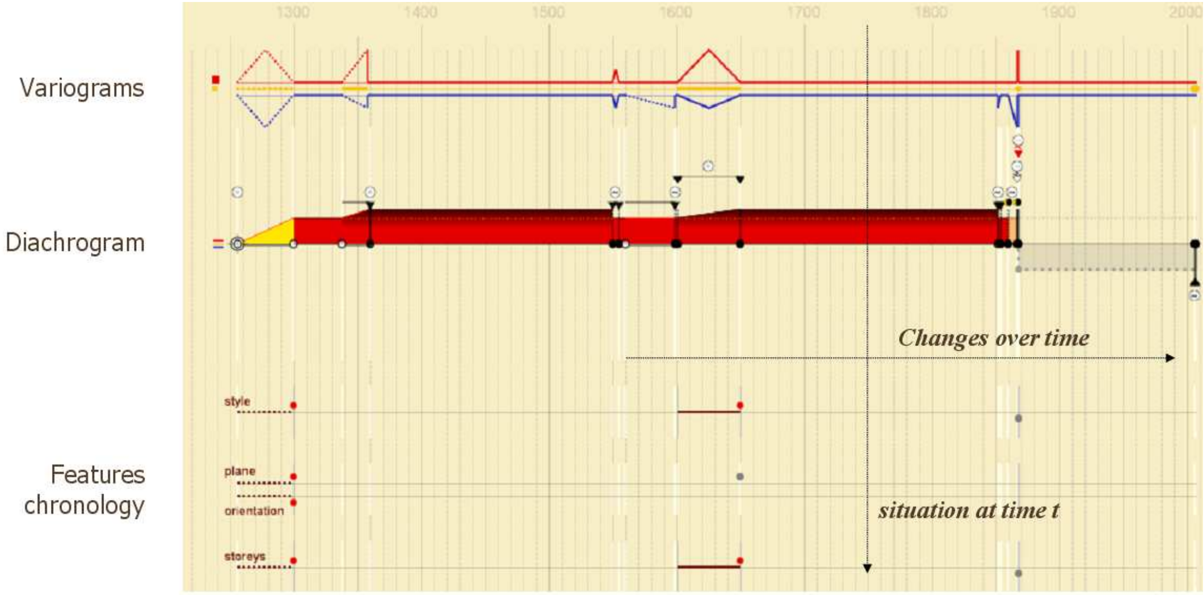

Figure 2 . Correlating pieces of information in time : the chronographs experiment (Dudek and Blaise 2010) combines variograms (parallel reading of morphological/structural/functional changes), a diachrogram (positions typed states and transitions all along the object's lifeline) and chronologies of features.

As food for thinking and debate, let us take a classic example: virtual reality.
Is it that virtual? From the point of view of devices, gloves, helmets, captors are certainly not virtual. Now about the content – so-called virtual worlds. Are software, hardware, files virtual? Well in fact preserving such content on the long run is a recurrent issue, and not at all a virtual one. And so at the end of the day what is virtual in a virtual world? Well what is shown is virtual – pieces of architecture, reconstructed or not, i.e. *virtual* pieces of knowledge about an artefact's evolution. Is this the goal of science?
And what has virtual reality to do with reality? If talking about realism in graphics, well then VR is as difficult to understand as reality itself. Furthermore, the actual reality analysts face when producing or processing historical data is partial indications, heterogeneity, uneven distribution of clues in time and space, etc. Is this the information virtual reality helps delivering? (Raposo and al 2008) comment this recurrent issue with this adroitly imprecise quote from (Devine, 2007) "tension between authenticity and completeness" (sic.) Virtual reality might be "close to a reality", but hardly to the reality of our knowledge on the evolution of artefacts. Our reality is packed with doubts, and therefore one should be cautious with what words like "VR technologies" covertly introduce in our practices.

Now we do acknowledge these arguments are a bit far-reached. But we believe technologies and corresponding practices are now mature enough to try and weigh cold-bloodedly their actual cost – no offence in that, I suppose. Our position is that 3D technologies in general – not only VR – not only at rendering time neither - invite us to say too much: Too much 3D, too many details, too many choices, too much rendering. And at the same time they do not allow us to say enough: not enough temporal aspects, not enough support for uncertainty and alternatives, not enough context. In other words these technologies, although convincing by many ways, might not be fully suited to the kind of pieces of knowledge and info we would like to communicate: they might not be least the only instrument we should use. And when indeed this instrument needs to be used, we then in return should better understand its cost in terms of relevance, readability and faithfulness in the context of historical analysis, and in terms of cognition for the end user.

