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**Architectural transformations on the Market Square in
Krakow. A systematic visual catalogue: Section 1:
Method of analysis**

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Architectural transformations on the Market Square in Krakow. A systematic visual catalogue : Section 1: Method of analysis

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Method of analysis

Section one presents a method of analysis developed over the years in order to model and visualise the evolution of architectural objects. The method combines a systematic description of transformations, qualification and classification of references, and visualisation tools that support reasoning tasks inside an object's lifeline, and across the whole collection of objects.

In this section some fundamental epistemological issues will be discussed (diachronic bias, intersubjectivity, historical criticism, *etc.*). Details will be given on the choices we made in order to describe architectural transformations and to cope with classic uncertainty problems (trustworthiness, precision, credibility, *etc.*). Section one is concluded by a chapter presenting the set of time-oriented data visualisations designed for section two - catalogue, and by an overview of that catalogue's general layout.

1 - Method

According to Henri Poincaré [7], science is, above all, a system of classification, a way of connecting facts apparently dissimilar, although connected by some innate yet hidden kinship. As Poincaré [8] clearly expounds, science is, in other words, a system of relations, for, amongst all that can be observed, only *relations* (between facts) are objective. It is pointless to search for them in unitary objects, considered separately from one another. Hence the need to analyse objects not only as isolated individuals, but also to look for relations among them on diverse levels of granulation (e.g. proximity relations are needed in order to understand how fires spread from an object to its neighbours, whereas at a different level of granulation the presence and position of intersecting passageways is needed in order to study communication flows between the various areas of the Market Square).

But what exactly are the facts and relations we are concerned with? Architecture as an art? Construction as an ensemble of techniques and know-how? People deciding to do this or that? Natural disasters that may have impacted the architecture? Observing facts and relations is here clearly a goal-dependant effort. Umberto Eco [9] puts it this way: ... *when we cannot provide a definition by essence of something* [that we wish to portray], (...) *to make it in some way perceivable, we list its properties...* In other words, we select this and (or) that property, this and (or) that relation, promote this and (or) that classification, and end up with results that are inherently fragmentary, but that *do* foster comprehension.

In addition, one of the bases of the scientific method is *intersubjective verifiability* [10], that is, making sure others have the possibility to trace and critically examine each step of a given analysis process. As a consequence, the method we investigate in this book combines a classification effort (facts and relations) and a readability effort (causal chains, choices made accessible to others).

The method is applied to past events that may have impacted the city's architecture, and this aspect should not be overlooked. Studying past events can usually be described like this: on the basis of various pieces of data, reasons and (or) consequences are identified or supposed, and a hypothetical cause and effect chain is proposed. However, one should be aware of the fact that getting too attached to such constructs can be a mistake, and can lead to faulty conclusions. In history there is no such thing as a unique, direct reason for a given consequence. Reasons - the plural is essential here - are scattered, and a great number of often apparently unrelated and irrelevant facts suddenly may in some place combine, causing a consequence rather than another (church baroqueisation, for instance, is typically a multi-factorial consequence).

When dealing with past events, the data available for us to analyse is naturally limited, and heterogeneous. What is available to us is only this that has remained: documents, traditions or, as far as architecture is concerned, archaeological relics.

When not enough data about an event (construction, transformations, *etc.*) reaches us, when accordingly nothing much can be said about its consequences, it is unsurprisingly arduous to draw conclusions. In such cases analogies are sometimes used [11] - that is, general knowledge about recurrent cause-and-effect relations. However conclusions drawn by means of reasoning by analogy should not be imparted the status of *principles* or *rules* but ought to be considered rather as *hints*.

Note 7. cf. H. Poincaré, *La Valeur de la Science*, (*The value of science*, trad. by authors), Chapitre XI – La science et la réalité, §6 - Objectivité de la science, 1902, [on-line], <http://fr.wikisource.org/wiki/La_Valeur_de_la_Science>

Note 8. *Ibidem*

Note 9. cf. U. Eco, *The infinity of lists*, MacLehose Press, London 2009, p. 15 (translated from Italian by A. McEwen)

Note 10. ... *Intersubjective verifiability is the capacity of a concept to be readily and accurately communicated between different individuals ("intersubjectively"), and to be reproduced under varying circumstances for the purposes of verification. ...*, cf. Wikipedia, [on-line], <http://en.wikipedia.org/wiki/Intersubjective_verifiability>

Intersubjectivity is sometimes called *objectivity*. ... *What is objective should be shared by several minds, and consequently be such that it can be passed on ...* (transl. by the authors) cf. Henri Poincaré, *La Valeur ...*, *op.cit.*

Note 11. For instance, supposing that an object's roofing system corresponds to one of the roofing systems that existed for that historical period and in that region.

Furthermore, the documentation available can be unevenly distributed, in terms of periods, and of objects. A relative accumulation of information for a given period indirectly puts the emphasis on the corresponding step in the object's evolution, whereas a complete lack of information results in "silence in the ether" concerning another step. Informational clusters appear irregularly, with density patterns that should be considered as a significant aspect of our knowledge.

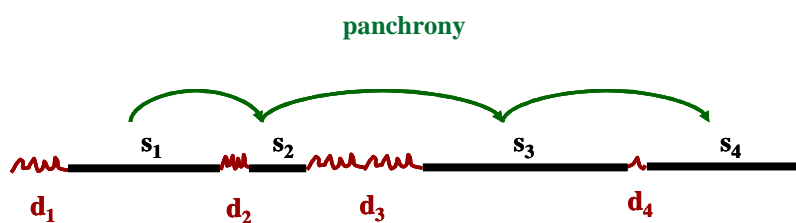
Finally, in an attempt at systematising, specialists have divided the past into conventional time intervals and given them names (e.g. Bronze age), incidentally not always universal (e.g. Piast dynasty, Nara period, etc.) [12]. On the one hand, that makes it easier for people to communicate [13], on the other it has its bad sides: those time intervals are often subdivided, each with experts (sometimes specialising in very short periods of time, e.g. World War II experts) tightening the borders of their territory. This convention has thereby repeatedly led to artificial and counter-productive divisions when studying objects than bridge several such intervals. Indeed, analysing the evolution of an object on long time spans requires a general (transversal) view on the whole developmental process.

The method we investigate in this book applies to past events, running over more than a millennium. Accordingly, it implies handling heterogeneous hints (unevenly distributed in time and space), and causal chains bridging long time spans.

Synchrony vs. Diachrony vs. Panchrony : the method's conceptual framework

Naturally various methods may be used to investigate the past of a given object. The concepts of *synchrony* and *diachrony* were introduced into language analysis by Ferdinand de Saussure, the former meaning analysis of the structure of language, the latter analysis of the evolution of language. Their methodological potential made them transgress the boundaries of linguistics and resulted in them being used at present in the epistemology of a great number of sciences. In the context of this book, the *synchronic analysis* concentrates on the state of the object at a particular historical moment, whereas the *diachronic analysis* allows us to focus on changes over time. The third term, strictly connected with the previous two, is *panchrony*. Oleg Leszczak [14] calls it a *cognitive state* - such as, for instance, knowledge. Panchrony is the concept that allows us to declare that an object retains its identity despite changes.

Using the above notions, the evolution of a given object can be described as a chain of successive *transformations* and *states* - the latter being consequences of the former. Transformation is seen as the diachronic function, subsequent states are seen as synchronic beings which retain the object's identity thanks to knowledge, intuition and experience - the panchronic level. (Fig. 1)



Note 12. The *Piast dynasty* concerns the history of Poland and embraces the period of its first ruling dynasty (from AD c 930 to 1370).

The *Nara period* is specific to the history of Japan (it covers the time interval from AD 710 to 794, when the imperial government was located in the city of Nara, and during which Sinicization and Buddhism were most highly developed).

Note 13. At least within a given culture, and although it is not always possible to explicitly limit particular historical periods.

Note 14. cf. O. Leszczak, *Problem czasu w semiotyce: idiosynchronia B diachronia – panchronia.* (*The problem of time in semiotics: idiosynchrony B diachrony B panchrony*, (transl. by the authors) [in] *The Peculiarity of Man*, vol. 9, Warszawa-Kielce, 2003, pp. 301-330)

Fig. 1. A diagram presenting the evolution of an object as successive *transformations* (d₁, d₂, d₃, ... - the diachronic function) and *states* (s₁, s₂, s₃, ... - subsequent evolutionary stages, that is synchronic beings). *Panchrony* (i.e. knowledge, but also, to a great extent, experience or intuition) is the concept used to maintain an object's identity despite changes.

[I. Dudek, J.Y. Blaise, 2008]

1.1 Persistence of architectural objects

This book is about architectural objects, about how and why they get transformed. And so the first challenging question is: what makes a piece of architecture retain its identity through time and changes? Defining rules on the basis of which the **persistence of identity*** of a given object can be claimed is a crucial problem - in particular if wanting to narrow down “interpretative play” [15].

Neither the uniformity of function, nor the identity of form (object morphology) or even the name under which the object was known, can be the criterion here. The Cloth Hall in Krakow underwent both formal and functional changes. Its name also changed - *Pannitbeca*, *Camerae pannorum*, *Kaufkammer*, *Tuchlauben*. Yet, we generally consider it as one, unambiguous object, retaining its identity through time. Some buildings changed position, but still some people perceive them as one same object, regardless of the otherness of successive states. Even more striking, the market hall for minor traders in Krakow was physically removed at some moment – what remained was only its function, transferred somewhere inside the Cloth Hall. Nevertheless, some sources keep on mentioning the object as such, as if it retained a physical existence [16]. In many other situations - such as translocation, demolition or reconstruction - the decision whether or not to grant an object *persistence of identity* tends to be subjective, when not even emotional [17].

A serious debate on this subject requires a systematic analysis of all transformation types and subsequent states. Inside our area of analysis, narrowed to the historic architecture of Europe, we have so far defined up to eighteen transformation types and eight types of states [18]. Yet we shall make no claim that this is enough to axiomatically define the persistence of identity of an object over time. Thus, we consider the issue remains open, and nothing guarantees it can be solved unequivocally. In fact, the absence of unambiguous criteria when making decisions about the persistence of identity of an object over time is a feature of the knowledge we handle. The purpose of this publication is - as mentioned before - a synthesis of the pieces of knowledge available today concerning the development of the Main Market Square in Krakow. Choices made in the context of this publication will be clarified, object by object, in section 2, and doubts concerning the persistence of identity of objects will be systematically pointed out.

Stating on whether or not an object retains its identity, or establishing filiation relations between objects, is even more arduous when facing what Gershon calls ill-defined knowledge. Our knowledge, depending on the object being analysed, is of more or less hypothetical nature. Some objects are more seldom mentioned and fewer specialists dwell on studying their evolution or verifying facts (the soap or gingerbread stalls for instance are poorly documented, rarely investigated as such, with a number of continuing ambiguities). As a result, in such cases pieces of knowledge we handle are based mainly on **circumstantial evidence***, with a great number of potential, simultaneous solutions.

The visualisations we introduce do take into consideration these doubts (alternative hypotheses, possible results of actions known only from short, incomplete notes, etc.). Applied to the whole collection of objects, this approach may help better understanding individual behaviours, and uncover knowledge patterns.

* Persistence of identity

The fact that a given architectural object, although altered, modified, is still seen as the same. Not to mix with filiation, *i.e.* the fact that a given object inherits something from a previous one (may it be its position or function for instance) but is seen as a different object.

Note 15. Whether a given object, moved from position p to position p' , retains its identity is not a matter of objective reasoning, it is a matter of point of view (goal and method), a matter of intuition and experience. Differences in the ways of analysing and interpreting the identity of an architectural object are probably unavoidable. However, in the context of a systematic catalogue, the issue has to be raised.

Note 16. Consciously or not, two separate concepts are being mixed up here: the concept of a *physical*, independent architectural object and the *functions* for which it is or was used.

Note 17. A good example of this issue is the Royal Castle in Warsaw. Is the object standing today - rebuilt after WWII - the latest state of a unique, persistent object, which underwent a series of transformations including the post WWII reconstruction? Is the reconstructed castle only an “ideological descendant”?

Note 18. For example, transformations comprise *creation, modification, annexation, hibernation, demolition, secession etc.* Typical states are *segmental anaesthesia, reincarnation, abandon, agony, etc.*

More information concerning the above can be found in: I. Dudek, J.Y. Blaise, *Profiling artefact changes: a methodological proposal for the classification and visualisation of architectural transformations*. [in] *Digital Heritage*, M. Ioannides *et al.*, Proceedings of VSMM 2008, Budapest 2008, *Archeolingua*, pp. 349-356

* Circumstantial evidence:

Pieces of information that we interpret as concerning an object (although they do not directly mention it) and basing on which we consider possible transformations.

1.2 Choosing a level of granulation

On the basis of historical sources, scientific studies, or results of field study, events which cause changes in a given object can be detected, described, analysed. But these changes may concern the urban ensemble it belongs to, the whole object as such, its relations to the neighbouring objects, its internal décor, *etc.*. Each of these examples corresponds to a specific “information scale”, a different **level of granulation*** [19].

The level of granulation in this study encompasses **transformations*** of architectural objects with regards to the urban structure (Main Market Square) in terms of role, significance, mutual relations. Therefore, the information that we take into consideration concerns:

- the external form of an object (changes in form or style of elements - as seen from the outside, changes in the cubage or the surface of the object),
- the constructive structure of an object (the materials and structural systems, excluding interior work),
- the functions of an object (each change in usage, *i.e.* adding or lifting it),
- the changes of ownership, which may influence an object’s transformations - or be their result,
- the potential changes of location or of geographical orientation.

Within this level of granulation, we take into consideration a *primary evolutionary factor* – physical changes, that involve a change of appearance, and a *secondary evolutionary factor* - changes of function or ownership (social use). The former imply the emergence of new, separate **evolutionary phases*** in the lifeline of an object, whereas the latter only pinpoint moments within one evolutionary phase. Internal transformations, such as, for instance, the change of internal decor, are not taken into consideration as long as they do not cause or are not connected with the modifications of the external form.

Selecting a unique level of granulation amounts to filter documents, facts, events. Accordingly, we shall leave aside pieces of knowledge and information undoubtedly significant as far as history in general is concerned, but that fall out of the abovementioned area of concern.

1.3 Identification and classification of transformations

Once a given level of granulation has been chosen, and evolutionary factors defined and organised, a set of relevant transformations and succeeding states need to be identified and classified in order to serve as an unambiguous and common ground of comparison for the collection of objects.

The role of a classification is to have items better distinguished – here transformations, and with regards to their specific role in the evolution of an object.

The initial division line of the classification (connected with the definition of the primary evolutionary factor mentioned here above) separates them into two groups: transformations that influence the form (e.g. extension, change of roof shape or facade baroquisation, *etc.*) and transformations which do not involve any crucial changes of form

* Granulation (level of):

Range of problems an analysis wishes to focus on. As a consequence, choosing a level of granulation means operating a *de facto* selection of sources, facts, phenomena, objects.

* Transformation:

Any type of discrete modification that impacts an architectural object, may it result from a volunteer human act, or from an accidental event.

Note 19. What we define as *level of granulation* is sometimes called *the study scale*. The choice of a given level of granulation depends on the problems that we wish to analyse, not on the resolution of spatial units. Therefore we consciously and deliberately do not use the word “scale” so as to avoid misunderstandings connected with the ambiguity of the word.

...with the change of the level of granulation, phenomena change not only in terms of size but in terms of nature ... (transl. by authors)
cf. J. Tricart, *Cours de géographie humaine. (Courses in human geography*, transl. by authors), Fascicule II, *Habitat Urbain*, CDU, Paris 1952

... A change of the level of granulation is connected not only with the omission of details [...] it is an intellectual operation altering, sometimes in a significant way, the issue and way of thinking. A change of scale is connected with a change of the level of analysis and should be linked to a change of the level of conceptualisation ... (transl. by authors)
cf. Y. Lacoste, *La géographie ça sert d’abord à faire la guerre. (Geography serves first of all to make war*, transl. by authors), Maspéro, Paris 1976

...A scale is not included in another one, nor does it contain it [...] It is a register ... (transl. by authors)

P. Boudon (acc. to N. Verdier)

cf. N. Verdier, *L’échelle dans quelques sciences sociales: Petite histoire d’une absence d’interdisciplinarité, (The notion of scale in some sciences: Brief history of the absence of interdisciplinary approach*, transl. by authors), [on-line], <halshs.ccsd.cnrs.fr/docs/00/10/44/85/PDF/verdier_echelle.pdf>

* Evolutionary phase:

A state, following a given transformation, corresponding to a time interval during which the object undergoes no major physical change.

(e.g. renovation aiming at improving the technical state of an object, change of the function, *etc.*).

The first group of transformations is called *leading transformations*. The second group of transformations is called *episodic transformations* since they can episodically appear in any evolutionary phase. Choosing between these two groups of transformations is a decisive point in the analysis process, since it determines the number of evolutionary phases. (Fig. 2)

leading transformations

transformations introducing essential morphological changes, leading to the creation of a new evolutionary phase

- **morphological transformation**

a transformation introducing major physical changes (e.g. construction, extension)

- **regressive transformation**

a transformation leading to the creation of a new evolutionary phase by removing part of an object (e.g. the demolition of a fragment of an object)

- ⊙ **destructive transformation**

a transformation which causes the removal of an object and the retrieval of the whole space occupied by it (e.g. demolition) or a total annihilation of an object

episodic transformations

transformations which can sporadically appear during one evolutionary phase, not leading to volunteer or major morphological changes that would imply a new evolutionary phase

- **degrading transformation**

a transformation which causes the deterioration (aggravation) of the present state but does not result in the creation of a new evolutionary phase (e.g. a fire)

- **neutral transformations**

transformations which do not cause any essential changes of morphology

- **recurring transformation**

a transformation occurring regularly during the evolution of an object (e.g. roof renovation)

- **on-site investigations**

a “non-interventionist” transformation concerning archaeological relics

Leading transformations

As we have pointed out, leading transformations modify the form of an object indelibly, leading to the creation of a new evolutionary phase. The new evolutionary phase may correspond to an expansion process (e.g. heightening, addition of new volumes, *etc.*), as well as to a retraction process, *i.e.* reduction of its components.

A particular case of leading transformation is the *destructive transformation*, and a typical example of the latter is demolition. It leads to the removal of an object, and to the retrieval of the space occupied

Fig. 2. The classification of transformations: *leading* and *episodic* transformations, definitions of the classes, and division lines.

[I. Dudek, J.Y. Blaise, 2011]

by it, which may remain undeveloped (e.g. the Small Scales) or be reused (e.g. the granary, built on the space formerly occupied by the market hall for minor traders) . It is a singular case, since, although undoubtedly the removal of an object changes its form, one could dispute the thesis which assumes that this fact leads to the creation of a new evolutionary phase. The question requires a deeper analysis.

Dismantling and (or) demolition do not usually lead to a complete removal of all the remains of an architectural object [20] – hardly anyone goes to the length of demolishing the underground parts of an object. Therefore, what exactly are those remaining, underground parts? They are often called archaeological relics. However, that name does not define the state or character of the remains [21], but only points to a scientific discipline that deals with them. As long as underground fragments of object λ remain, they can be physically observed and analysed – which means object λ itself can be observed, and accordingly that object λ , although demolished, still lives. Consequently, we indeed view demolition as followed by a new evolutionary phase, a new state - except when no single physical trace of it remains as a result of an *annihilation*.

Briefly said, the demolition and (or) dismantling of an object do not unconditionally mean the termination of its existence. The fact that it becomes invisible, inaccessible and does not have any functions usually ascribed to architectural objects does not mean that it ceases to exist and to “be itself” [22]. As long as there is no certainty - confirmed by solid research - that an architectural object has been voluntarily annihilated (or has undergone natural annihilation), we assume it exists.

Episodic transformations

Within the *episodic transformations* group, we have made an additional and, in our opinion, essential, subdivision between *degrading transformations* (those causing the destruction or deterioration of the present condition, but not leading to the creation of a new evolutionary phase - e.g. a degradation of the technical state of an object, a fire, *etc.*) and *neutral transformations* (not connected directly with any essential morphological changes - adding a new function, painting the facade, a change of the owner, *etc.*). In order to distinguish typical neutral transformations from on-site architectural research or archaeological interventions, the former are called *recurring transformations*, and the latter *onBite investigations*.

This rather simple classification is basically an *attempt* at systematising analyses of the complex processes of evolution of architectural objects. It should be seen as designed in relation with a given level of granulation. Its potential application for different levels of granulation remains to be tested. The challenge when proposing such a classification is to find the golden mean between readability (not too many classes) and expressiveness (not too few classes). We make no claim that this classification did reach this point, but it has proved reasonably workable up to now.

Note 20. An annihilation (complete removal) of all the remains of an architectural object can be the result of a natural, long-lasting process following the demolition (e.g. disintegration connected with the decomposition of organic materials) or in some cases, an intentional, conscious human activity (e.g. construction of new underground structures).

Note 21. The term *archaeological relic* is used to define erratic physical traces that may remain of objects (e.g. the traces of foundations' outlines), as well as fairly well preserved objects (e.g. whole underground storeys).

Note 22. From the point of view of usage, our position can be considered as a bit far-reaching. But our point of view is architecture as a whole – not only its function. In that sense physical traces identify a *being*.

Summary

Numerous scientific disciplines deal with the study of the past, each using their own methods. The *diachronic* method presented in this chapter, taking its inspiration from Ferdinand de Saussure' approach, helps studying *changes* of architectural objects in the course of time.

Building on the notions of *diachrony*, *synchrony* and *panchrony*, we describe the evolution of objects as chains of transformations and states. Transformation is seen as the diachronic function, subsequent states are seen as synchronic beings which retain the object's identity thanks to knowledge, intuition and experience - the panchronic level.

We apply this framework to the analysis of the evolution of architectural objects – *i.e.* how they get transformed on long time spans. In that context, a level of granulation has to be chosen. The level of granulation adopted in this work comprises transformations of architectural objects in terms of role, significance, and mutual relations in the urban structure.

We take into consideration a primary evolutionary factor – physical changes, that involve a change of appearance, and a secondary evolutionary factor - changes of function or ownership (*social use*). The former imply the emergence of new, separate evolutionary phases in the lifeline of an object, whereas the latter only pinpoint moments within one evolutionary phase.

As a consequence, transformations are classified and divided into two groups: *leading transformations* - these introducing changes in the form of the object, and resulting in the creation of a new evolutionary phase - and *episodic transformations*, which do not imply a change of evolutionary phase.

In both groups specific types of transformations are defined that emphasize differences we consider as essential in terms of effects and character. The resulting classification serves purposes of readability and comparability : making similarities and differences visible inside the collection, building on these comparisons to shed a new light on individuals objects.

2 – The data: interpretation issues

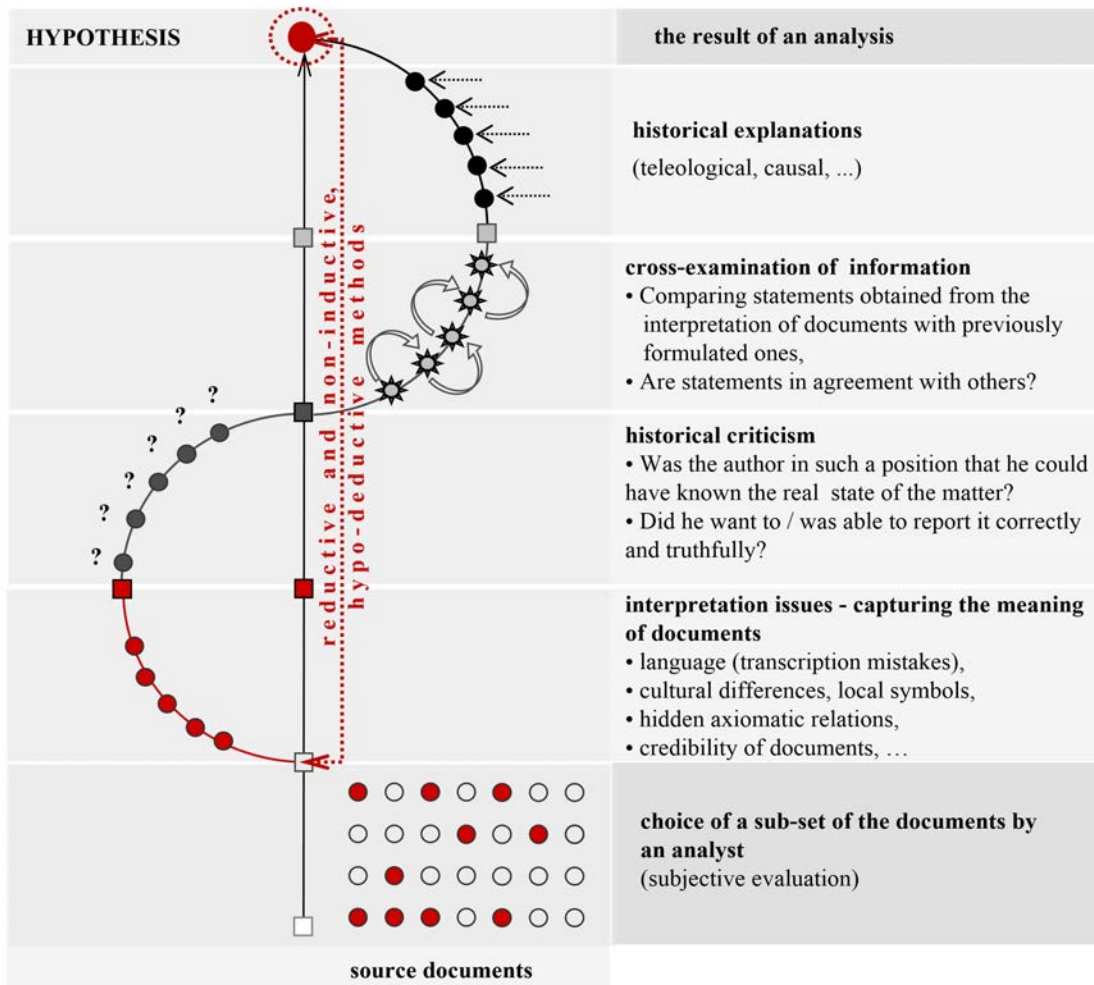
Research into the evolution of architectural objects is based on an analysis of source documents as well as on the study of material traces which have survived until our times. A wide gamut of sciences and methods are therefore concerned (including for instance archaeobiology). But by limiting ourselves to an analysis of documents - historical documents and documents describing the results and conclusions drawn from research on material traces - we can narrow down our field of concern to methods that are a common characteristic of historical sciences.

Historical sciences, as opposed to, for instance natural sciences, are based on documents, and not on observations (*i.e.* not on observation statements). Therefore, it is obviously much more difficult to round out the information when facing weak data sets [23]. Historical sciences cannot rely on experiments as a method of verification, neither. Another essential difference is the fact that historical sciences do not formulate general statements - the formulated laws and hypotheses are always individual [24]. (Fig. 3)

Note 23. “Completing” lacking data sets is possible through the discovery of so far unknown sources, or as a result of research into remains (architectural objects or archaeological relics) - if these processes can be called completing source documents at all. Another problem is of course weighing to which extent the interpretation of existing data is correct, and if needed completing by re-interpreting.

Note 24. Analogies (analogous examples) can be seen as “general statements”, but their applicability is questionable and in all cases hazardous.

cf. Józef M. Bocheński, *Współczesne metody myślenia (The Methods of Contemporary Thought)*, W drodze, Poznań 1992, pp. 129-138



Historical sources require interpretations (language, historical context, *etc.*). In parallel, both the credibility of sources and their degree of precision strongly vary, questioning the analysis process. Both factors

Fig. 3. A diagram illustrating the analysis process leading to the formulation of a hypothesis in the context of historical (idiographic) sciences. Re-interpreted from J.M. Bocheński, *The Methods...*, *op.cit.* [I. Dudek, J.Y. Blaise, 2006]

should therefore be considered: they are discussed in detail in the following sub-chapters [25].

2.1 The truth is doubts : credibility, precision (etc.)

The aim of science - turgidly though it may sound - is the search for the truth, that is the congruence of our knowledge with the actual state of things [26]. Whether and to what extent this state of things is cognizable, is a completely different matter, and we shall not debate this issue here. What needs however to be said is that *truth* does not succumb to the laws of democracy: the fact that a lot of people, including scientific authorities, regard some fact as *true* does not automatically make it such. In addition, pleading human authority is the weakest possible scientific argument, since what others claim should never be treated as a solid basis (a rule which was already formulated clearly by Saint Thomas Aquinas). In historical sciences, historical sources (plans, texts, drawings, *etc.*) are the work of people, and are analysed by other people – wherefrom a significant data credibility issue is raised.

Thus, considering in detail the credibility of sources (*cf.* Fig. 3 – historical criticism) is key in historical investigations. Conclusions uttered by others (they may prove erroneous due to a variety of good or bad reasons) should be questioned without hesitation, along with, what is most important, our own subjective attitudes and convictions [27] - which sometimes is even more difficult than controverting the opinions of others, including these of scientific authorities.

As a consequence, we need to keep in mind that even when a scenario of evolution emerges as more convincing, more plausible, than others – others, still, *do* exist, and should be considered. A self-announced *degree of plausibility* should not be seen as a *degree of truthfulness*. All the more so on the ground of history, where choosing one unique cause-and-effect path is so widespread. This is why in the context of this publication we made our best to consider different possible variants, and ultimately alternative scenarios of evolution of objects. This is done by identifying systematically events that may have lead to various consequences, or are questionable themselves, and by mentioning those alternatives. In other words, we do not take position on the relative credibility of this or that source in the context of this catalogue. Instead, we identify moments of doubts concerning *leading transformations*, *i.e.* moments for which alternative scenarios are possible, most often as a result of unreliable or conflicting pieces of data and information.

2.2 Assessment and visualisation of alternative scenarios

When analysing the evolution of an architectural object, and trying to spot and type leading transformations, one meets a gamut of situations: from here exhaustive, corroborated data sets, to there highly questionable, scarce pieces of data or circumstantial evidence.

To start with, there are transformations that raise no particular questions – neither about whether or not they took place, nor about their actual consequences in terms of physical change. In that case no alternative scenarios are needed: we will refer to such transformations as *definite transformations*.

Note 25. The fact whether a given text or plan should be considered credible (as a whole or in part) is an opinion. It is not related to the source's precision.

A given source has its own, inherent precision: precision therefore is not an opinion. Noticeably, within one document the degree of precision may vary.

Note 26. A classic epistemological definition of *truth* states that it is a compatibility of what is in our intellect with the reality. (*verum est adaequatio intellectus et rei*) [St Thomas Aquinas].

cf. Wikipedia [on-line],
<http://pl.wikipedia.org/wiki/The_truth>

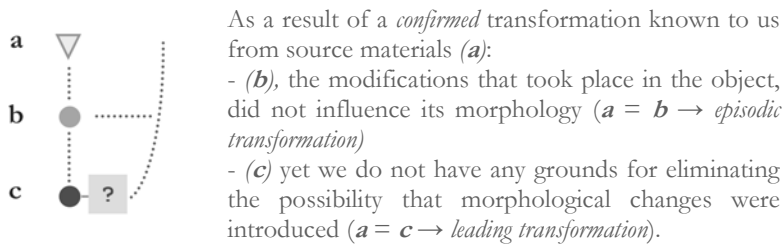
Note 27. ...Through our ignorance [of alternative explanations] slogans are inserted in our understanding that, by dint of being repeated, bring to the fore certainties that our knowledge alone would not justify... (transl. by authors)

cf. P. Delattre, *Concepts de formalisation et concepts d'exploration*, (*Formalisation and exploration concepts*, transl. by authors), [in] *Scientia (Rivista di scienza)*, Milan, no V-VIII, 1974, p. 22

[after] J. L. le Moigne, *La théorie du système général B théorie de la modélisation (General Systems Theory – theory of systemic modelling*, transl. by authors), Les classiques du Réseau Intelligence de la Complexité, 1994, p. 33

[on-line], <www.mexapc.org>

Then there are transformations about which we have no particular doubts concerning whether or not they did occur. However, despite the certainty of the transformation itself (*i.e.* the certitude that it did occur), its character and effects are not always known or certain [28], and accordingly several possibilities should be considered in terms of consequences. We will refer to such transformations as *confirmed transformations*. (Fig. 4)

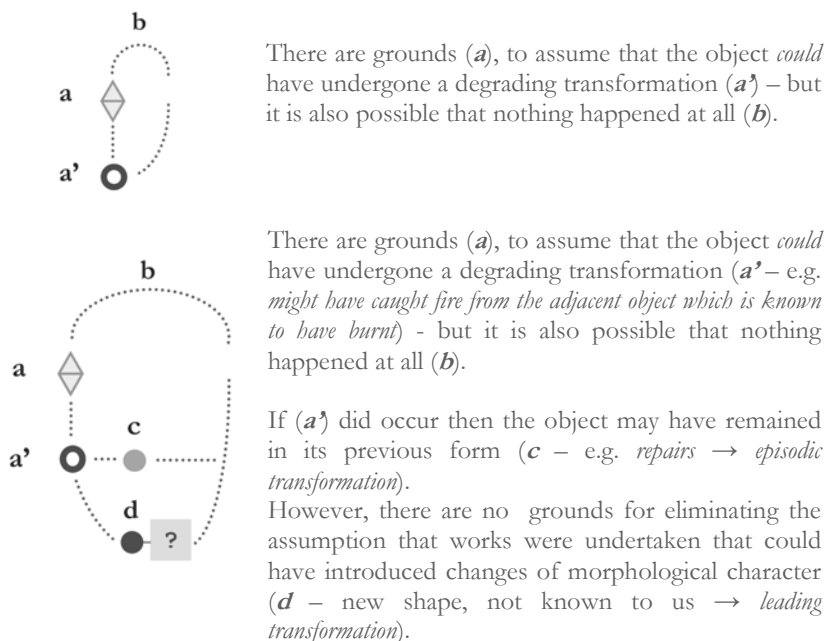


Note 28. For instance, the 1589 fire of the southern cloth-cropping workshop is a *definite*, degrading transformation, followed by a *confirmed* transformation: its renovation (whether or not the 1598-1599 renovation introduced changes in the external form of the object remains unclear).

Fig. 4. A confirmed transformation (triangle downwards) and its alternative potential results.

[I. Dudek, J.Y. Blaise, 2011]

Finally there are transformations which are only likely to have happened (potential) - and that can be inferred from historical sources [29], or from the development of the adjacent objects [30]. Since no reliable indications can confirm they did or did not occur, we shall refer to such transformations as *potential transformations*. (Fig. 5)



Note 29. For instance, a document mentioning the purchase of a big amount of wood for the sake of some object, could be used as an indication that repairs (or even changes) could have taken place.

Note 30. Information about a serious fire on a big object can be used to consider the possibility that the fire spread to the neighbouring, wooden objects.

Fig. 5 Potential transformations (triangle upwards and downwards) and their potential results.

[I. Dudek, J.Y. Blaise, 2011]

Confirmed transformations and *potential transformations* inherently introduce hypotheses inside the analysis process. Naturally, once pointed at - and this is what this catalogue actually does - such hypotheses would need to be verified. Field studies and a dissection of source documents may allow to falsify some hypotheses and to corroborate others [31]. In all cases this is an expert's task. It goes beyond our focus, which is primarily listing, and positioning in time alternative scenarios for each object, and accordingly 'areas of knowledge' needing verification.

Note 31. Corroboration is an unsuccessful attempt at falsifying some statement. (*cf.* K. Popper).

In natural sciences a hypothesis is corroborated if it cannot be proved false. But this does not apply to historical sciences, both because almost no experiments can be carried out, and because of the very nature of hypotheses (not laws but facts or properties).

In that context corroboration could be interpreted as pulling together pieces of data and information that do not contradict one another, but that do not allow to draw a definitive conclusion.