3 Background and related issues

Naturally, our intent is not to question the impact and potential benefits of emergent “virtual worlds” technologies, in particular since we also use them at times (Blaise and Dudek, 2009). Our intent is to discuss if for some purposes – workgroup discussions, abstract reasoning tasks, acceptability and usability for visually impaired people – we should not put more efforts on alternative solutions.

A full range of approaches do exist, in particular in the fields of *infovis*, positioned by (Friendly 2006), in terms of legacy, at the intersection of cartography, and statistics.

In cartography (Rød 2000) proposes a brilliant analysis of *reality and its representation*, quoting for instance Muercke: “the features on the map represent symbolic versions of reality, not reality itself”. And so a distance with reality would be welcome? (Delaunay 1995) says it in a clear-cut manner: the power of evocation of maps can be found in their capacity to reduce. To this day, at the scale of architecture, what this author calls a reduction process remains ill-formalised.

Moreover, when talking about historical sciences, time obviously plays a major role. But here again, at the scale of architecture, time plays a secondary role – with most often a series of states positioned along a timeline. The focus is usually put on “what did my artefact look like at this period of history, and then 200 years later” in a synchronic approach. Other aspects of the time parameter like densities, durations, and rhythms remain poorly dealt with. By contrast, key contributions have emerged in the visual analytics field on how to handle the parameter time in general terms (Aigner et al 2008), or in the specific context of uncertain data sets (Matousek et al 2007)(Blaise and Dudek, 2011).

4 Motivation and challenges:

Basically our motivation when this research started was to get closer to the reality we handle, and to find some media that, as an end-product, would be relatively free of unevenly mastered technological layers. Tangibility was for us only a track at start, fed by experiences showing physical models, provided that they are adapted to the public, can play a major role in communicating digital content in a more friendly way, as shown for instance by the InterANTARCTICA interactive museum installation presented by (de Bérigny Wall and Wang 2009) or in (Thuvander et al 2008). And indeed, the recent development of rapid prototyping techniques, along with the adoption of de-facto geometrical standards stemming from the industry, opens unprecedented opportunities to rethink the role and impact of physical models. In addition, wireless communication technologies now enable easier interaction between physical models and digital content. It is also important to state that tangibility opens real opportunities for 3D content reuse – a challenge in itself (see Bilasco et al 2006) in particular when looking back on what remains of 20 years of geometric modelling in and around historic architecture.

Accordingly, hot research is today emerging on tangible interfaces for all (for the able-bodied as well as for the disabled people – see braillenet.org for instance) in cultural applications, but also in education (Scarlatos 2002), and more generally in interaction with multimedia content (Hirabashi et al. 2008).

And so at the end of the day tangibility appears as a promising solution, well suited for workgroup activities, relatively technology-free (as far as users are concerned), and what is more bringing in visually impaired people, and people with learning disabilities.

Yet in historical sciences time is key to understanding dynamics of change - and making time tangible is a challenge. Time to time transfers (transferring the 750 years evolution of an artefact into 750 seconds) are theoretically possible, but as shown by W.Aigner (Aigner et al 2008) ill- suited to analytical reasoning since no comparison is possible between events separated in time, or between large numbers of sequences. Furthermore, the readability of such a transfer for the wide public remains to be evaluated.

So to which extent is tangibility compatible with constraints one faces in historical sciences, namely reasoning on the parameter time, and handling uncertainty? A physical model can hardly represent the whole evolution of an artefact, and is by definition rather well-determined (at least in terms of geometry). This is precisely the issue behind the tangible chronology prototype: representing through physical models notions like changes (including non-morphological changes), durations and intervals, doubts. From this issue derive the experiment’s priorities:

1. one product - several possible audiences,
2. one product - several possible uses,
3. communicate on temporal aspects,
4. handle uncertainty in dating,
5. support workgroup discussions,
6. exhaustive spatial & temporal coverage on a test case.

The development and test of the prototype, as will be described in the following section, focuses on these specific challenges.

5 The tangible chronology prototype

The prototype combines four elements: a *masterboard* on which *3D physical models* of the various evolutions of edifices are positioned, *chronocordes* that act as a physical equivalent to timelines, and a carved *variable values dice*. Its specificity lies in tangible codifications used for various purposes, from positioning 3D physical models on the masterboard to confidence assessments. The initial concept, applied to Kraków's medieval market square, was to offer users means to analyse visually and tangibly the site's architectural composition, for any time slot of their choice inside the 750 years covered. To do so users combine on the masterboard *3D physical models* corresponding to each edifice's evolution at the period chosen. In other words, users are supposed to be given enough information to combine physically on the masterboard, and to analyse, *all possible market squares between 1257 and today* (this naturally implies working in discrete time, with a reasonable chronon - here one year - 754 combinations). Both spatial information (where was this edifice?) and temporal information (did it exist at the date I am investigating?, if it did exist, which evolution did it reach?) have to be conveyed. Corresponding tangible codifications are at the heart of the prototype: in this section we first describe each code one by one, before presenting possible scenarios of use it finally comes in, and the test case.