On the whole, alternative scenarios match the following situations:

- A binary situation ($p \vee \sim p$), (Fig. 6)
e.g. the object exists, or not, the object underwent a degrading transformation - for instance a fire, or not, *tertium non datur*.
- a series of mutually exclusive hypotheses which exhaust all possibilities ($q_1 \vee q_2 \vee q_3$);
e.g. the possible consequences of a fire are as follows: q_1) no subsequent action – the object remains in the same evolutionary phase (although possibly seriously degraded); q_2) restoration works were undertaken which did not impact the morphology of the object; q_3) reparation works modified the morphology of the object.
- A group of mutually exclusive hypotheses which do not exhaust all possibilities ($r_1 \vee r_2 \vee \dots$);
A typical example is the search for the first element of an object's evolutionary chain.

For example, the suggested antecedents of the Cloth Hall are as follows: (r_1) Boleslaus' Stalls [32] or (r_2) the wooden (cloth?) chambers discovered under the Cloth Hall [33]. On the premise that King Boleslaus's promise to build a cloth hall was fulfilled, the Cloth Hall's antecedent could in theory also be yet another object (r_3), to this day undiscovered, which was either incorporated or destroyed during the construction works of the Cloth Hall.

We should also consider the possibility (r_4) that the Cloth Hall as such is *not* a continuation of the pre-existing cloth stalls promised by Boleslaus, but an independent object, constituting the first element of a chain – a typical persistence issue (cf. chapter 1.1 – Persistence of architectural objects).

Potential transformations combine a binary situation – either something occurred or not – with mutually exclusive hypotheses concerning the actual modifications introduced. (Fig. 7)

As mentioned before (cf. chapter 1.3 – Identification and classification of transformations) only *leading transformations*, those that impact the form of the object, can introduce a new evolutionary phase in the lifeline of an object. As a consequence, ramifications along an object's evolutionary path – *i.e.* presence of alternative scenarios – most often correspond to moments when a *leading transformation* may have occurred – *i.e.* with a potential new evolutionary phase.

2.3 Space and time : data precision issues

Not only is the data we use sometimes questionable, leaving space for various interpretations, various alternative scenarios, but it also strongly varies in terms of precision. Naturally data precision issues may include notions such as accuracy of dimensions, quality of the description of the interior décor, thoroughness of the biography of owners, *etc.*

What we shall examine and assess in the context of this catalogue is precision issues in relation with the localisation of objects, and in relation with the dating of transformations.



Fig. 6. A binary situation: either p or *not* p .

[I. Dudek, J.Y. Blaise, 2011]

Note 32. cf. Komorowski W., Sudacka A., *The Main Market Square*, Ossolineum, Wrocław 2008, p. 21

Note 33. cf. Buško C., *Z badań archeologicznych nad miastami południowej Polski. Rynek Główny w Krakowie w świetle prac przeprowadzonych w latach 2005B/07* (From the archaeological research on the cities of southern Poland. The Main Market Square in Krakow in the light of the work conducted in the years 2005B/07) (transl. by the authors), p. 229

[in] Kouřil P., Měřínský Z., *Sborník příspěvků přednesených na XXXVIII. mezinárodní konferenci archeologie středověku s hlavním zameraním archeológia stredovekého mesta*, Archaeologia historica 32/07, Brno, 2007

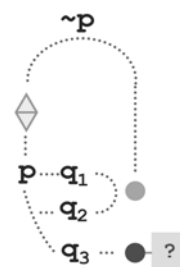


Fig. 7. Combination of a binary situation and of a series of mutually exclusive hypotheses : a *potential transformation*.

Note that only p - q_3 leads to the creation of a new evolutionary phase.

[I. Dudek, J.Y. Blaise, 2011]

2.3.1 Assessment of precision concerning an object's localisation

The extent to which we can precisely localise a given object on the Market Square is closely connected to the precision of the underlying data. Talking about objects that for some can only vaguely be situated in this or that area of the Market Square because of a poor documentation, the very concept of precision has to be rethought - we shall not mean here comparative performances of survey apparatus. When very few documents are available, guessing at the localisation of an object is a two-shot hazardous process : getting an idea on whether the source should be trusted, and then interpreting it correctly.

In that context, and considering the level of granulation of this catalogue, we shall distinguish only two fundamental cases:

- *localisation is known* (i.e. based on observation or confirmed by field studies or precise and corroborated historical sources),
- *localisation is approximated* (i.e. based on indications that are imprecise, and only allow for a surmised localisation).

The objects whose localisation may only be surmised, will be represented visually using “probability clouds” – groups of dots that show the entire area within which the object is likely to have been situated (Fig. 8). The “probability cloud” should not be interpreted as affirmative, but as indicative. When meeting cases where no single indication is available, an even more abstract representation mode has to be chosen – glyphs typically.

2.3.2 Assessment of precision concerning the dating of transformations

Handling time-oriented data most often implies choosing a chronon (smallest unit of time) that makes sense in the context of the phenomenon one analyses. A one-second chronon makes no sense when analysing geological eras, nor does a one-century chronon make sense when observing the behaviour of stock markets. Basing on what previous experiments taught us, we shall here apply a one-year chronon - a reasonable compromise, when analysing the evolution of architectural objects on long time spans, between thirst for precision and the reality of the data (cf. chapter 3.2 - Representing time : issues and choices).

Indeed, the precision of dating tends to dissolve the further we reach into the past – although this is not a rule. Moreover, in numerous studies some dates are given approximately (e.g. *the second half of the 13th century, the turn of the forties and the fifties of the 17th century*), or events are positioned inside a far too big interval (e.g. *a flood during the reign of Wenceslas II*). Dates are often accompanied by modifiers emphasising a lack of certitude (e.g. *probably, perhaps, most probably, around, ...*). A text written in such a way reads well and we are usually not disturbed by the fact that it could be received with various deviations, interpreted differently in terms of precision (e.g. *the second half of the 13th century* may be interpreted as “anywhere in that period but most probably around 1275”, “anywhere in between the 1st January 1250 and the 31st December 1299”, “anywhere in between 1251 and 1300”, etc.).

Often enough, managing dates comes along with the necessity to compare them, or to order them so as to produce a readable and workable chain of events. This effort requires transferring qualitative, textual dating into either a numerical format, or into a systematic

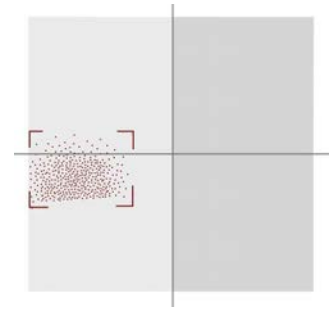


Fig. 8. Representation of an approximated localisation on a schematic map of the Market Square. In this example the object's localisation should be read as “on the west side of the Market Square, north of the Town Hall and in its vicinity”. (cf. Chapter 4.1)

[I. Dudek, J.Y. Blaise, 2011]

representation such as lexical scales. And anyone who once faced that necessity knows how difficult it is, for example, to find out how *around 1450* or *at the turn of the 13th and 14th century* should be interpreted [34].

There is here clearly no easy and consensual solution. We introduce four categories of dates (definite, dubious, approximate and unknown dates), both for purposes of simplification and for purposes of visual comparability inside the collection. These categories may be seen as an imperfect way of presenting dates, however they have proved efficient enough both when wanting to record pieces of data and when wanting to cross-examine resulting chronologies. They do not impact the actual interpretation of dates : an indication such as *around 1450* is left as it is, but tagged as *dubious*. Ultimately, categories help distinguishing ranges of precision and visualising them.

- Definite dates

The *definite dates* are those about which historians do not have or do not express doubts - e.g. dates confirmed by credible source documents (for instance the fire of the Cloth Hall in 1555). We record them without any additional indications (e.g. 1555).

- Dubious dates

The *dubious dates* are given with a level of precision that does not match their level of certainty. Often expressed by numbers these dates are accompanied by modifiers emphasising that lack of certainty (e.g. *probably in the year 1457*).

This may for instance concern dates that are found inside sources considered as rather untrustworthy, or dates reasoned out on the basis of other events or facts.

It may also concern the results of analyses that are conducted with a precision lower than the time resolution chosen (in our case one calendar year). For example, we consider some dendrochronological analyses of wood as providing dubious dates - not because of questioning the credibility of the method, but when the error margin is bigger than a calendar year (e.g. the dating of the construction of the eastern stall of the bread benches - the *W* wall is dated as follows: *after 1302 - 1308*) [35].

Dubious dates are recorded with one question mark (e.g. 1457? , 1302 ? - 1308 ?)

- Approximate dates

The *approximate dates* are those that are of estimative character, usually recorded as texts (e.g. *the turn of the 13th and the 14th century*). Periods recorded using approximate dates quite often define not the actual or estimative length of a transformation, but only the time bracket inside which it might have taken place. The length is liable to be shortened (more often than prolonged), and the date itself liable to be moved or reconsidered.

Approximate dates are recorded with two question marks. (e.g. 1340 ??, 1290 ?? - 1310 ??).

- Unknown dates

There are some situations in which there is simply not enough data to define any kind of dating, since any time bracket would be absurdly wide, with far-reached arguments backing up the proposition. (e.g. if an event or a transformation can only be dated

Note 34. Not mentioning repeatability issues : should the same interpretation be done whatever source is used? Can we count on the fact that others will interpret dates the way we do?

Note 35. cf. Zaitz E., *Report from archaeological excavations conducted in Cracow in 2004 while rebuilding the surface of the main market square on the west side of the Cloth Hall*, Archaeological Materials, vol. XXXVI, Krakow 2006, p. 89

because we know it occurred somewhere in the history of the Main Market Square - the resulting time bracket covers more than 7 centuries).

Because the absence of date can hardly be called an approximate date, we define such dates as *unknown dates* and record them as two question marks preceded by an ellipsis (e.g. ... ??).

2.3.3 Short-term and long-lasting transformations

Transformations differ from one another in terms of length - the construction of an object may last for decades, and its destruction may take a few hours or even a few minutes (e.g. tsunami).

Short-term transformations are expressed as one digit; they are defined either by definite (e.g. 1764) or dubious dates (e.g. 1300 ?).

Long-lasting transformations – those lasting more than one year - are defined by a time interval, *i.e.* two separate digits. Each of these digits may have its own precision assessment (e.g. 1300 - 1305 ?). They can correspond to definite, dubious, approximate or unknown dates (e.g. the period of construction of the Town Hall tower may be described as 1300 ?? – 1316, and the time when its rebuilding and raising took place as 1350 ? - 1399 ??) [36].

Noticeably, a transformation that is “in real life” a short-term transformation may need to be defined by a time interval too when the underlying data will not allow for better. In other words, what we record is not the theoretical duration of this or that transformation, but the actual information we have on it.

At the end of the day, a transformation can be seen as two overlapping time intervals : a smaller one, the actual duration of the transformation – generally unknown, somewhere inside a bigger one, the information we record and visualise. The more the margins between the inner interval and the outer interval can be reduced, the easier temporal relations between objects can be analysed – for instance using Allen’s topological relations (Tab. 1). By contrast, the more the margin thickens – in particular in the case of approximate or unknown dates, the more error-prone any speculations on temporal relations will be.

Note 36. Approximate dating concerning the construction of the components of the Town Hall complex, proposed by Waldemar Komorowski.

Tab. 1 James Allen’s 13 topological relations between time intervals.
cf. B. Lefebvre, X. Rodier, L. Saligny, *Understanding urban fabric with the OH_FET model based on social use, space and time*, *Archeologia e Calcolatori*, 19, 2008, pp. 195-214,
 [after] J.F. Allen, *Towards a general theory of action and time*, *Artificial Intelligence*, 23, pp. 124-154

the relations suggested by J.F. Allen	the relation concerns occurrences which are:		
<(X,Y): X before Y >(X,Y): Y after X	disjunct in time		
m(X,Y): X meets Y mi(X,Y): Y met by X	tangential in time		
o(X,Y): X overlaps Y oi(X,Y): Y overlapped by X	overlapping in time		
=(X,Y): X equals Y	parallel in time		
s(X,Y): X starts Y si(X,Y): Y started by X	partly parallel	with a common beginning	
d(X,Y): X during Y di(X,Y): Y during X		internal	
f(X,Y): X finishes Y fi(X,Y): Y finished by X		with a common end	

Summary

A characteristic feature of historical sciences is that reasoning most often bases on historical sources, by nature fragmentary and questionable. Such sources do not only require interpretations (language, historical context, *etc.*) but also vary in terms of credibility and of precision, challenging the analysis process.

In the context of this publication we do not take position on the credibility of this or that source, but focus on identifying moments in the lifeline of architectural objects for which alternative scenarios are possible (most often as a result of unreliable or conflicting information) and various potential results should be considered.

Scenarios combine *definite*, *confirmed* and *potential* transformations. *Definite* transformations raise no particular questions (e.g. transformations repeatedly confirmed in credible and independent of one another historical sources). *Confirmed* transformations are known to have occurred, but their consequences remain unclear. *Potential transformations* are transformations which are only likely to have happened - inferred from historical sources, or from the development of adjacent objects.

Potential transformations combine a *binary situation* where either the transformation did or did not occur ($p \vee \sim p$), and consequences that can be described as a *series of hypotheses which are mutually exclusive and exhaust all possibilities* ($q_1 \vee q_2 \vee q_3$). A third situation - *group of hypotheses which are mutually exclusive but do not exhaust all possibilities* ($r_1 \vee r_2 \vee \dots$) is typical of cases when doubts exist concerning the first element of an object's evolutionary chain.

Only *leading transformations*, those that impact the form of the object, can introduce a new evolutionary phase in the lifeline of an object. As a consequence, ramifications along an object's evolutionary path most often correspond to moments when a *leading transformation* may have occurred – *i.e.* with a potential new evolutionary phase.

The data we use strongly varies in terms of precision – in the context of this catalogue we shall only address precision issues that are in relation with space (localisation of objects) and time (dating of transformations). Concerning the former, two elementary situations are considered: cases when the localisation is known, *i.e. duly identified localisation*, and cases when it is not, leading to *presumptive approximate localization*. Concerning the latter, we adopt an equally simple strategy, and introduce four categories of dates (*definite*, *dubious*, *approximate* and *unknown* dates) that help distinguishing ranges of precision and visualising them.

Durations of transformations are seen either as included inside a time point, corresponding to our one-year chronon, or as time intervals. The more imprecise the data about a transformation is, the more the time interval we define grows, and consequently the more it potentially differs from the *real* duration of the transformation. As a result, analyses of temporal relations can be inconsistent, inconclusive, or even lead to faulty conclusions.

Considering both the credibility and the precision issues, we made the same choices – show doubts, alternatives, heterogeneity of the evidence rather than hide them, and try to find a mean point between complexity and readability. It is assumable that such choices are key in many practices within historic sciences.

3 – Rethink the evolution of objects though visual means

We have up to now presented some fundamental knowledge modelling choices (classification of transformations, handling of alternative scenarios, *etc.*). But these choices were not made for the sake of making choices. They were made with regards to a goal : foster a renewed understanding of the data, of its interpretation, and ultimately re-investigate the evolution of architectural objects.

As mentioned earlier, this is typically the purpose of visualisations: assist the human expert in the analysis of complex and abstract data sets, support reasoning tasks, re-read the evolution of *one* object in the light of the evolution of *a collection* of objects.

So what kind of visualisations could help us gain that kind of insight into the evolution of Krakow's Market Square? Generally speaking, designing efficient visualisations requires a step of information layering - distributing a complex process into several separate levels, through the stratification and separation of different aspects of the same data. Layering should here be understood as a filtering of the problem into sub-parts, in order to facilitate the identification of hidden relations within the data. Uncovering these relations potentially broadens our understanding of the problem – in other words broadens our knowledge [37].

Knowledge discovery, through visual means, did not wait for digital technologies to appear – the many works of pioneers, such as M.F. van Langren, C. de Fourcroy, W. Playfair, C. Dupin, C.J. Minard, A.M. Guerry, E.J. Marey, F. Galton or J. Snow bear a testimony of that point. Yet digital technologies can be very helpful in this domain, in particular with regards to three aspects: interactivity inside the graphics, updatability of the graphics, reusability of the underlying data. As a consequence, time devoted to “drawing” is dramatically reduced, hand errors are avoided, and through simple user selections or interactive “filtrations” a unique graphic can be used to allow multilevel analyses. Computer-based solutions do have their dark sides though : physical limits of the screen, cognitive overload in many systems, poor support of collective interactions, graphic choices often dictated by the tool rather than by the designer, *etc.*

From the comparison of pre- and post-computer visualisations a conclusion can easily be drawn : layering or stratification should be performed regardless of the drawing technique, but the actual graphic design (interactions, colour schemes, animations, *etc.*) does depend on it. Designing an efficient visualisation is primarily a matter of filtration into the data – graphic design itself is efficient when it makes this filtration readable (*cf.* section 4 – Visual analysis of the collection).

In this chapter we first comment on the necessity to switch from visualising a univocal evolutionary path to supporting alternative scenarios, and on some general choices regarding the handling of time. We then focus on detailing contents of the graphics that systematically accompany the accounts of objects in section 2 - catalogue. These three visualisations all support the analysis of an object's lifeline, but operate on slightly different levels (alternative filtrations) and concern variant aspects of the same data.

3.1 Statement of need

Our first visualisations concerning the evolution of an architectural object over time were named *chronographs* [38]. Their purpose was to

Note 37. ... the point is to find design strategies that reveal detail and complexity – rather than to fault the data for an excess of complication. Or, worse, to fault viewers for a lack of understanding.

Effective layering of information is often difficult; for every excellent performance, a hundred clunky spectacles arise. An omnipresent, yet subtle, design issue is involved: the various elements collected together on flatland interact, creating nonBnformation patterns and texture simply by their combined presence. Josef Alberts described this visual effect as $1 + 1 = 3$ or more. ...

cf. Edward R. Tufte, *Envisioning Information*, Graphic Press, Cheshire 1990, p.53 *cf.* Josef Albert, *One Plus One Equals Three or More. Factual Facts and Actual Facts*, [in] J. Albert, *Search Versus ReSearch*, Hartford 1969, pp. 17-18

Note 38. More information on this subject can be found, among others, in :

I. Dudek, J.Y. Blaise, *Profiling artefact changes...., op.cit.*

Idem, Visual assessment of heritage architecture life cycles, [in] Journal of Universal Computer Science, Graz 2008, pp. 349-357,

Idem, Understanding changes in historic architecture. Can we provide tools and methods for visual reasoning, [in] Proceedings of IVAPP 2010, Angers, International Conference on Information Visualization Theory and Applications, INSTICC Press, pp. 91-100

recap visually the lifeline of an architectural object *as reported by a particular analyst*, that is, with regards to one and only one interpretation and understanding of the historical evidence. Chronographs combined three visualisations (Fig. 9):

- *diachrograms* - showing successive changes of an object, with detailed consideration of the type, character and effects of particular transformations; (Fig. 10)
- *variograms* – presenting the intensity and frequency of different types of transformations (morphological, structural and functional);
- *variation assessment indicators* and *features value indicators* - detailing the impact of changes on individual properties of an object (e.g. number of storeys, style, owners, *etc.*).

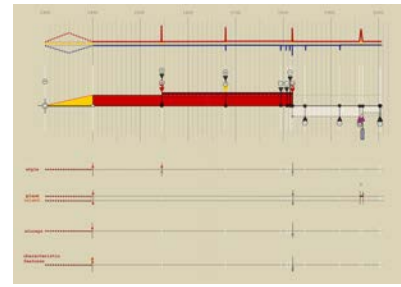
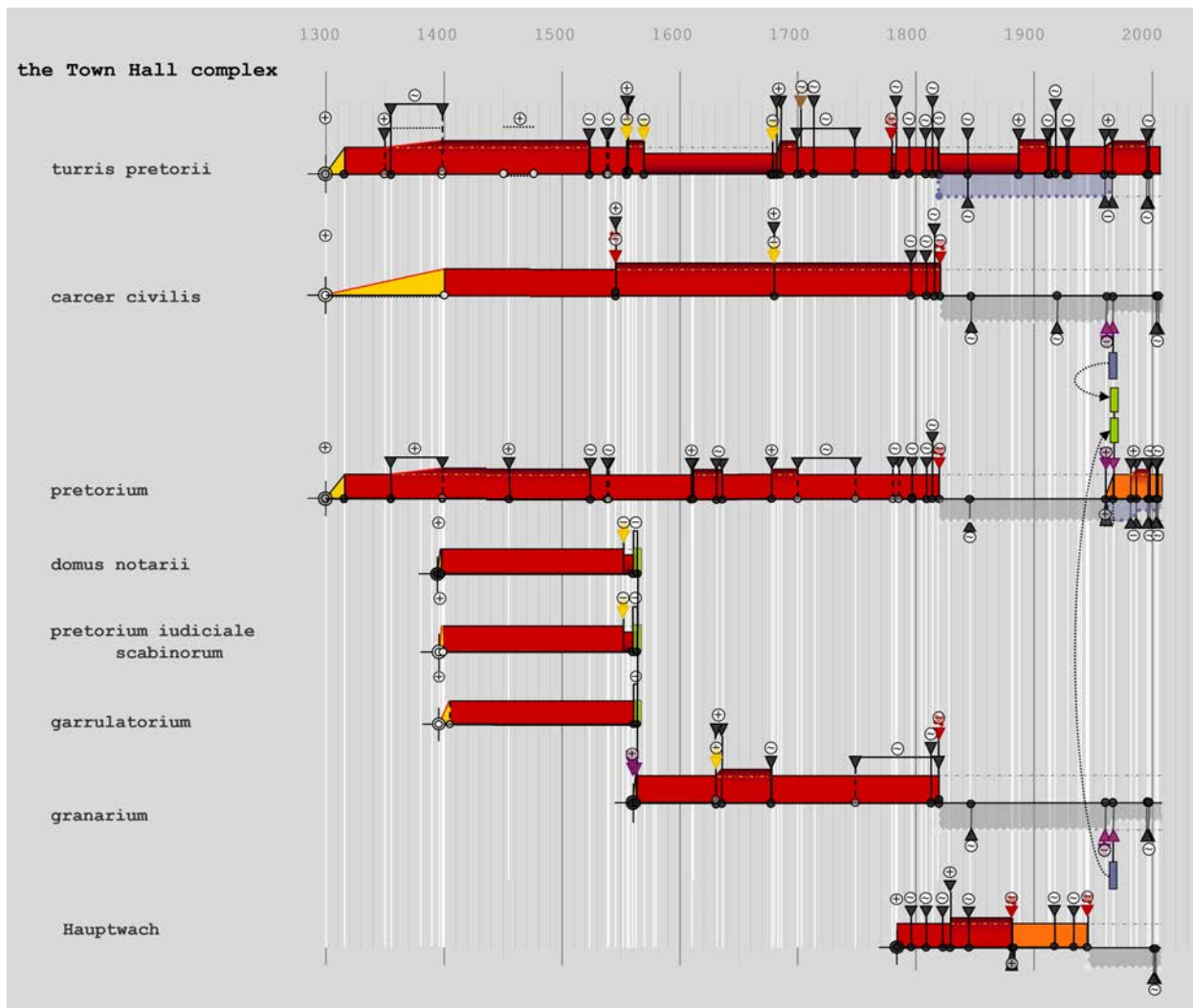


Fig. 9. From top to bottom, *variogram*, *diachrogram*, *variation assessment indicators*.
[I. Dudek, J.Y. Blaise, 2007]



Chronographs allow vertical readings - “what precisely happens at period p ” – and horizontal readings “how does a feature change over time”. The prominent visualisations in the chronographs ensemble is the diachrogram. It works like a classic timeline – distance represents time with a given scale (e.g. 1 cm = 100 years). Events are positioned in time, and the relative proportion of durations of particular states and transformations is retained. This naturally implies being able to define, then position and quantify in time each and every change, and this univocally. When analysing the evolution of an architectural object, there may be periods in the object’s lifeline for which that level of

Fig. 10. A comparison of *diachrograms* corresponding to the various architectural objects that form the Town Hall complex. Prepared within the framework of the ATIP project. Historical analysis by W. Komorowski.

[I. Dudek, J.Y. Blaise, 2007]

constraint is out of reach. The main weak point of the *chronographs* method lies there : the necessity to choose one and only “path of evolution”. The reality may look different - the analyst sometimes does not have enough data to exclude alternative possibilities, and accordingly may *need and want* to retain them.

Privileging this or that interpretation in order to end up with one unique storyline also has an indirect consequence: it pushes the analyst into *micro* information spaces. The object is isolated from possible alternative causal relations, its storyline is marked by hidden choices that are made, and are relevant, *only* in the context of this object. Such an approach, although useful in many ways, undermines efforts to fruitfully read the collection at a *macro* level, get a general synthetic picture, reveal possible relations, patterns and exceptions [39] – which is precisely the objective of this catalogue.

As a complement to the chronographs approach, we therefore have developed three new visualisations, operating on slightly different levels, supporting different reasoning tasks:

- *multihypothesis chronology diagram* (Where do alternative scenarios appear in time? How dense are they? What are the relative durations of transformations and states?),
- *graph of potential interactions* (How many transformations and states are chained? In what context do they occur? What possible consequences do alternatives open?),
- *visual measure of complexity* (How do levels of complexity, densities of doubt, compare?).

The role these visualisations can play in attempts at understanding and interpreting the processes to which architectural objects are subject - and as a result of which they evolve – is detailed in the following sub-chapters.

3.2 Representing time : issues and choices

All three abovementioned visualisations share a common general structure: time is represented as linear, running from left (past) to right (present and future). Choosing this convention is of course not without consequences, and should be done on purpose. Cycles and rhythms for instance are harder to read on a linear diagram. When the phenomenon under scrutiny is of a cyclic nature, alternative visual solutions should be privileged (Fig 11). In the scope of this catalogue though, the phenomenon we are interested in (spotting changes inside an object’s lifeline), and the data we handle, are not primarily of a cyclic nature. We therefore stick to the classic “linear time convention”.

The one-year chronon: consequences

The choice of a **time resolution*** using a one-year chronon (*i.e.* the basic time unit, undividable) is as mentioned earlier (*cf.* chapter 2.3.2) a compromise resulting from the lack of precision of the underlying data. The further we go back into the past, the more rarely we deal with a “complete” date, that is one expressed in the form of day, month and year (e.g. 15th December, 1367) – not to mention hours, minutes and seconds (e.g. 13:24:18).

Estimative dating concerning architectural changes, as can be found in historical sources, is done with a precision usually not exceeding a year

Note 39. ...We are much better at totally disregarding all the micro stuff, and making big guesses ...all the causality happens at the microlevel, and we can't analyse it... – i.e. Cause and effect relations hidden behind every historical event are so complex that they are impossible to encompass directly. In such cases a change of the analysis level tends to be helpful in a better understanding of the analysed issues.

cf. T. Pratchett, I. Stewart and J. Cohen. The Science of Discworld 3 : Darwin's Watch, Ebury Press, London, 2005



Fig. 11. In this visualisation of cyclic events each circle represents a year (clockwise) during which a fire occur end somewhere on the Market Square, from the smallest (1100) to the biggest (1945). The four colours in the central part represent seasons (blue is winter), and dots close to them months. When the date is precise enough, fires are represented by an orange, triangular shaped glyph, otherwise by a thick orange arc. When only the year is known the whole circle is thickened. The visualisation does help reading some patterns (no fires in summer for instance, or densities) but also underlines the weakness of the underlying data set (a majority of dates that cannot be localised inside a year). The very existence of cycles appears as questionable, but such a visual solution does help investigating them.

[I. Dudek, J.Y. Blaise, 2012]

* Time resolution :

Corresponds to the necessity of counting time, and therefore of fixing a smallest unit. A smallest unit is chosen with regards to a range of phenomena: archaeologists rarely need milliseconds, nuclear physicists do.

– decades, centuries or even millennia are rather more common. This is why the time resolution we adopt equals one calendar year. But this means that events which take place in the same year are presented at the same “position”, at the same time point. The drawback of this situation is that events that are indeed ordered in time can end up being undistinguished – except if representing events in ordinal time, as is done in *graphs of potential interactions* or *visual measure of complexity*.

As an answer, we store the order of events, inside a one year chronon, and represent it visually : their number and sequence can be read from the number and sequence of the *time markers* (glyphs composed of a line and a circle), and from the position of the dates placed above a given time marker (Fig. 12). Naturally we acknowledge that this very simple visual solution can be applied if and only if the number of events to order inside one year remains low.

Increasing the time resolution - for instance to a month - would apparently solve the problem of markers overlapping, but in most cases would not match the time resolution of the data. Being able to say that event λ happens before event τ inside one year does not mean we can trace dates down to the month. A flood happening somewhere during spring will be followed by a drop in the water level – the order *is* known, but not the month.

Furthermore, a thinner time resolution encourages discretionary over-interpretation of the data. Any attempts at over-interpreting the data so as to somehow “guess” during which month an event occurred would cause deception and spread unreliability to the whole collection. An additional consequence would be a significant extension of the visual figure, which, in certain circumstances, might be onerous.

Time discontinuities

Visualising and dating occurrences in time is impacted by a number of temporal discontinuities – historical (disruptions in the evolution of an object), historiographic (what is said, what is analysed inside a lifeline) or psychological (questionable testimonies and reports, *etc.*) [40].

Temporal discontinuities are by essence *individual* : facts themselves, (individual events and objects), reports about facts (impacted by subjective individual psychological time), analyses of facts and reports (impacted by individual interpretations). Individual discontinuities overlap and interact with one another – creating here information clusters, there information deserts, and in all cases opportunities for inconsistency to pave its way into the analysis process.

This phenomenon can be studied and described – but what we have privileged in the context of this catalogue is another way out. We have tried to take this aspect into consideration in the analysis and visualisation of the credibility and precision factors on one hand, and on another hand have strived to unveil patterns of inconsistency and discontinuity by cross-examining a whole collection of objects.

Besides unexpected, unpredictable time discontinuities there are events and conventions, rooted in history itself, that introduce their load of discontinuities. One of these discontinuities is changes of the calendars in use. The considerable differences in the periods of introduction of these changes in various countries, questions the credibility and the precision of dating.

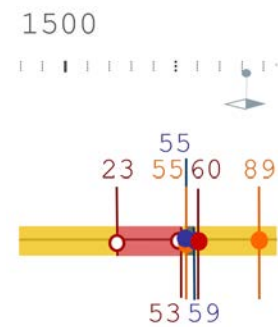


Fig. 12. How events ordered inside the one-year chronon can be represented.

Note two successive events during year 1555: a fire – orange colour, and the beginning of the renovation - blue colour).

[I. Dudek, J.Y. Blaise, 2011]

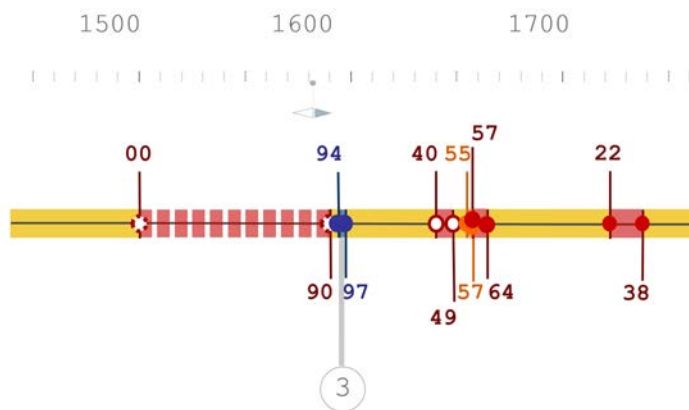
Note 40. Psychological time – the way each of us pictures past events, selecting some and forgetting others, deforming durations depending on how we perceived these events - strongly impacts testimonies or reports, and introduces a number of subjective discontinuities. This issue was addressed by, among others, Henri Poincaré : ... *Psychological time* [is] *discontinuous* (...) *We order our recollections in time, but we know there are compartments left empty. (...) We do not have a direct intuition of simultaneity, nor of the equality of two durations* ... (trad. by authors)

cf. Henri Poincaré , *La Valeur de la Science*, (*The value of science*, trad. by authors), *op.cit.*, Chapitre/II – La mesure du temps,

For instance, in 1582 Poland switched from the *Julian calendar* to the *Gregorian calendar*. The new calendar reduced the gap that had been growing since 46 BC. between the Julian calendar and the astronomical year. The introduction of the new calendar was progressive : it started from year 1582, only in a handful of countries. It shortened the year 1582 by 10 days in Poland, Spain, Portugal, France, Austria, and almost the whole of Italy – although in Italy, Spain and Portugal it happened in October (the 15th October fell right after the 5th October), whereas in Poland, France and Austria the change took place at the end of the year [41].

This discontinuity may not be really vital as far as our diagrams are concerned, since they use as chronon a whole year. But if we disregard that fact, we cannot be certain whether analyses of historical sources based on disparate calendars - dating the same day in a different way - will not result in the overlapping of two events that in reality were disconnected in time (or whether it will not cause a one-year leap) [42].

The date of the calendar change is systematically marked on diagrams showing the chronology of events (in accordance with the period in which the calendar was adopted in Krakow) . (Fig. 13)



3.3 Multi-hypothesis chronology diagram

Multi-hypothesis chronology diagram provide a quick, synthetic view on where alternative scenarios exist in time. They show doubts concerning the precision of dating (*cf.* Chapter 2.3.2 - Assessment of precision...), and alternative paths, along with their potential consequences (*cf.* Chapter 2.2 Assessment and visualisation of alternative scenarios). In *multi-hypothesis chronology diagrams* time is represented in real scale, and in **discrete time***: durations are therefore assessed, their relative lengths can be compared. These diagrams present alternative paths as they appear from the analysis of the data obtained from historical sources and of material traces: what they show is what we know, and consequently is most probably incomplete, and possibly deformed as a consequence of the source effect.

3.3.1 Classes of transformations : colour codes

The classification of transformations which we have adopted introduces two basic groups: *leading transformations* and *episodic transformations*. In multi-hypothesis chronology diagrams, leading transformations can be marked either in blue (*morphological transformations* and *regressive transformations*), or in grey (*destructive*

Note 41. The calendar reform, announced in the *Inter gravissimas* Papal bull, was not introduced in all European countries and regions of particular countries, at the same time. The introduction of the Gregorian calendar in Europe lasted until the beginning of the 19th century (Greece 1924, Turkey 1927) and required a correction of the different number of days (in 1700 the difference increased to 11 days).

cf. Wikipedia, *Calendrier grégorien*, [on-line], <http://fr.wikipedia.org/wiki/Calendrier_gr%C3%A9gorien>

Note 42. April, 23rd, 1616 is usually given as the date of death of both Shakespeare and Cervantes – but these writers in fact did not die on the same day. Shakespeare's date of death is given following the Julian calendar, whereas the date of Cervantes' death follows the Gregorian calendar. Noticeably, the calendar according to which a date is given is very often *not* specified. According to the Gregorian calendar, Shakespeare died on the 3rd of May.

cf. S. Schoenbaum, *William Shakespeare: A Compact Documentary Life*, Oxford University Press, Oxford 1987

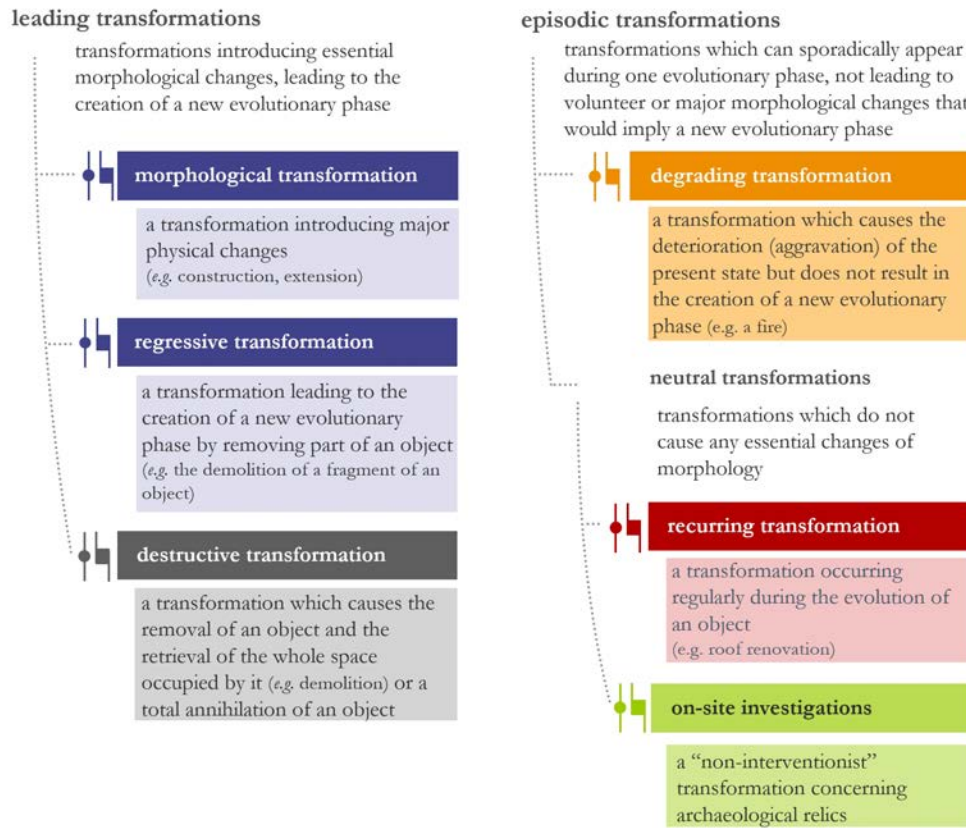
Fig. 13 Fragment of the multi-hypothesis chronology diagram for the Grand Scales – the date of the calendar change in Krakow (1582) is shown by a bluish-grey double arrow positioned along the time scale.