5.1 Code 1: positioning edifices in space on the masterboard

The first thing needed is to position edifices in space, on the *masterboard* representing the market place. Each edifice is localised through a univocal and tangible *geocode* carved in positive beneath the physical model. The geocode is a simple 3 X 3 grid combining flat squares and thick cylinders, measuring approximately 1cm^2 allowing 2^9 combinations. In addition to the grid, the geocode includes a small rectangle, 1cm long, that acts as a positioning pin at assembly time (in order to avoid mirror effects). For each edifice a corresponding geocode is carved in negative on the masterboard, allowing a univocal and fully tangible assembly.

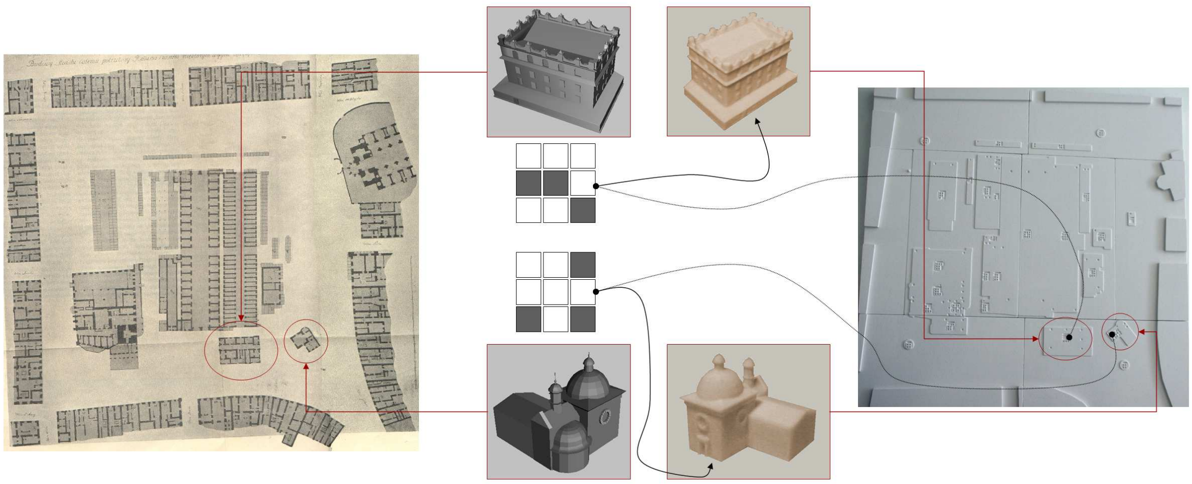

Figure 3 . Concept and implementation of the geocode.

For almost each edifice, and therefore for almost each geocode, there are several 3D physical models, corresponding to the successive morphological evolutions of the edifice. There are for instance nine different 3D physical models for the town's hall belfry – one of the three structures that remain standing up to now (the average number of physical model per edifice is between 3 and 4). And so we needed yet another code to distinguish the edifice's first evolution from the second, the second from the third, *etc*.

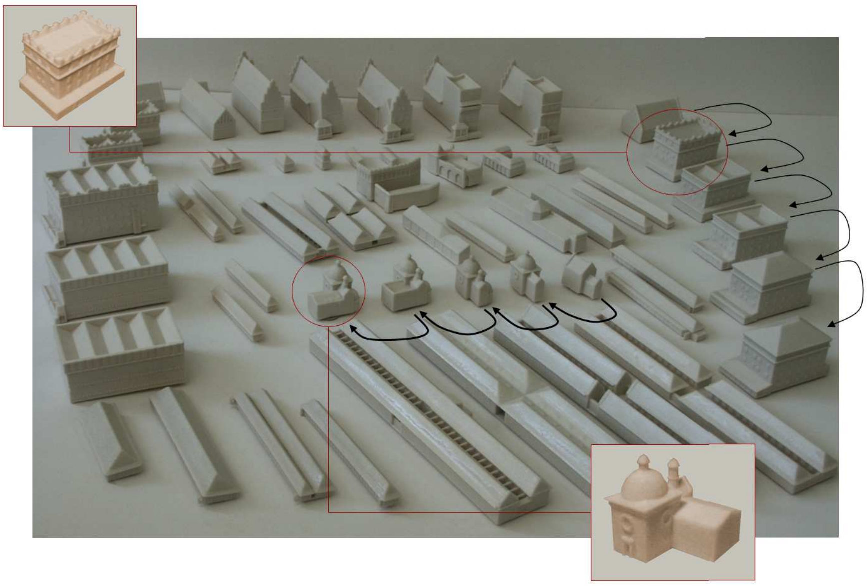

Figure 4 : a number of physical models for each edifice, that need to be ordered in time

5.2 Code 2 : dating evolutions of edifices in ordered time

Each evolution of each edifice is localised in ordered time (*i.e*. first, second, *etc.*) thanks to ordonators (cylindrical pins), a tangible codification carved in positive beneath the physical model. Corresponding slots are carved in negative on the masterboard, allowing users to check at a glance the overall number of known evolutions for each edifice.