[I. Dudek, J.Y. Blaise, 2011]

* Discrete time :

Time is modelled as a *continuous* chain of *discrete* values (time units). Reasoning in discrete time implies choosing a basic time unit – may it be seconds, days, years, *etc.* (*cf.* chronon). The concept of discrete time is equivalent to this of integer numbers.

transformations). Episodic transformations can be marked either in red (*neutral transformations*), in orange (*degrading transformations*) or in green (*research into the relics of an object*). (Fig. 14)



3.3.2 General structure of the diagram

The diagram uses the linear concept of time (past on the left, present on the right). A time scale runs above the diagram itself on which dates are reported, marked in grey. (Fig. 15)

Fig. 14. Classes of transformations and corresponding colour codes [I. Dudek, J.Y. Blaise, 2011]

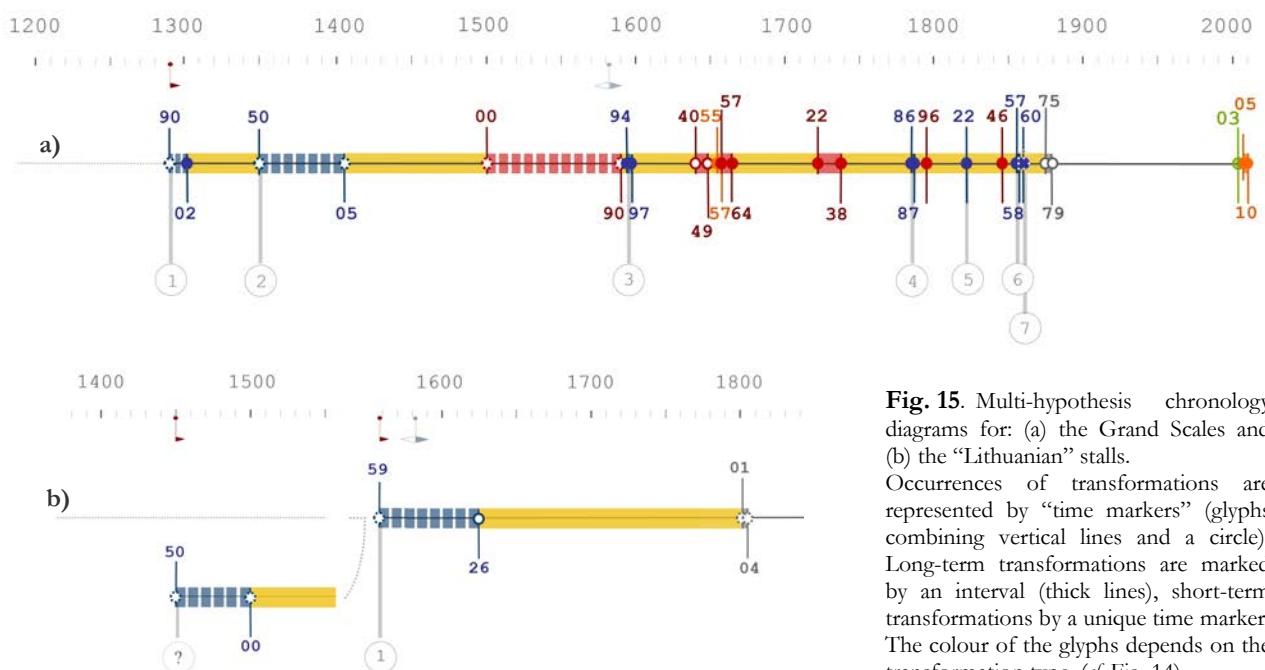


Fig. 15. Multi-hypothesis chronology diagrams for: (a) the Grand Scales and (b) the "Lithuanian" stalls. Occurrences of transformations are represented by "time markers" (glyphs combining vertical lines and a circle). Long-term transformations are marked by an interval (thick lines), short-term transformations by a unique time marker. The colour of the glyphs depends on the transformation type. (cf. Fig. 14) [I. Dudek, J.Y. Blaise, 2011]

The diagram is composed of a thick yellow line, representing the time interval during which the object has existed (excluding periods when it is buried and inaccessible, following a destructive transformation). Transformations are distributed along this line, and either represented by one *time marker* (when occurring inside one year) or by two time markers that bound a thick coloured line, the *transformation duration indicator* (when corresponding to a time interval exceeding one year). Numbers written inside circles, in the bottom part of the graphics, identify and order each transformation that leads to a new evolutionary phase.

Alternative scenarios are displayed vertically below the main timeline, one above the other (from the one which modifies an object the least to the one modifying it the most, Fig. 16-c,g). Grey dotted lines and arcs are used to connect these alternative solutions to the main timeline (Fig. 16-ab,c,g).

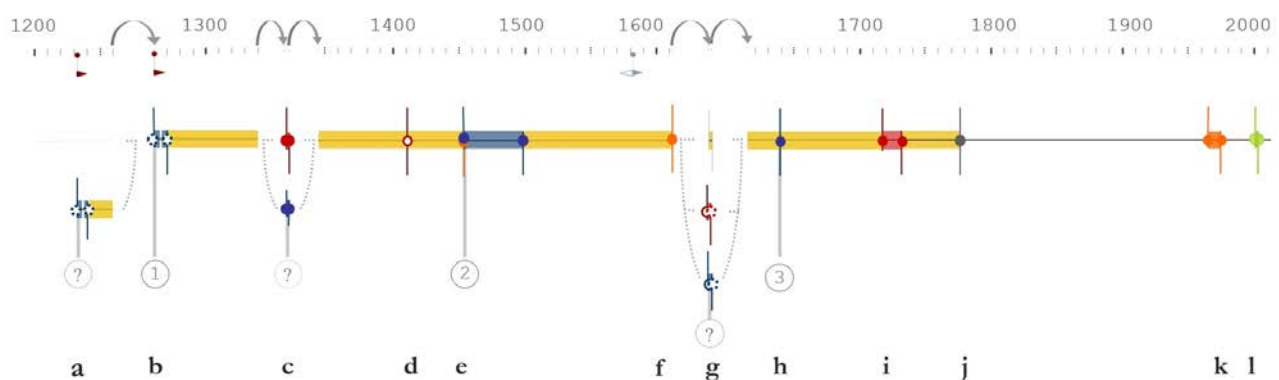


Fig. 16. A simplified theoretical multi-hypothesis chronology diagram.

a) two disparate hypotheses are represented: *no antecedent* (horizontal grey line); *there is an object that could be seen as an antecedent* (fragmental timeline connected to the main one by a grey dotted arc),
 b) construction of the object (*morphological transformation* - blue colour),
 c) some ill-defined intervention – two alternatives are possible: no formal changes in the object (*episodic transformation* - red colour) or changes potentially introducing a new evolutionary phase (*morphological transformation* - blue colour, circle with a question mark),
 d) short-term *episodic transformation* (red colour),

3.3.3 A discontinuous time scale : pluses and minuses

As can be seen from the example above the introduction of alternative scenarios along the timeline results in breaking the continuity of the time scale (Fig. 16-ab,c,g). Such a solution significantly hinders a direct comparison of the overall durations in diagrams - since “discontinuities” may appear anywhere in time, depending on the object being analysed. In fact, these discontinuities stem solely from the extent to which our knowledge is saturated with uncertainty. By contrast, a solution that would preserve the timeline’s continuity would hinder the readability of alternatives in turn, or at least their readability in terms of storytelling.

The main purpose of *multi-hypothesis chronology diagrams* is to recap and position alternative scenarios : once a given path is chosen by the analyst, further investigation, and more detailed analyses of each transformation, can be supported by other visualisations such as chronographs for example (cf. Fig. 9 and 10).

3.3.4 Precision of dates: ranges and graphic codes

The four categories of dates that we have introduced (definite, dubious, approximate and unknown dates) are represented in the diagram by graphics codes that impact both the time markers and the transformation duration indicators. When dates are *definite*, time markers are filled with the colour corresponding to the

e) two transformations beginning in the same year are marked with “time markers” placed one above the other – a fire (*degrading episodic transformation* - orange colour) followed by a *morphological transformation* (blue colour, time interval).
 f) short-term *degrading episodic transformation* (e.g. the destruction of the roof during a windstorm - orange colour),
 g) circumstantial evidence-based transformation, three possibilities: no action undertaken (short yellow segment), works which do not cause formal changes (*episodic transformation* - red colour) or *morphological transformation* (blue colour, circle with a question mark),
 h) short-term *morphological transformation*,
 i) *episodic transformation* running over a time interval,
 j) *destructive transformation* (e.g. demolition - grey colour),
 k) *degrading transformation* concerning relics (orange colour),
 l) *onBite investigations* (green colour).

Alternative scenarios (a, c, g) – here highlighted with grey arrows – result in breaking the continuity of the timeline.

[I. Dudek, J.Y. Blaise, 2011]

transformation's class (Fig. 17a), and so is the transformation duration indicator. When dates are *dubious*, time markers are marked with a white filling (Fig. 17b), and the transformation duration indicator left unchanged. *Approximate* dates are represented by time markers with a white filling and a dashed outline (Fig. 17c), transformation duration indicators are dashed too. Transformation duration indicators represent time intervals – they are bounded by *two* time markers. It is enough that one of these dates is approximate to consider that the interval itself is approximate. Accordingly, as long as one of the two time markers is approximate, the transformation duration indicator is dashed (Fig. 19c).



Fig. 17. Time markers for:
 a) definite dates,
 b) dubious dates,
 c) approximate dates.
 [I. Dudek, J.Y. Blaise, 2011]

When dealing with *unknown* dates, we naturally cannot use time markers. Two different solutions are adopted. When the transformation considered is a construction or a destruction, we show it through a dashed, arrow-like shaped, transformation duration indicator (Fig. 19a). When the transformation is supposed to have occurred somewhere inside the lifeline of the object, it is represented by a dotted arc below the main timeline, with possibly the transformation's number written inside a circle. Such transformations do need to be bounded in time - otherwise the arc would run from creation to now. We try to bound them by preceding and succeeding transformations, the dates of which are better known. In the worst case this would result in the transformation “floating” between the construction and the destruction, represented by an arc running from the former to the latter (Fig. 18).

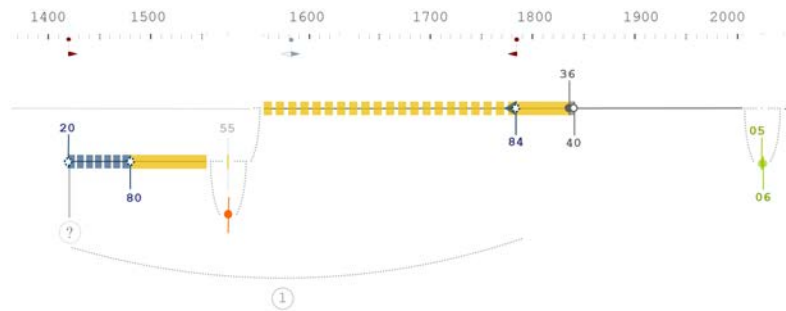


Fig. 18. Marked by the bottom dotted arc, a transformation that is supposed to have occurred, but at unknown dates. The arc is bounded by two other dates : on the left presence of a presumable antecedent, on the right, date starting from which the object is known to have existed.
 [I. Dudek, J.Y. Blaise, 2011]

Short-term transformations (time point) and long-lasting transformations (time intervals) are represented by glyphs close to which digits are written that correspond to the last two digits of a year (e.g. 1627).

In a number of cases time intervals are bounded by dates that differ in terms of precision – this information can be conveyed in the graphics thanks to the use of two independent time markers (Fig. 19-b,c).

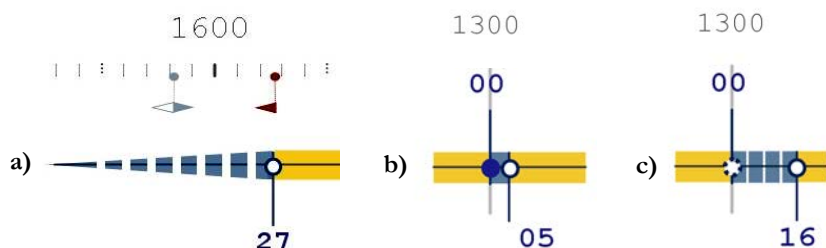


Fig. 19 Various displays of time intervals in multi-hypothesis chronology diagrams:
 a) ...?? – 1627 ?,
 b) 1300 -1305,
 c) 1300 ?? – 1316 ?.
 [I. Dudek, J.Y. Blaise, 2011]

3.3.5 Numbering of the evolutionary phases

Uncertainty or lack of data concerning the consequences of a given transformation result in the possibility that a new, yet hypothetical, evolutionary phase of an object should be considered. However this phase differs from others by the fact that it *is* hypothetical.

Confirmed evolutionary phases are marked in the diagram with a number, and hypothetical evolutionary phases with a question mark (Fig. 20). The numbering of phases we propose only recounts these that are known – if an analyst chooses to validate a scenario that includes hypothetical phases, then the overall number of evolutionary phases for one object has to be updated.

Small red flags along the time scale mark the potential beginning of the evolutionary process. When the first element of an object's evolutionary chain raises questions, construction dates corresponding to each alternative scenario will be marked with this symbol (Fig. 20).

3.3.6 Interpretation of linear diagrams

Some objects – may they be well-known or poorly documented – are represented by linear diagrams – with no ramifications, no alternative scenarios (*cf.* Fig. 15a). How should this be interpreted? The linearity of a diagram does not necessarily mean the compliance of sources and opinions as regards the evolutionary process of a given object, nor should it be understood as an absence of doubts. What it merely means is that, from the reading and analysis of the evidence:

- to the best of our knowledge, no conflicts arose between sources, and no doubts were clearly postulated regarding the occurrence of a fact or the character of its consequences,
- no contextual information or no known relation (neighbouring objects for instance) justify the creation of a ramification.

A multi-hypothesis chronology diagram shows hypotheses about the development of a given object. Time is represented in real scale, helping the analyst to weigh durations and densities, and to localise periods of doubt. However this graphic solution has its constraints (discrete time for instance) and its limitations. The most significant is probably the fact that no visual difference is clearly made between alternatives that are based on duly established facts from those that are based on circumstantial evidence. In other words, multi-hypothesis chronology diagrams are good at localising in time, but not that good at depicting the reasoning process itself. This is done through *graphs of potential interactions*.

3.4 Graph of potential interactions

These diagrams allow a reading of transformations, states and contextual information in *ordinal time**, detailing the nature of alternatives and distinguishing clearly alternatives that are based on duly established facts from those that are based on circumstantial evidence. *Graphs of potential interactions* use the same classes of transformations as *multi-hypothesis chronology diagrams* (Fig. 21). The chronology of events is retained, but the durations do not appear (they are written in the vertical texts though): only the order is assessed. The diagram emphasizes visually differences between *definite*, *confirmed* and *potential* transformations (Fig. 22). As a result, these diagrams support other reasoning tasks: comparisons between objects (in terms of number and type of transformations and alternatives) or densities, order,

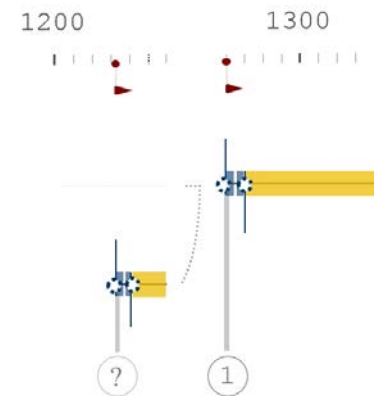


Fig. 20. Fragment of a theoretical example of multi-hypothesis chronology diagram.

The numbering of evolutionary phase is reported in the bottom part – ‘1’ refers to the first confirmed evolutionary phase, whereas ‘?’ refers to a hypothetical phase, not taken into consideration in the numbering.

Red flags along the time scale (top part) show the potential beginnings of the evolutionary process.

[I. Dudek, J.Y. Blaise, 2011]

* Ordinal time :

In ordinal time, the duration of events, as well as the time interval between two events, are not shown – only the chronological order of appearance needs to be given (*a* before *b* before *c*, ...).

frequencies and transformation patterns are easier to read in ordinal time since the actual length of the lifeline ceases to command the length of the visualisation.