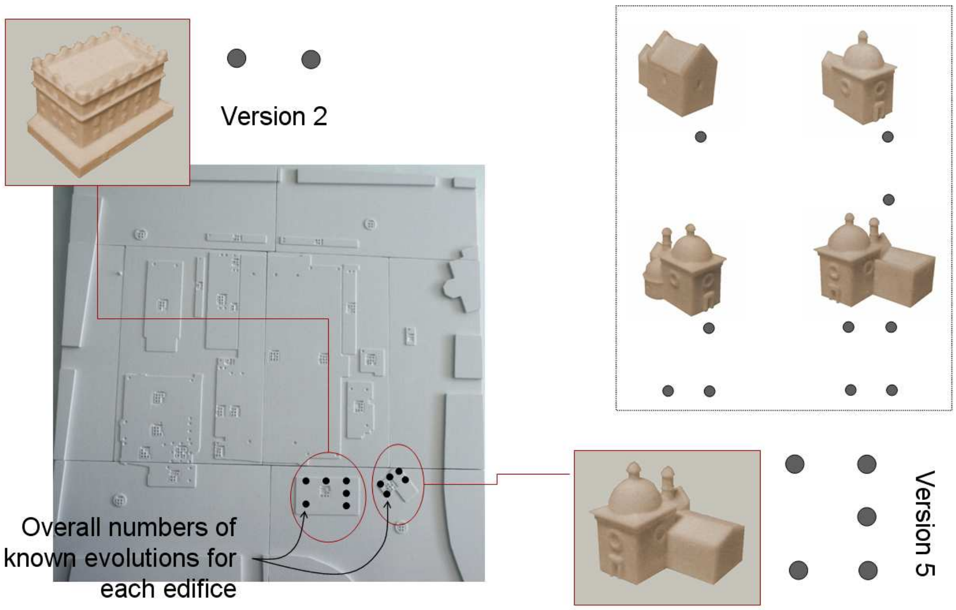

Figure 5 : tangible codification of ordered time

Taken together, geocode and ordonators are a univocal, time + space, patented assembly system. Yet evolutions of edifices are at this stage only ordered, not dated – no direct relation from edifice to edifice is possible, no mean is given to say which evolution was present at this or that year. A third codification was introduced to deliver more in-depth information on temporal aspects of each artefact's lifeline.

5.3 Code 3: localising changes inside edifices in discrete time

For each edifice a sort of tangible timeline called *chronocorde* positions what happens and when in discrete time (chronon 1 year). A chronocorde features tangible codifications of dates, durations, key dates, uncertainty in dating, and differentiates functional transformations from morphological transformations. It is composed (Figure below) of shapes meaning time (square - turn of the century **[a]**; cylinder – decade **[b]**) and of shapes meaning events & processes (thick cylinders - functional transformations **[c]**; plates - dating of a morphological transformation **[d]**). In the case of events & processes, the position of the shape says "when", the width of the shape says "for how long".

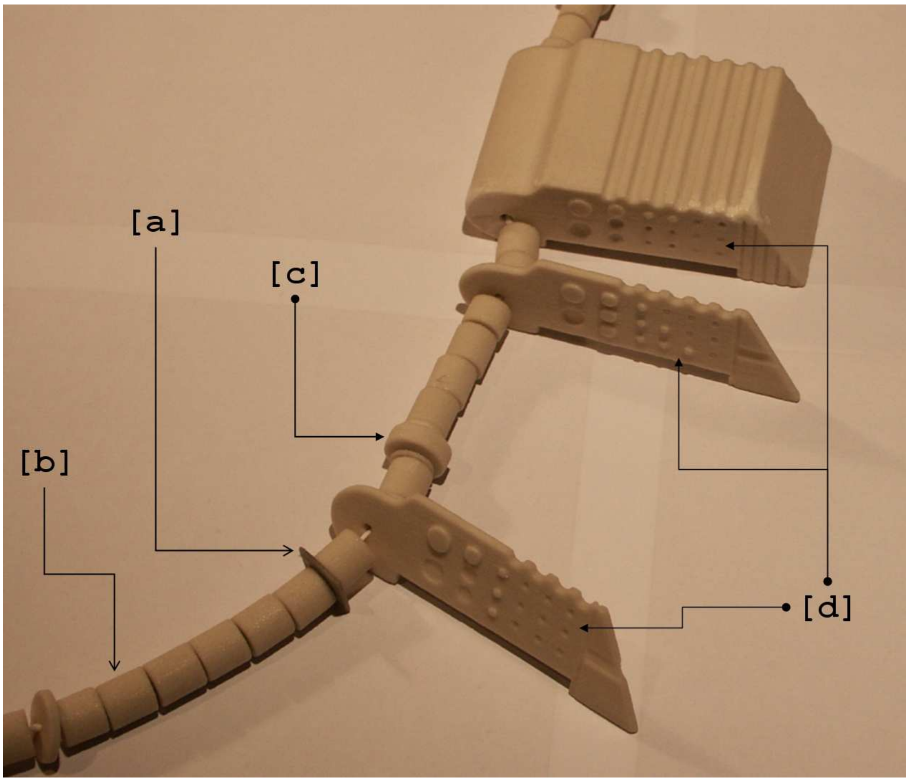

Figure 6 : Chronocordes - basically a tangible equivalent to the concept of timeline

Morphological transformations are dated by a time interval (2 dates in YYYY format). Plates representing these transformations combine three pieces of information:

- The actual numerical dating (YYYY) is coded through small hemispherical shapes on both sides of the plate if the transformation lasted more than the one-year chronon, on one side only if it lasted less than one year.
- The top surface of the plates is engraved with gutter-shaped carvings so as to identify the order of appearance (ordered time) thereby allowing a direct relation of the plate to a given 3D physical model through ordonators (three ordonators <> three carvings) .
- Finally, the foremost side surfaces of plates is carved with different iconic–like tangible shapes that represent a qualitative evaluation of the dating's credibility (data stored as numerical scale).

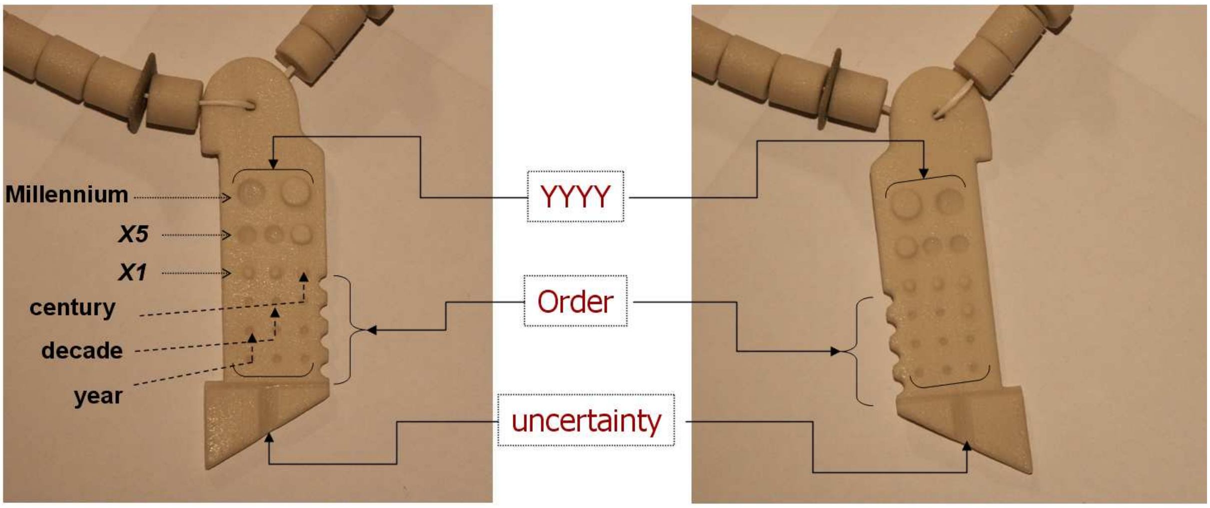

Figure 7: Codification of plates corresponding to morphological transformations

5.4 Code 4 : learning to say less, yet say it all.

At this stage we now can position edifices in space, order then in time, date their changes with, to some extent, an uncertainty assessment. Yet, when talking about uncertainty, besides temporal aspects the morphology has to be taken into consideration (with unknowns of its own). In some cases, the information we have can help state “what kind of edifice” it was in terms of structure and usage but not exactly how many windows it had, or how steep the roof was. And so if we are to question the relevance of tangibility as a media, in the context of weak data sets, we need to learn saying not too much about edifices, with tangible means. Still, as a result of our first evaluation campaign, it appeared clearly that in the case of visually impaired people infos like “how many storeys”, “on which side was the entrance” or “what material” could be very useful to deliver in order to foster comparisons. Accordingly, we introduced codifications that say, broadly speaking, “all we know is…” and thereby help us get closer to saying *all* we know, and *nothing more*. This clearly calls for further development – and is a challenging issue not only in the context of tangible models.