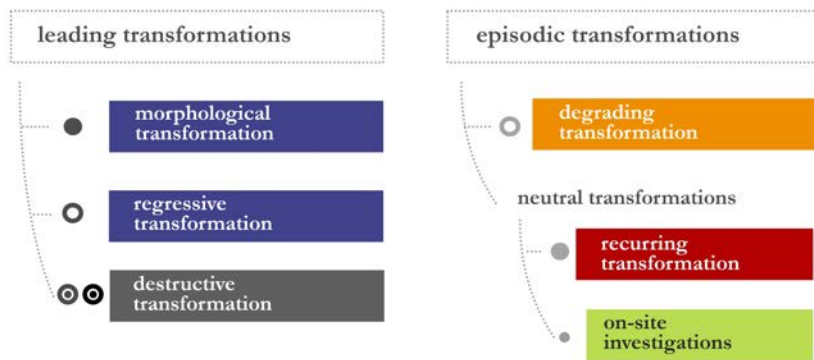


Fig. 21. Circles, in different shades of grey, on the left of the coloured rectangles, are the symbols used to identify classes of transformations in the *graphs of potential interactions*.
 [I. Dudek, J.Y. Blaise, 2011]

3.4.1 A focus on corroborative information

Confirmed and *potential* transformations differ by the fact that the latter are based on circumstantial evidence, *i.e.* indirect indications that something may have occurred in the object’s evolution. In other words, besides pieces of information that explicitly signal *definite* or *confirmed transformations*, there are source documents that mention facts which are not transformational by nature [43]. These documents are considered here as *corroborative* information, *i.e.* either initiating a possible cause and effect relation that will lead to a *potential* transformation, or bringing to the fore chosen elements of context, that back up the hypothesis.

Note 43. For instance, the location privilege granted to Krakow (*The Boleslaus Charter’ from 5th June, 1257*) demonstrates the will of the King to build cloth stalls, but is not a valid indication that these stalls were actually built right away.

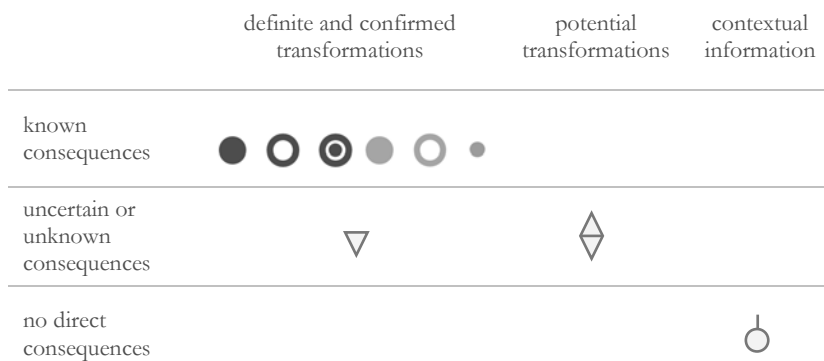


Fig. 22. Glyphs used and their relation to transformation types and context. The use of corroborative information in the analysis process is clearly signalled in the graphics, either by the double triangle or by the contextual information icon (bottom right).

[I. Dudek, J.Y. Blaise, 2011]

Either in the case of *confirmed* transformations or in the case of *potential* transformations, one among the alternative scenarios *did* occur. Generally speaking the co-existence of alternative possibilities would require that the method through which one could prove their respective authenticity or falseness is specified – a clear challenge in historical sciences (the *graphs of potential interactions* show moments when this issue is raised, and nothing more).

Confirmed transformations correspond to binary situations ($p \vee \sim p$, e.g. morphological changes or not) – in that case the falsification of one possibility confirms the occurrence of the opposing hypothesis. *Potential* transformations also differ by the fact that the falsification of one possibility only, to a greater or lesser degree, increase the level of *corroboration* of alternative hypotheses.

Corroborative information and *corroboration* are important to spot and to visualise since they are **not** conclusive indications. They thereby better match the reality of the reasoning process in historical sciences, often packed with orphan branches and non terminated storylines. Ultimately, they leave more space for future, incoming, pieces of knowledge, and for new relations to be investigated.

3.4.2 General structure of the diagram

Graphs of potential interactions use an achromatic scale (*i.e.* shades of grey). These diagrams are basically timelines, to be read from left to right, along which successive states, transitions, alternatives are presented in ordinal time.

They are composed, from top to bottom, of three parts: brief texts written vertically that summarise what is known about an event or a transformation, dates written along vertical lines, and glyphs. Brief texts are linked to dates, and dates to glyphs distributed along a horizontal timeline (circles – transformations, rectangles – evolutionary phases, triangles – alternatives) (Fig. 23).



Fig. 23. A graph of potential interactions - example of the tanners' stalls.

At present, two evolutionary phases of this object are known. The period of creation of the first known evolutionary phase is approximate. The object could have burnt down in 1552, during a fire that stroke the western part of the Market Square. The results of possible renovation works are not known. The consequences of the two fires which followed (1555 and 1589) and affected the tanners' stalls are not known neither – the works which followed could have caused a change of the form of the object.

A known and documented change of the form probably happened in the fifties of the 17th century. During the second evolutionary phase of the tanners' stalls, two recurring transformations took place (a renovation and an introduction of a new function into the object).

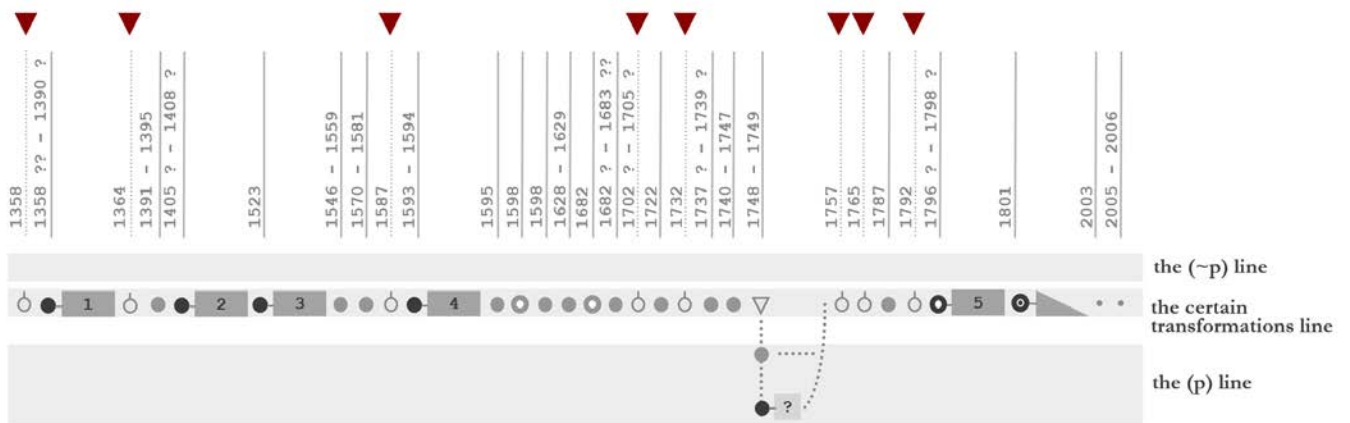
In 1867 a demolition of the object was enacted. The stalls were demolished in the years 1868-1875. During the construction of an underground fire protection container (1943-1944), parts of the relics of the stalls were probably destroyed – fragments of their walls were excavated and examined in 2004.

[I. Dudek, J.Y. Blaise, 2011]

The timeline itself (glyphs) is composed of three rows (Fig. 24), each of them corresponding to the varying nature of the information we have collected. When the information cannot be disambiguated, and alternatives should be considered, circles on the main horizontal line are replaced by triangles from which different paths can be taken.

A path through the top row means the event initiating the path may not have occurred at all (*the ~p line*). A path through the bottom row means the event initiating the path did occur, but its consequences can vary (*the p line*). The central basic path is *the line of definite transformations*. Contextual information is distinguished by a specific glyph on the main line and a specific underlining of the date (Fig. 24).

The precision of dating is presented in the text part (*cf.* 4.2.2 – Precision of dating). In the situations where approximate dating is not possible – *i.e.* there is at least one unknown date – this information is also visible on the graphs of potential interactions (Fig. 25).



In that case an arc is combined with the circle marking the transformation type, as in the examples below.





- a)  a) a morphological transformation leading to the formation of the third evolutionary phase of an object, it occurred somewhere inside the time interval marked with an arc;
- b)  b) a morphological transformation leading to the occurrence of the first (known) evolutionary phase of an object – the period of the transformation is unknown;
- c)  c) a morphological transformation connected with a change of localisation of an object (the second evolutionary phase was built in a different place - the period of the transformation is unknown);
- d)  d) a destructive transformation, which led to the demolition of the overground parts of an object - the period of the transformation is unknown;

Fig. 24. Bottom part of the graph of potential interactions for the Small Scales.













Contextual information is here marked with red arrows – note for instance for year 1358 an information concerning the object but preceding its assumed construction.

[I. Dudek, J.Y. Blaise, 2011]






Fig. 25 Examples of symbols informing on the difficulties in dating, used in graphs of potential interactions.

[I. Dudek, J.Y. Blaise, 2011]

Shades of grey applied to the glyphs are used to differentiate consequences that are considered in the context of alternative scenarios (in other words consequences that should be read as hypothetical) – light grey, and consequences that are well established – dark grey (cf. Tab. 2).

the situation did occur	the situation may have occurred	
		occurrence of a new evolutionary phase (consecutive phases are marked with numbers <i>i.e.</i> 1, 2, 3, ...)
		Handling of antecedents : occurrence of a new evolutionary phase of an object whose existence is confirmed, but whose sameness with the object under scrutiny is hypothetical (separate hypotheses are marked with letters <i>i.e.</i> a, b, c, ...)
		hypothetical occurrence of a new evolutionary phase – the fact cannot be excluded (marked with a question mark)
		When hypothetical antecedents or successors are proposed, this symbol is used to mark a denial of these propositions.
		an object has undergone destruction (its underground parts were preserved – the foundations, the underground tiers,...)
		an object has undergone annihilation (no traces of it remain)
		detachment (secession) of a fragment or of fragments from an object
		incorporation (annexation, absorption) of a fragment or of the whole object into another one

Consequences are further differentiated through line types : a continuous line is used when the consequences are well-established, and a broken line for hypothetical ones, as illustrated in the examples below (Fig. 26).

-  a) a destructive transformation which led to the demolition of the overground parts of an object;
-  b) a destructive transformation which may have led to the demolition of the overground parts of an object;
-  c) a destructive transformation which may have led to the loss of an object, either by its annexation by a so far unidentified object, or as a result of its demolition;
-  d) a morphological transformation, connected with a change of localisation of an object (the second evolutionary phase was built in a different place);
-  e) a morphological transformation, connected with a possible change of localisation (the second evolutionary phase might have been built in a different place);

Tab. 2. Glyphs and shading codes used to differentiate hypothetical and well-established situations.
[I. Dudek, J.Y. Blaise, 2011]

Fig. 26. Line types used to differentiate hypothetical and well-established situations.
(a), (d) – the situation did occur
(b), (c), (e) – the situation is hypothetical
[I. Dudek, J.Y. Blaise, 2011]

By combining the above-mentioned graphic codes the analyst can propose a relatively precise visual record of his state of knowledge. The process of destruction is often quite complex to handle and reveal visually. One of the difficulties here is stating relations such as secession and annexation that may link an object 'loosing parts of its being', and an object 'gaining volume'. In the examples below we show how these relations can be spotted in the context of the graphs of potential interactions (Fig. 27).

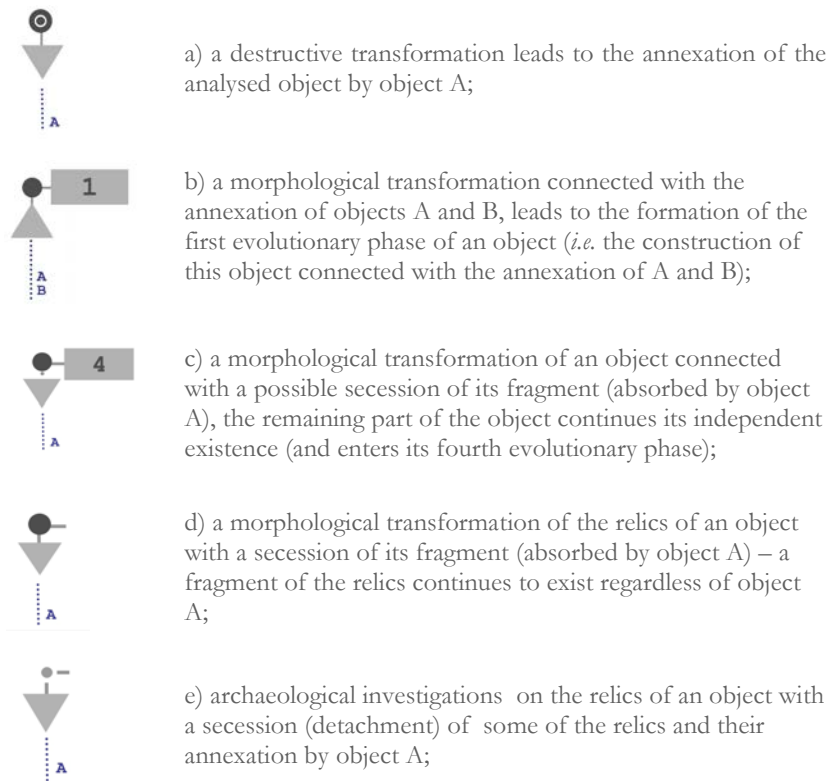


Fig. 27. Recording and visualising secession and annexation processes with graphs of potential interactions: (a) annexation of the object under scrutiny by another object one, (b) the object under scrutiny annexes another object (c, d, e) secession of fragments. [I. Dudek, J.Y. Blaise, 2011]

3.5 Visual measure of complexity

This diagram allows a synthetic comparison of levels of complexity, underlining the amounts of alternatives and the density of doubts.

It is created by simplifying a graph of potential interactions – reducing continuous chains of definite transformations to one unique element, omitting transformation symbols and contextual information symbols. By contrast, each alternative scenario is preserved and visualised, without symbols but with all its possible paths (Fig. 28).

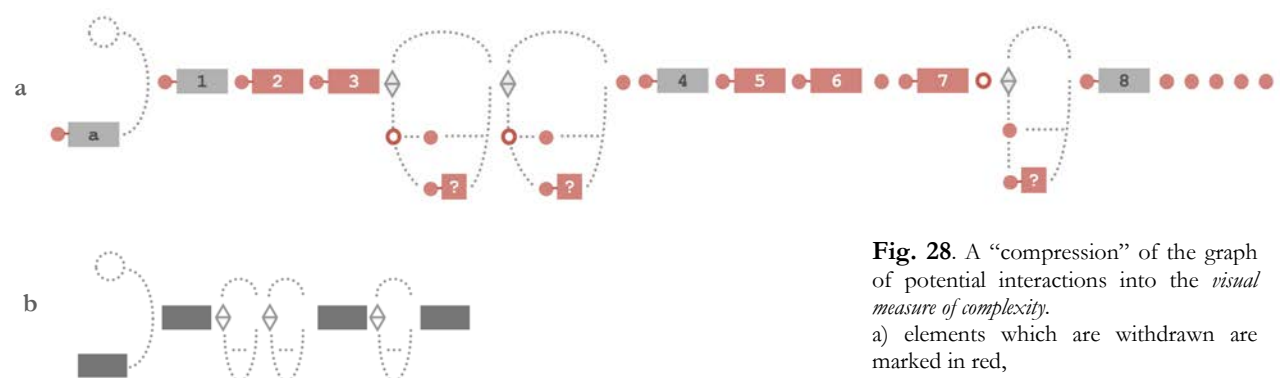
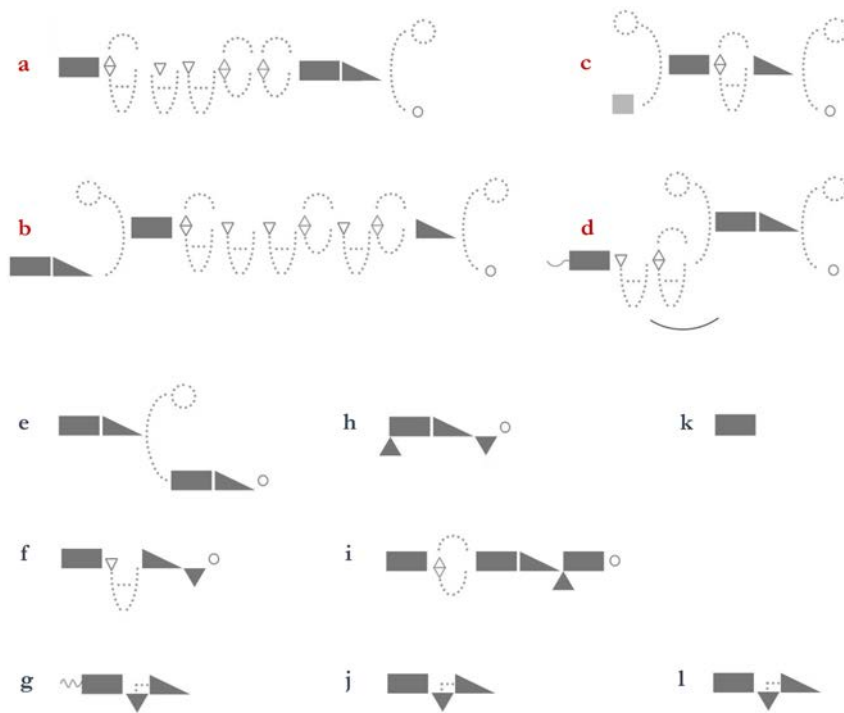


Fig. 28. A “compression” of the graph of potential interactions into the *visual measure of complexity*. a) elements which are withdrawn are marked in red, b) the resulting visualisation. [I. Dudek, J.Y. Blaise, 2011]

The main role of the visual measure of complexity is to foster comparative analyses. Juxtaposing visual measures of complexity for a group of objects with some features in common [44] gives a broader picture, summing up the character of our current state of knowledge concerning this group. (Fig. 29)



Note 44. For instance, their localisation on the Market Square, period of creation, owner, ...