Figure 8: Information delivering through tangible codifications (material, levels, entrance orientation).

5.5 Scenarios of use

Although some issues it raises do call the researcher’s attention, the tangible chronology prototype is primarily targeted at use for the wide public, in the context of museums and/or education. It was initialled developed to serve in the context of expert-guided pedagogical activities planned by the MHK (historical museum of the city of Krakow) as part of its extension.

Elements presented here above can be combined in three scenarios of use: guided interactive workshops, standalone presentation, board game.

In the guided interactive workshops (museum and / or education) mode, users are invited to recompose the market square for any time ***t*** since 1257 under the guidance of an expert who intervenes to comment on the context of the period, the reasons for changes, the historical sources available, the doubts that remain. In this mode all the 3D physical models are laid out on an assembly table, along with their chronocordes. As will be discussed in the evaluation section, the whole installation is part of the educational benefit of the prototype. It favours what in *infovis* is known as *context + focus* approach (giving an interactive access, in the same space, to an overall view the chronology of all edifices and to a detailed view on each evolution of each edifice). It has proven to perform extremely well in terms of support for workgroup discussion – an aspect we had absolutely not anticipated, by the way. Furthermore, unlike one-user computer-centred installations, it clearly encourages collaborative group interactions, and is suited to groups of various sizes. But naturally there is a cost to this benefit: such a use requires guidance. Accordingly, there might be more perspectives of applications in the educational field, as part of the pedagogical material through which the teaching is done, than in traditional museums.

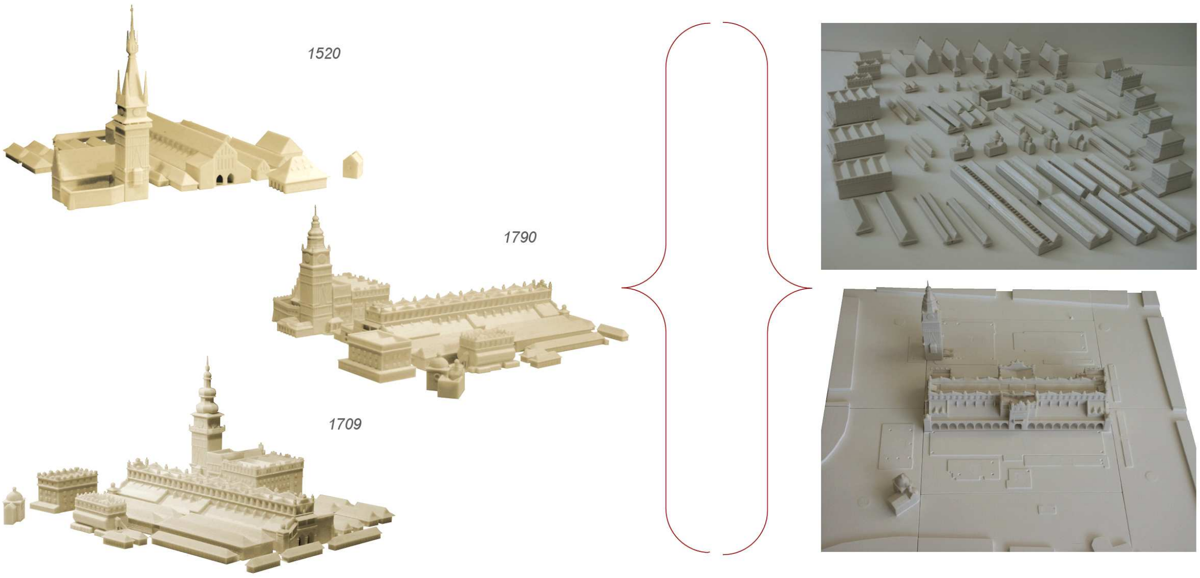

Figure 9: guided workshops use - recomposing the market square at various periods.

The prototype can be also laid out as a standalone presentation: 3D models are then positioned with regards to the morphological transformation plates of the chronocorde. Focus is here put on comparative reading, combining temporal + morphological aspects edifice by edifice.