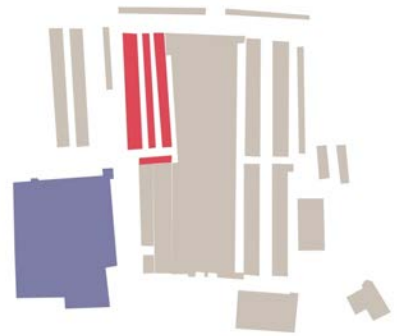


Fig. 29. The visual measures of complexity for two groups of objects: (a-d) diagrams, saturated with a great number of doubts and uncertainties, for the ensemble of stalls located on the north-western side of the Cloth Hall (in red);

(e-l) diagrams for the Town Hall ensemble (in blue), relatively complex but indicating a small number of doubts and controversies.

a) the pottery stalls, b) the baker's stalls, c) the fish stalls, d) the gingerbread stalls, e) the guardhouse, f) the dungeon, g) the market hall for minor traders, h) the granary, i) the Town Hall, j) the council members' house, k) the tower of the Town Hall, l) the notary's house;

[I. Dudek, J.Y. Blaise, 2011]

Summary

Investigating into the evolution of an architectural object, and using visual means to do so, is primarily a matter of filtration into the data, and of stratification (parallel analyses of various aspects of the same data). The analysis process a particular scientist carries out in order to understand and interpret specific facts concerning the development of an architectural object over time can be backed up by univocal visual solutions such as *chronographs*.

In this catalogue we privilege the analysis and visualisation of alternative scenarios, and introduce three visual solutions that share a common general structure: time is represented as linear, running from left (past) to right (present and future).

The time resolution we adopt uses a one-year chronon, considered as a reasonable compromise resulting from the lack of precision of the underlying data.

All three visualisations support the analysis of an object's lifeline, but operate on slightly different levels (alternative filtrations) and concern variant aspects of the same data:

- *multi-hypothesis chronology diagrams* provide a quick, synthetic view on where alternative scenarios exist in time. They show doubts concerning the precision of dating, and alternative paths, along with their potential consequences. Time is represented in real scale,

and in discrete time: durations are therefore assessed, their relative lengths can be compared, but the introduction of alternative scenarios along the timeline results in breaking the continuity of the time scale.

- *graphs of potential interactions* allow a reading of transformation, states and contextual information in ordinal time, detailing the nature of alternatives and distinguishing clearly alternatives that are based on duly established facts from those that are based on circumstantial evidence. Additionally, these graphs include the contextual information that the analyst considers as potentially corroborative.
- *visual measures of complexity* allow a synthetic comparison of levels of complexity, underlining the amounts of alternatives and the density of doubts. They are created by simplifying graphs of potential interactions.

4 – Representing the spatial parameters

An overwhelming majority of the publications recounting the history of architectural objects strongly focus on the 2D or 3D spatial parameters, meaning here *where was the object*, and *what was its shape, what did it look like*. Noticeably, the extent to which the actual knowledge (including doubts) on which these spatial parameters are based is not always clearly stated.

In this catalogue the focus is clearly put on temporal aspects. Yet we shall also include some pieces of information concerning the localisation and the possible morphology of objects at this or that moment in history. This chapter sums up the choices we have made with regards to the handling and the representation of these pieces of information.

4.1 Localisation of objects on the Market Square

Many solutions can be used to represent in 2D the successive localisations and layout of an object, among others *temporal density layers*, *time sliders*, *concentric time*, etc.. But these solutions most often imply we actually *have* the information – which is not always the case here. As mentioned in section 2.3.1 - Assessment of precision concerning an object's localisation - we distinguish two fundamental cases:

- *localisation is known* (i.e. based on observation or confirmed by field studies or precise and corroborated historical sources),
- *localisation is approximated* (i.e. based on indications that are imprecise, and only allow for a surmised localisation).

The localisation of objects is represented on a schematic map of the Main Market Square, that reuses an 1803-1804 map in order to convey a general idea of the urban structure [45]. To avoid complicating the diagram unnecessarily, we did not include in the schematic plan objects with unidentified, uncertain or changing localisation (e.g. market hall for minor traders), as well as overlapping objects (e.g. Boleslaus' Stalls which partly overlap with the Cloth Hall and the Rich Stalls).

When *the localisation of an object is known*, it is represented by a red simplified polygon, and other objects as grey polygons, helping to read the relative position of an object inside the Market Square ensemble. Since the plan of an object - and sometimes its location - evolved with time, the outline of the building presented on the diagram corresponds to only one chosen moment in the sequence of numerous phases (Fig. 30-b,c).

When *the localisation of an object is approximate* it is represented by a sort of "probability cloud" showing where the object is likely to have been situated. In that case the background greyish context is withdrawn so as to avoid misleading interpretations (Fig. 30a).

It should be made quite clear that this diagram is of approximate character, and so are the divisions of the Market Square into four sectors and its assimilation to a simple square. Sectors where an object is localised are represented with a lighter grey background, helping to spot the area where potential neighbouring relations should be investigated in priority, and helping to spot objects that span over several sectors.

Note 45. The schematic map is based on a 1803-1804 plan of the Market Square.

cf. J. Banach, *The iconography of the Main Market Square in Kraków*, TAIWPN UNIVERSITAS, Kraków 1998, fig. 2

cf. D. Rederowa, *Studia nad wewnętrznymi dziejami Krakowa porozbiorowego (1796-1809)*. (*Studies on the internal history of post-partition Krakow (1796-1809)*), transl. by authors), Część I. *Zagadnienia urbanistyczne*, (jako zeszyt 2) T. XXXIV, 1958-1959, p. 87, fig. 2

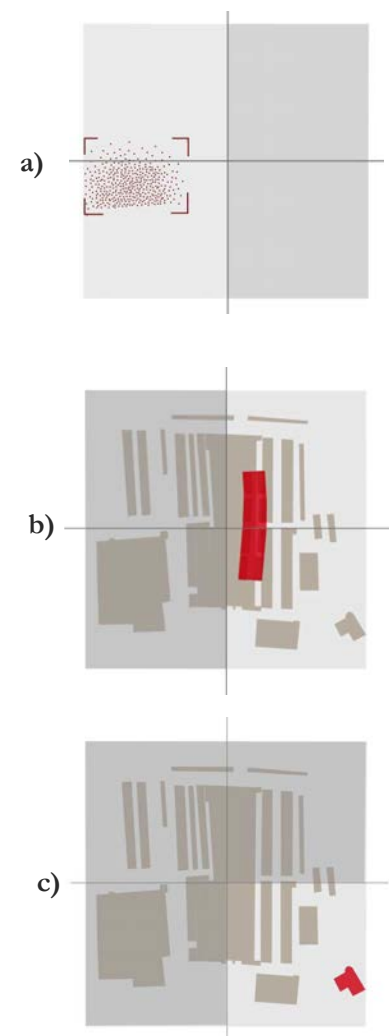


Fig. 30. Schematic maps for:
a) the council members' house,
b) Boleslaus' stalls,
c) St Adalbert Church.

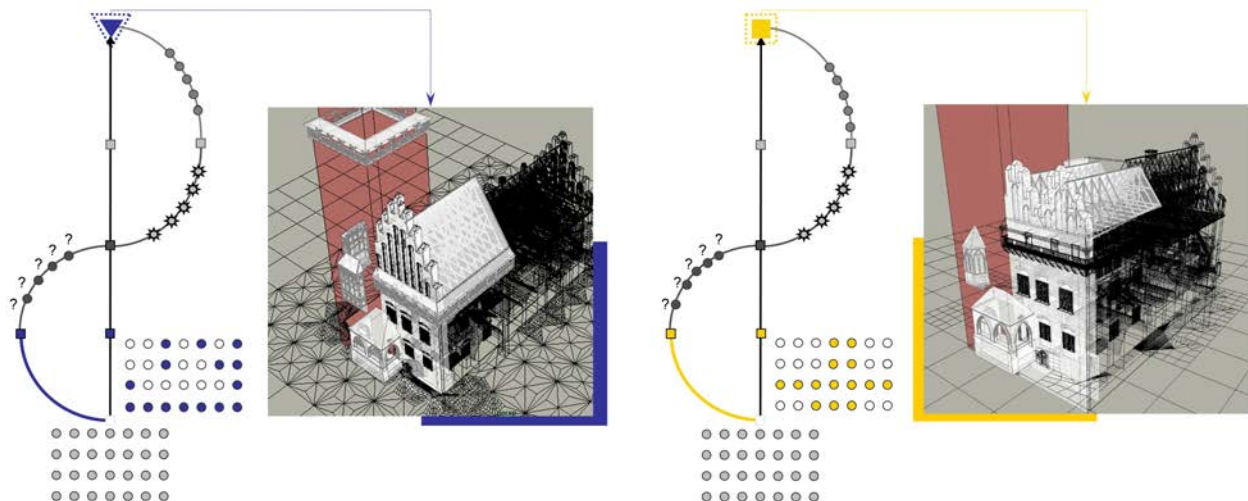
[I. Dudek, J.Y. Blaise, 2010]

4.2 Reconstruction hypotheses – morphology restitution

Recreating the form of a non-existent object is a much more sensitive problem – in terms of amount of interpretation, in terms of confusion between what is *shown* and what is *known* – than a general description of the chain of transformations occurring in its evolution.

The description, allowing a visual recreation of the form of an architectural object requires a lot of information – and in most cases we do not have enough data (e.g. colour of the material or brickwork of the walls, proportions and subdivisions of openings, floor height, *etc.*). Sometimes even analogical examples are missing.

Furthermore, for the majority of successive states of any object, it is possible to suggest several variant restitutions, which do not collide with the data. These representations may even differ substantially – since they are usually prepared on the basis of incomplete data sets that leave much room for individual and subjective interpretations (e.g. the gradient of the roof, the location and shape of the chimneys, the shape and arrangement of the architectural details, *etc.*). (Fig. 31)



That is why almost every realistic presentation of the form of a non-existent object (restitutions) is a hypothesis – and sometimes even more a “divagation on an object”, or a vision, than a hypothesis as such. [46].

Even in the case of hypotheses based on skilfully selected sources, on relevant analogies learnedly analysed, it is not always convenient in terms of communication to visually separate the elements whose restitution has been documented [47], from those for which there is no substantive justification (except for the necessity to avoid a white spot on paper).

By this we do not mean to say that creating restitutions of destroyed objects or earlier evolutionary phases of existing objects, *a priori* makes no sense or lacks scientific character. Such studies are necessary – they can help to verify the coherence of hypotheses, or make us aware of the extent of thing we would need to know.

What is important, however, is to understand and explain the aim of a restitution. The pragmatic aspect (who the information is targeted at) makes us present information in a different way to children, and still in a different one to visually impaired people. And so the opinion that it is possible to achieve separate goals with the help of one unique means is simply an illusion: a 3D model is by essentially synchronic, if it is a

Fig. 31 The process of creating a reconstruction hypothesis begins with choosing the sources and ends with explanations – casual or teleological (*cf.* Fig. 3). Representing the results in the form of illustrations or of a 3D model rarely allows to present the choices made by the author and his line of thought.

Below, two restitutions (reconstruction hypotheses) of the Town Hall (third evolutionary phase, after 1454), made with a different choice of source documents: the choice of sources influences the final outcome.

On the left - the restitution according to F. Christ (1950) [C. Radi, 2000], on the right - the one according to A. Essenwein (1869) [C. Radi, 2000];

[I. Dudek, J.Y. Blaise, 2011]

Note 46. After J.M. Bocheński, we should assume that in historical (idiographic) sciences, a formulation of a hypothesis is based on : a selection of documents (historical sources, results of research into material traces, *etc.*), their interpretation (an analysis of what the author meant) and historical criticism (an attempt at establishing if statements thus deduced are true). Only after that can we pass on to historical explanations, allowing us to formulate a hypothesis. (*cf.* Fig. 3)

cf. J. M Bocheński, *The Contemporary...*, *op.cit.* pp.129-136

But some restitutions are based mainly on intuition founded on a general knowledge of the problem, and contain more suppositions and subjective resolutions than decisions based on the abovementioned rigorous analysis process.

Note 47. Not to mention all the shades of uncertainty connected with the credibility or precision of the documents.

realistic model it goes by essence beyond what we know. If the aim is to communicate information intended for the wide public, the very choice of the form of presentation will impose the ignorance of “insignificant doubts”, since the aim of communication understood in this way is usually to convey what we know (*i.e.* the known), and not to explore the unknown. If the aim is, by contrast, to spot and discuss the unknown, in space and in time, restitutions are not enough, by far.

We shall not here discuss further on the issue of *how to represent reconstruction hypotheses*. However, some visual elements will be given in section two – catalogue, that do show the morphology of objects.

These visual elements are presented as complements of the graphs of potential interactions. Their role is to help getting an overview of synchronic steps: differences in terms of morphology between successive states. They include iconographic and cartographic source documents – typically fragments of maps or sketches, restitutions proposed by this or that author, and *tangible models* [48]. We built the latter with regards to three priorities: a visual character (‘white’ models) that is in line with the nature of the underlying data, a representation of detailed architectural features (number of windows, type of roof, *etc.*) if and only if they are well-established, and the will to support a ‘reading’ by visually impaired people.

In all cases we have chosen to *redraw* the visual content with an ambition to ensure a better graphic consistency, to filter semantically the original graphics if needed, and to avoid the “*looks real? – has to be real!*” effect that so often hinders the readability and trustworthiness of many 3D models.

Summary

Whereas an overwhelming majority of the publications recounting the history of architectural objects strongly focus on the 2D or 3D spatial parameters, we here have chosen to focus on temporal aspects. Still, some pieces of information concerning the localisation and the possible morphology of objects is conveyed in this catalogue.

The localisation of objects is represented using a schematic map of the Main Market Square on which, when *the localisation of an object is known*, it is represented by a red simplified polygon, and when *the localisation of an object is approximate* it is represented in the shape of a “probability cloud”.

Visual contents concerning the morphology of objects, presented as complements of the graphs of potential interactions, are redrawn from a variety of sources including archival material and 3D tangible models.

Note 48. Physical models part of a system called *Tactichronie* (patented by CNRS), allowing to recreate a hypothetical state of the development of the Market Square in Krakow at a given moment in history (beginning with the granting of the charter to the city).

The models of particular objects, as well as the plate of the Market Square were constructed in a way that allows a tangible cognition of the hypotheses (physical codes), so as to be adapted to blind or visually impaired people – people that have very limited possibilities of direct contact with architecture.

5 - The catalogue of architectural objects

The catalogue part of this publication (section two) presents an abridged analysis of sources for most of the objects that used to exist on the Main Market Square in Krakow. Some objects are not mentioned, for various reasons. These exceptions are as follows:

- the objects mentioned in text sources, whose existence as independent and permanent architectural objects has not been clearly confirmed so far. The names known from the sources in some cases could have concerned only functions appearing within another object.

For example, stalls or stands of: cheese traders, candlemakers, needlemakers, fustian weavers, cutlers, cardmakers, linen drapers, lard traders, independent butchers, seed traders, *etc.*

- the names of objects which do not define more than a customary place of sale. Some of the names quoted in sources could have referred to objects of mobile nature (removed for the night, temporarily built on the Market Square, *etc.*).

among others: florists' stalls

- the objects which belong to the tenement houses on the sides of the Market Square,

among others: bookbinders' stalls, booksellers' warehouses and stalls in front of the RG 5 tenement house

- the objects which are of the so called "street furniture" nature rather than of architectural character.

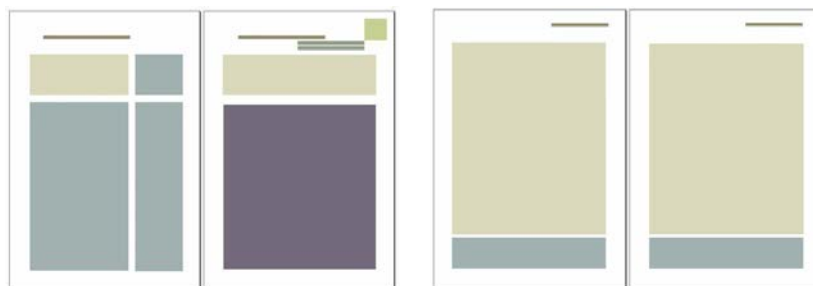
among others: the pillory, wells, fountains, Adam Mickiewicz's monument

5.1 General layout of the catalogue pages

The architectural objects are presented in turns in alphabetical order (following the names which we have assumed as the leading ones) [49].

Apart from the leading and the historical names (**a**, **a₁**), the following content is provided for each object:

- (b)** a schematic map showing its approximate localisation on the Market Square (*cf.* chapter 4.1 - Localisation of objects on the Market Square);



- (c)** the following diagrams : *the visual measure of complexity*, *the multiB hypothesis chronology diagram* and *the graph of potential interactions*. When possible, redrawn visual contents showing potential differences in terms of morphology between successive states are added [50];

Note 49. A leading name has been chosen, in Polish, and translated into English. This leading name is complemented by a list of the object's main alternative historical names (*cf.* Fig 32, the **a₁** element).

Fig. 32 Layout and relative positions of the various informational components systematically present within the catalogue's pages.

[I. Dudek, J.Y. Blaise, 2011]



Note 50. These freehand drawings are simplified, schematic sketches redrawn on the basis of iconographic and cartographic materials, and of restitutions. (*cf. References section.*)

- (d) short texts (often quotations) referring to the object itself, or to information connected with it, concerning a wider historical context (function and role of the object in particular, legends of diagrams);
- (e) the chronological chart – inside which for each transformation or each significant element of context a short “analysis of historical sources” is written, backed up by the full list of iconographic and cartographic documents and restitutions used in the analysis (cf. chapter 5.3).

On the first (left) page, the amount of various kinds of information significantly varies from object to object. When the information is particularly brief, the *graph of potential interactions* is placed systematically on the first page (Fig. 33), whereas in other cases, it systematically follows the *chronological chart*.

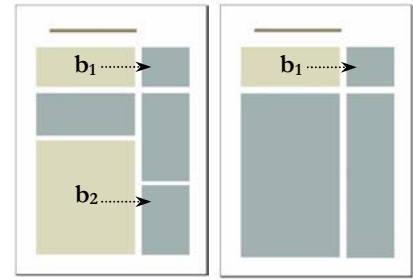


Fig. 33 Two possibilities of the layout of the first page.

b1) – a visual measure of complexity accompanied by a short description,
 b2) – a graph of potential interactions with a short description.

[I. Dudek, J.Y. Blaise, 2011]

5.2 Content and layout of the chronological chart

Chronological charts sum up, in chronological order, object by object, the information on which each transformation or contextual information is based – may it be well-established facts or hypotheses.

Accordingly, each row of a chart corresponds to a particular occurrence in time. It contains a commentary on the transformation and (or) facts, along with all the necessary references. Colours (background shades of grey and colours of the left column) define the nature and effect of the events (Fig. 34, 35).

The prominent part of each row - columns 1,2,3on Fig. 34 and 35 - can be white, light- grey or dark – grey:

- white rows concern contextual information - facts connected with the object, which are not of transformational nature (e.g. The building is in a very bad condition and a renovation is suggested.) (Fig. 34-e)
- light-grey rows concern *episodic transformations* appearing repeatedly within one evolutionary phase, but not leading to the creation of a new evolutionary phase (e.g. archaeological research, renovation, rebuilding in the same form). (Fig. 34-c, d, g)
- dark-grey rows contain information on the *morphological transformations*, which introduce a new evolutionary phase. (Fig. 34 - a, b, f)

These columns consecutively contain what follows:

- (column 1) – the dating of the transformation or facts. (Fig. 34-1) (cf. chapter 2.3.2 – Assessment of precision concerning the dating of transformations)
- (column 2) – a commentary on the suggested dating (alternative sources and dating); (Fig. 34-2) In the case of conflicting sources, the dates on which the dating is based is underlined.
- (column 3) – short information summing up the facts and references (historical documents and studies), used to spot the transformation / contextual information and to describe it. (Fig. 34-3)

For morphological transformations, the iconography and the cartography, as well as a list of restitutions showing the object after the introduction of changes, are quoted. When what visual sources

	0	1	2	3
a)				Przedpokład budowy państwowych kamień walcowych... 1800-1802
b)				Przedpokład budowy państwowych kamień walcowych... 1800-1802
c)				Przedpokład budowy państwowych kamień walcowych... 1800-1802
d)				Przedpokład budowy państwowych kamień walcowych... 1800-1802
e)				Przedpokład budowy państwowych kamień walcowych... 1800-1802
f)				Przedpokład budowy państwowych kamień walcowych... 1800-1802
g)				Przedpokład budowy państwowych kamień walcowych... 1800-1802
h)				Przedpokład budowy państwowych kamień walcowych... 1800-1802

Fig. 34 An example of a chronological chart-columns 1-2-3.

[I. Dudek, J.Y. Blaise, 2011]

show is not for sure the object being analysed, references are signalled with a question mark. (e.g. [Kozarski A., around 1868]?).

- (column 3) – experts’ opinions regarding one or another interpretation of the underlying data are not always unanimous. When significant differences arise, we also mention the alternatives in this third column.

The left column (Fig. 34-0 amd 35-0) contains codes which further detail the nature of the transformations. These codes closely match the classification of transformations as presented in chapter 1 (cf. Fig 2):

- rows preceded by a grey field with a question mark concern morphological transformations and are connected with hypotheses concerning the first element of the object’s evolutionary chain (Fig. 35-a),
- rows preceded by a blue field with a number concern the morphological transformations that initiate a new evolutionary phase (Fig. 35-b),
- rows preceded by a pink field contain information on neutral transformations - those that do not cause any vital changes in the morphology of an object (Fig. 35-c),
- rows preceded by a red field contain information on degrading transformations. (Fig. 35-d),
- white colour signals contextual information (Fig. 35-e),
- rows preceded by a dark-grey field with the letter **R** concern destructive transformations – those that cause the removal of an object and the retrieval of the whole area occupied by it (e.g. demolition) or its annihilation (Fig. 35-f),
- rows preceded by a light-grey field concern architectural or archaeological investigations (Fig. 35-g). Such interventions are, at least theoretically, of non-interventionist nature.
- rows preceded by a light-grey field with the letter **S** contain information on the secession of a fragment of the relics of an object (Fig. 35-h) – separation of some archaeological relics and joining them to another complex – even without the necessity of translocation.

In case of doubts concerning the nature of the transformations (e.g. their result), the field in column 0 can be divided into several vertical sections, each of them suggesting a different possibility. The presence of a white subsection means that a given transformation may not have taken place or may not have concerned the object (*potential transformations*) (Fig. 36-a,b,c,d,f). If no white subsection is used (Fig. 36-e), the transformation is a *confirmed transformation* – something did occur but various consequences are possible .

	0	1	2	3
a)	?			Przebudowa budowlanych kamień walcowych... 1303-1304 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134) 1305 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134) 1306 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134) 1307 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134) 1308 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134)
b)	1			Przebudowa budowlanych kamień walcowych... 1309 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134) 1310 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134) 1311 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134) 1312 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134)
c)				Przebudowa budowlanych kamień walcowych... 1313 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134) 1314 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134) 1315 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134) 1316 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134)
d)				Przebudowa budowlanych kamień walcowych... 1317 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134) 1318 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134) 1319 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134) 1320 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134)
e)				Przebudowa budowlanych kamień walcowych... 1321 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134) 1322 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134) 1323 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134) 1324 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134)
f)	R			Przebudowa budowlanych kamień walcowych... 1325 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134) 1326 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134) 1327 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134) 1328 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134)
g)				Przebudowa budowlanych kamień walcowych... 1329 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134) 1330 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134) 1331 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134) 1332 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134)
h)	S			Przebudowa budowlanych kamień walcowych... 1333 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134) 1334 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134) 1335 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134) 1336 - wybudowanie kamienia walcowego (Kozarski W., Tabaka A., 1914, 134)

Fig. 35 The left column (column 0) of a chronological chart – codes and colours [I. Dudek, J.Y. Blaise, 2011]

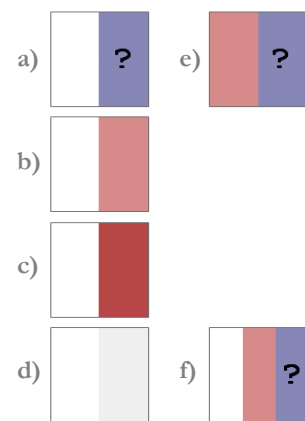


Fig. 36 Divisions of column 0, some examples:
a) either a morphological transformation or no transformation,
b) either a neutral transformation or no transformation,
c) a degrading transformation, which may not have concerned the analysed object,
d) archaeological research which may not concern the analysed object,
e) a morphological or a neutral transformation,
f) a morphological transformation, a neutral one or lack of any transformation. [I. Dudek, J.Y. Blaise, 2011]

References

(thorough list of the sources used in this study)

The most frequently used abbreviations:

The National Archive (<i>Archiwum Państwowe</i>)	AP
The Krakow Library, Krakow (<i>Biblioteka Krakowska</i>)	BK
The Museum of the History of Photography, Krakow (<i>Muzeum Historii Fotografii</i>)	MHF
The Historical Museum of the City of Krakow (<i>Muzeum Historyczne Miasta Krakowa</i>)	MHmK
The National Digital Archives, Warsaw (<i>Narodowe Archiwum Cyfrowe</i>)	NAC
The Studio of the iconography of Cracow, the National Museum in Krakow (<i>Pracownia Ikonografii Krakowa, Muzeum Narodowe w Krakowie</i>)	PIK
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- [plan 1836] Plan Krakowa T. Żebrowskiego z 1836 r., ANKr, sygn. II-16 [in] *Katalog dawnych ...*, *op.cit.*, ill.39
- [plan 1850] Plan Krakowa Niewiarowskiego z 1850 r., ANKr, sygn. II-18 [in] *Katalog dawnych ...*, *op.cit.*, ill.43
- [plan niwelacyjny 1878] Plan sytuacyjny i niwelacyjny miasta Krakowa z 1878 r., ANKr, zb. kart. sygn. I-6 [in] *Katalog dawnych ...*, *op.cit.*, ill.53

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Illustrations:

A specification of the drawings used in the graphs of potential interactions

Freehand drawings used in the graphs of potential interactions are simplified, schematic sketches redrawn on the basis of iconographic and cartographic materials, as well as restitutions. They contain the basic information on the appearance, proportions or the arrangement of particular objects in consecutive developmental phases.

In the diagrams comparing a potential form of an object in particular periods, for each drawing there have been used abbreviations containing information on the documents on the basis of which each drawing was prepared. The abbreviations could be expressed, for example, in the following way: [4] *drawn around 1850*.

The respective components of each abbreviation contain: the number of the diagram (e.g. [4]) – according to the chart below, the information on the character of the source used (e.g. drawn), as well as the approximate date characterising the period that the drawing concerns. (e.g. *around 1550*).

The information on the character of the source used is presented in the following way:

The *hip.* abbreviation is used for sources presenting restitutions (i.e. reconstruction hypotheses).

The *ill.* abbreviation is used for representations of artistic nature, made on the basis of observations or life sketches. This group comprises freehand sketches, watercolours, woodcuts, *etc.*

- The *phot.* abbreviation is used for photographs.
- The *inv.* abbreviation is used for drawings and diagrams presenting the results of architectural or archaeological research, as well as adaptation projects of particular objects.
- The diagrams prepared on the basis of documents of cartographic nature are marked as *plan.*

the
diagram
number

a reference to the materials on the basis of which a simplified drawing was made

1. XX., *Makieta Ratusz XVIII w., op.cit.*
[Gottwald, *Rynek XVIII w.*, 2008]
2. *Civitas Nostra Cracoviensis, A.D. 1650, op.cit.*
[Civitas ..., 2007]
3. STACHOWICZ M., *Pochód księcia ..., op.cit.*
[Stachowicz M., *Pochód ...*, 1796, ban17]
4. EKIELSKI A., *Sukiennice około 1850 roku, op.cit.*
[Ekielski A., około 1850]
5. BRODOWSKI J., *Zabudowa przy Sukiennicach, op.cit.*
[Brodowski J., 1843, ban253]
6. BRODOWSKI J., *Kramy w północno-zachodniej części Rynku, op.cit.*
[Brodowski J., 1840, ban252]
7. KOZAKIEWICZ Ł., *Zachodnia połowa Rynku od północy., op.cit.*
[Kozakiewicz Ł., 1827, ban127]
8. XX. *Domniemany zespół Sukiennic z końca XIII w., op.cit.*
[[Krzysztofory nr 28, cz.1, p.115, il.2]
9. NIEWALDA W., FIRLET E., OPALIŃSKI P., *Trzy fazy rozbudowy Sukiennic: z końca XIII w., op.cit.*
[Krzysztofory nr 28, cz.1, p.121, il.12]
10. XX. *Rekonstrukcja zabudowy Rynku Krakowskiego. Stan z około 1450 roku., op.cit.*
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11. ŚWISZCZOWSKI S., *Sukiennice krakowskie ok. 1450 r., op.cit.*
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12. LEPIARCZYK J., SCHÖNBORN B., *Makieta Krakowa średniowiecznego ..., op.cit.*
[Lepiarczyk J., Schönborn B., *Makieta ...*, 1949-1950]
13. XX. *Rekonstrukcja wyglądu Sukiennic w XIX w., op.cit.*
[XX, przed 1873, NAC 1-U-2569]
14. PIĄTKOWSKI T., *Widok zachodniej części rynku krakowskiego, op.cit.*
[Piątkowski T., 1837, ban120]
15. HEGENBERGER M. (?), *Wieża ratuszowa od północy, op.cit.*
[Hegenberger M., przed 1866, ban131]
16. ŚWISZCZOWSKI S., *Sukiennice przed przebudową, przyziom, op.cit.*
[Świszczowski S., przed 1975, przyziom]
17. *Plan Rynku przed 1820, op.cit.*
[plan 1820ir]
18. BOJĘŚ-BIAŁASIK A., *Północna partia Zachodniej ściany ..., op.cit.*
[Bojęś-Białasik, 2004, w Łukacz M., *Badania...*, il.24]
19. XX., *Kraków, zachodnia część płyty Rynku Głównego, relikty drewnianych ..., op.cit.*
[XX., 2004, w Zaitz E., *Sprawozdanie z badań...*, il.2]
20. XX. *System oznaczania numerycznego ław chlebowych w stosunku do „krzyża”. ..., op.cit.*
[Tyska P., około 1450, il.5]
21. XX. *Rekonstrukcja zabudowy Krakowa w końcu XIV i XV w., op.cit.*
[MHmK, 1450-1478]
22. ŚWISZCZOWSKI S., *Sukiennice krakowskie ok. 1450 r., op.cit.*
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24. ŚWISZCZOWSKI S., *Sukiennice krakowskie ok. 1550 r., op.cit.*
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25. *Civitas Nostra Cracoviensis, A.D. 1650, DVD, op.cit.*
[Civitas ..., 2007]

26. Plan Rynku Głównego (1803-1804), *op.cit.*
[plan 1803-1804]
27. Plan Krakowa Dominika Pucka 1787 r., *op.cit.*
[plan Pucka 1787]
28. Plan Krakowa Dominika Pucka sprzed 1773 r., *op.cit.*
[plan Pucka 1787]
29. KOZAKIEWICZ Ł., *Zachodnia połowa Rynku od północy.*, (1827), *op.cit.*
[Kozakiewicz Ł., 1827, ban127]
30. Plan położenia kramów na Rynku Głównym Krakowa (1832-1836), *op.cit.*
[plan 1832-1836]
31. Plan de situation du bâtiment dit Sukiennice ..., *op.cit.*
[Plan de situation, 1834]
32. EKIELSKI A., *Sukiennice około 1850 roku.*, *op.cit.*
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35. XX. *System oznaczania numerycznego ław chlebowych w stosunku do „krzyża”* ..., *op.cit.*
[Tysza P., około 1450, il.5]
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37. ŚWISZCZOWSKI S., *Sukiennice krakowskie ok. 1450 r.*, *op.cit.*
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41. Plan Rynku przed 1820, *op.cit.*
[plan 1820ir]
42. Plan Rynku Głównego (1803-1804), *op.cit.*
[plan 1803-1804]
43. Plan Krakowa Dominika Pucka sprzed 1773 r., *op.cit.*
[plan1700_1773]
44. Senacki plan Krakowa (1802-1808), *op.cit.*
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46. XX. *Rekonstrukcja zabudowy Rynku Krakowskiego. Stan z około 1450 roku.*, *op.cit.*
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49. Plan Krakowa Dominika Pucka sprzed 1773 r., *op.cit.*
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69. ESSENWEIN A., *Ratusz Krakowski w drugiej połowie XV w.*, *op.cit.*
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70. BALICKI K., *Południowa elewacja Ratusza*, *op.cit.*
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[plan 1975]
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[plan 2009]
78. Plan reliktyw średniowiecznych i nowożytnych budowli odsłoniętych na Rynku Głównym ..., *op.cit.*
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79. XX., *Śladem europejskiej tożsamości Krakowa - ...*, *op.cit.*
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[MHmK., Plan Podziemi]
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[XX., *Pierwotny ...*, w Łuszczkiewicz W., 1900, il.15]
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[plan Pucka 1787]
85. OPALIŃSKI P., KOMOROWSKI W., *Ratusz i Spichlerz około 1650 roku.*, *op.cit.*
[Opaliński P., 2007, w *Rynek Główny*, p.93]
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[Stachowicz M., 1794, ban103]
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[Walter H., 1858-1859, ban62]
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[plan niwelacyjny 1878]
92. XX., *Południowo-wschodnia część Rynku Głównego*, *op.cit.*
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97. Kollatajowski plan Krakowa z 1785 r., *op.cit.*
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99. STACHOWICZ T.B według Stachowicza M., *Wnętrze Kramów Bogatych*, *op.cit.*
[Stachowicz T.B., pocz. XIX w., ban259]
100. Plan Krakowa Dominika Pucka 1787 r., *op.cit.*
[plan Pucka 1787]
101. OPALIŃSKI P., SUDACKA A., *Sukiennice i Kramy Bogate*, *op.cit.*
[Opaliński P., *Sukiennice ...*, 2006]
102. Plan Rynku Głównego (1803-1804), *op.cit.*
[plan 1803-1804]
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108. XX. *Rekonstrukcja zabudowy Krakowa w końcu XIV i XV w., op.cit.*
[MHmK, 1450-1478]
109. STACHOWICZ T.B., *Wschodnia połowa Rynku Głównego ..., op.cit.*
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110. Plan Krakowa Dominika Pucka 1787 r., *op.cit.*
[plan Pucka 1787]
111. Kollątajowski plan Krakowa z 1785 r., *op.cit.*
[plan kollątajowski 1785]
112. ZALESKI M., *Północna część Rynku od zachodu, op.cit.*
[Zaleski M., 1836, ban158]
113. Plan położenia kramów na Rynku Głównym Krakowa (1832-1836), *op.cit.*
[plan 1832-1836]
114. Plan Rynku Głównego (1803-1804), *op.cit.*
[plan 1803-1804]
115. Plan Rynku Głównego (1803-1804), *op.cit.*
[plan 1803-1804]
116. Plan Krakowa Dominika Pucka 1787 r., *op.cit.*
[plan Pucka 1787]
117. Kollątajowski plan Krakowa z 1785 r., *op.cit.*
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118. Plan położenia kramów na Rynku Głównym Krakowa (1832-1836), *op.cit.*
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[XX, 1820-1822, ban51]
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123. PIĄTKOWSKI T., *Widok zachodniej części rynku krakowskiego, op.cit.*
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128. Plan de situation du bâtiment dit Sukiennice ..., *op.cit.*
[Plan de situation, 1834]
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