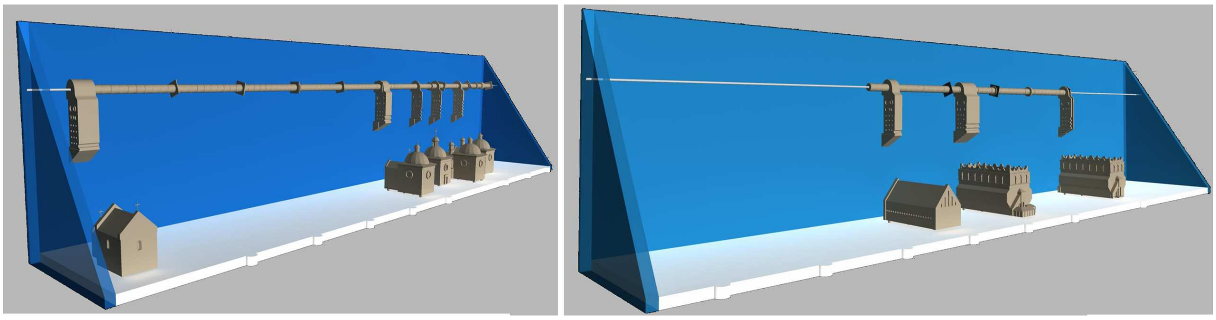

Figure 10: standalone presentation – a visual comparison of lifelines underling densities and durations of changes.

Tangible chronology is clearly an edutainment initiative, allowing users not only to perform data mining tasks by touch and vision, but also to perform intuitive assembling tasks (category 3 of the ESAR classification – Exercise play , Symbolic play ,Assembly, games with Rules, see Garon et al 2002) that are particularly fruitful for people that are emotionally vulnerable, or have learning disabilities. Accordingly, we tried to evaluate where the idea of *playing* with the prototype could lead. A board game was designed for which a dice with variable values was created. The baseline of the game's scenario is to have gamers get hold of edifices, in relation with dice-dependent time slots, and build an “impossible city” (putting together things that did not coexist in time). This application however goes a bit beyond the scope of this paper and we therefore do not detail it further.

5.6 Test case and Production process

As mentioned, our experiment was carried out on the development of Krakow’s market square over the past 750 years. Up to 40 structures coexisted at one moment in time or another during that period inside the 200m x 200m market square – yet only three of them remain up to now. Moreover, most of these structures are known to have changed repeatedly, may it be changes in terms of morphology or in terms of usage.

The documentation, the morphology of each evolution, as well as well as the chronology resulted from comprehensive architectural analyses we carried out and published in the past years, with ad-hoc contributions from our colleagues W.Komorowski and T.Weclawowicz. This input comprised dynamic VRML models, formerly used as interfaces in an online documentation platform (Blaise and Dudek, 2005), and a structured description of changes that occurred on each and every edifice during their lifeline (Dudek and Blaise, 2010). Naturally levels of knowledge, and levels of confidence, strongly vary from edifice to edifice, both in terms of morphology and in terms of dating. Furthermore, inside one edifice’s chronology, doubts exist here and there, and by the way not necessarily for the oldest period, as demonstrated in (Blaise and Dudek, 2011).

We transferred the VRML models into physical shapes with some additional CAD modelling needed to integrate the prototype’s codification (geocode, ordonators).

The actual physical models produced cover 25 structures, and 90 evolutions : we chose in a first stage to leave aside structures that are too weakly documented – their very existence as independent edifices being even questioned. Accordingly we do not claim we managed to transfer the whole indications we have gathered throughout the years to physical models – we did get closer to the reality of the knowledge we handle, but not exactly to it.

The prototype was produced using a rapid prototyping 3D printer from ZCorp. The codification was integrated inside the initial dynamic VRML 3D models so as to avoid dependence to the 3D printer technology. Models were translated into STL format at production time in order to allow geometric checking in the printer-specific software (consistency checking, accuracy, etc.). The *chronocorde* element however remains “hand-modelled” at this stage – a transitory and unsatisfactory situation.

6 Evaluation

At mid-development we carried out a first feasibility / readability check with visually impaired people, blind people, people with learning disabilities, thanks to the cooperation of an association specialised on these issues in Kraków. The idea was to evaluate the whole concept and the tangible codifications through informal discussions. A number of positive points were made on the acceptability and accessibility of the prototype, which apparently was a real help for testers to verbalize questions and concern.

However the readability of the architecture itself was questioned at two levels: the size of the edifices “in the real world” (*i.e.* readability of scale), and a frustration that “you can’t touch what’s inside the edifice”. To the first concern we did react by proposing additional codifications (see section 5.4), but the second obviously requires a change of scale – something we are currently working on, and testing.

More generally speaking, this first evaluation brought us to re-think the way we should try and make space sensible for blind people (typically for instance, direct geometric scaling and transfer from reality to 3D physical models can be totally inappropriate since they imply an a-priori knowledge of architectural spaces not necessarily part of their personal experience).

In a second round, we carried out a more structured evaluation with various age groups in a High school in Kraków (VIII PLO). Testers from three classes (ages 14 to 17) were first presented the various components of the prototype (masterboard, 3Dphysical models, chronocordes) and then left, unguided, with precise questions on the development of the market square. Questions required a clear understanding of the information conveyed by the above components. A typical exercise of the evaluation was for instance, given a painting, to date it by its architectural content using the tangible chronology prototype’s components.

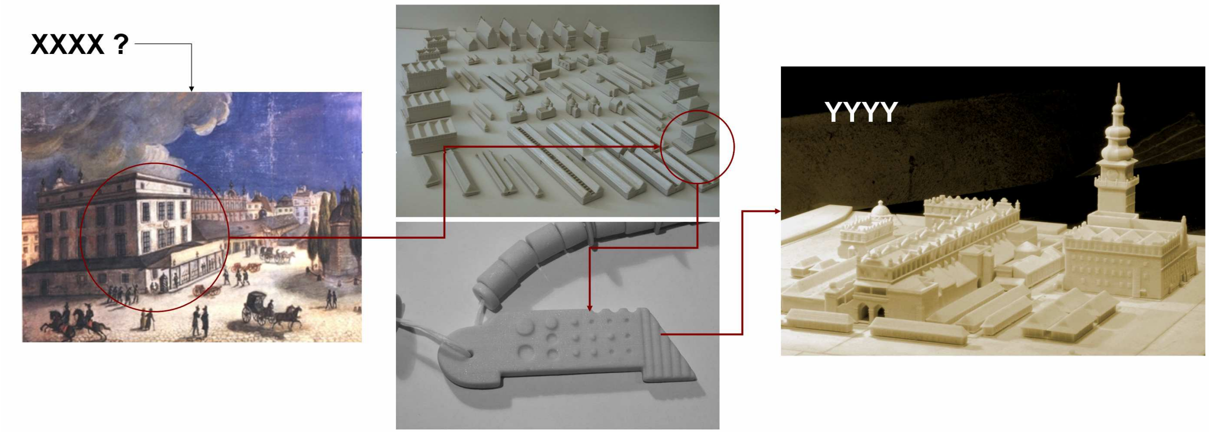

Figure 11: Testing how the prototype supports mining tasks.

Finally, written comments on the overall system were compiled and discussed informally. Lessons from this evaluation can be summed up as follows:

- the prototype clearly favours questioning and interactivity from the audience,
- at this stage an initial guidance is needed,
- the prototype helps shedding light on the process (interpretation of historical clues) rather than on the results (some set of 3D shapes),
- it helps going backwards, back to hints, clues, methods, have them understood by the audience, raises the audience's awareness of historical sciences,
- it uncovers differences in levels of knowledge between various elements in a data set, in our experiment an urban ensemble,
- It puts temporal aspects on equal terms with spatial aspects.

Additionally, and surprisingly in a way at a time when computer gaming is so strong, the board game use raised high interest. More generally, the evaluation proved that saying less, and in a tangible manner, through objects, means leaving more space for interaction and questioning, means more understanding, even fragmental, of what it looks like to face historical data sets – and therefore in what it is challenging, interesting.

7 Conclusion

This contribution was not about reaching to general conclusions on communicating science, but simply about reporting on an experiment through which we have tried to make the evolution of a site tangible. The tangible chronology prototype, initially designed as an edutainment platform in the context of museum activities, does however underline some more general issues:

- Scientists from the Humanities fields are not condemned to be stamp givers for tech developers blinkered by computation capacities and graphic realism.
- In some cases, and in particular in workgroup discussions, traditional "3D Modelling + Virtual environment" solutions are over-verbose solutions, which besides inadequacy to our data prevent users from an appropriation of the challenges behind historical sciences.

In short, what the tangible chronology experiment and its evaluation show is that consistency with the underlying data's specificity (temporal aspects, uncertainty) does not undermine scientific communication, *it helps it*.

It has to be said at this stage that for most of it we could have reached this conclusion without experimenting physical models. The prototype shows a succession of discrete states, and emphasizes time / uncertainty parameters – and this can naturally *also* be done through visual means. IT is not said though that the demonstration that *there is more to Historic Sciences than still life 3D my it be (interactive or, animated),* probably would not have been as radical. In addition, the experiment has not yet come to its end. In a next step we need to integrate technologies for object-computer interaction (*i.e.* 3D physical models / chronocordes as tangible interfaces) in order to deliver multimedia digital content. But for this step to be taken (a step at hand in terms of technology) freeing oneself from the screen's attraction is required from many…

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