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# Introduction

### R. Rubens

The 2016 volume of Sartoniana is the reflection of the Sarton Chair for the history and philosophy of sciences. Loyal to the ideas of George Sarton it again contains contributions from various scientific fields.

The lecture chair holder is dr. Willem Levelt whose contribution to the history of linguistics is paramount. In his inaugural lecture he sketches the origin of psycholinguistics. After the four original roots based upon simple observation of the philologist of the common root of the indo-european languages, came the knowledge of the anatomy of the brain and its functions, even the development of the child and the mechanical voice later are important. It is however mainly based upon neuranatomy that the knowledge of language development is based during the first period up to world war one.

In the second lecture dr.Levelt develops the principles of nowadays psycholinguistics with carefull reference to the twentieth century enormous increase in psychology. Hereby he confirms not only the old anatomical facts but underlines the holism as the basis of intelligent speech.

The contribution of Dr. Halperin tries to resolve an old dilemma in law history. The always residing dispute between law as based upon simple customs as opposed to law based upon abstract or revealed basic principles. As he goes back in time to the three classic systems: Hebrew, Roman and Chinese. His telescopic overview of legal history clarifies the basic principles of European legal science.

Very few ophthalmologists nowadays are aware that the studies of Plempius in the XVII century outlines the basic principles of human vision. The careful remake of the difficult experiments forms the core of the work of Dr.Vanagt. The correspondence between Plempius and Descartes, as well as the discussion in the pre-enlightment period about vision reminds us about the old body-mind problem.

The paper by William De Groote tries to give a general outline of the history of orthopedics. It grew out of a pure empirical discipline towards a more scientific approach. The methods used during centuries to cure fractures of the bones are the backbone of his report.

Since 2002 most countries of the EU joined a single currency, the euro. The creation of the banknotes employed the bridge structure underlining hereby the collaboration in the biggest democratic union of governments in the world.. The presence of the brigde on the banknotes make civic engineers search for the models. The detailed study by dr.Curbach tries to solve the riddle. As not only he discovers the model but also points towards a logical temporal sequence in the models it most certainly can be the truth!

Kekule, the chemist first describing the aromatic benzene ring was in the nineteenth century professor in Gent. With a painstaking study dr.Declercq reconstituted the workplace and surroundings making the hallmark possible. The information concerning the former is the content of his contribution to Sartoniana.

Finally dr.Celik describes the interaction between the Ottoman society and the archeological endeavours of the European archeologists in the Middle East. The relation between the scientist, the workers and the local authorities is very important and certainly creates a new field. Most of us tend to forget that discovery and cleaning old sites with remains of long forgotten cities only can be done with an enormous workforce. The marvellous pieces now in musea are the result of frequently decennia long careful digging and cleaning.

May we express the hope that the range of reports from different scientific fields can make the reader reflect and think in the spirit of the true polymath as George Sarton once was.

SARTON CHAIR LECTURE

# Laudatio Willem Levelt

### Marc Brijsbaert

As has been said in the previous talks, George Sarton was an alumnus of Ghent University, who left Ghent at the beginning of World War I, together with his British wife. Luckily, Ghent University honours its successful alumni and in 1984, on the occasion of the 100th birthday of Sarton, established the annual Sarton Chair for significant contributions to the history of science, a study theme Sarton almost singlehandedly initiated at Harvard University.

Laureates of the Sarton Chair usually are a combination of successful scientists and influential historians, and this year is no exception.

Indeed, most of us still must get used to seeing Pim Levelt as a historian, given that we all think of him as a historical figure in language psychology and psychology in the Netherlands. Anyone studying the history of these topics is bound to devote a substantial chapter to Professor Levelt's contributions. Let me summarise them in four highlights.

First, Pim Levelt has been a leading researcher, first on perception, then on language production. He wrote classic books on binocular vision and on speaking, in which he brought these topics to new levels and which are still heavily cited. Interestingly for us, Belgians, Pim Levelt has never hidden the fact that his affection for these topics was strongly influenced by his contacts with the Leuven professors Michotte and Knops.

Second, Pim Levelt has been the driving force making the University of Nijmegen the world centre of language research. Not only did he help to develop experimental psychology as one of the strongholds of the university, he also managed to convince the Max Planck Society to build their first research institute outside Germany. The success of the Max Planck Institute for Psycholinguistics can be seen in the fact that it has survived the retire-

ment of its founder, an extraordinary feat in the Max Planck Society. Because of Pim's efforts, Dutch also became one of the best studied languages in the world, probably second to English only. The collection of word frequencies in written and spoken language, for instance, has been one of the advantages Dutch has had for decades over many other languages.

Third, Pim Levelt has advanced Dutch intellectual standing, particularly when he became president of The Royal Netherlands Academy of Arts and Sciences. Two of the developments he initiated, were increased investments in the neurosciences and in digital resources for the humanities. Needless to say, both initiatives will be of utmost importance for many of us in the years, decades to come.

Finally, Pim Levelt was asked a few years ago to chair the committee set up to sort out the mess Dieter Stapel had left because of his fraud. Apart from the negative aspects related to this episode, the case and its handling have made researchers much more alert to the issue of statistical power in experimental research and, hopefully, in the long run will lead to better science. At least, we in Ghent are taking the power issue much more seriously now.

These are the reasons why Professor Levelt will appear in many history books to come. However, it is fair to say, Pim, that none of these achievements, no matter how impressive each of them is, would have gualified you for the Sarton Chair. To deserve that honour, you must have contributed to the discipline of history writing itself. And this you did. After a full life, full of excitement and responsibilities, you decided there was no better pastime than to read scientific books from the 19th century, to find out whether it was indeed true that language psychology only started in 1957, when Chomsky published his book on syntactic structures, as was assumed by nearly all researchers. What you discovered, was an unimaginable trove of publications (most of them in German), which completely overthrew the traditional view of prewar European psychology being interested in structuralism only. The outcome became your third opus magnum, which has completely changed our views of our own past. Writing the history of psychology will no longer be the same after the publication of your book. It is also to be hoped that your example will encourage other researchers to have an in-depth look at the history of their own subject and go beyond the wide assumption that nothing happened in psychology before the cognitive revolution.

This is why we invited you to come and to talk to us about your findings.

# The first golden age of psycholinguistics 1865 – World War I

### Willem J.M. Levelt

It is a great honor for me to be the recipient of this years' Sarton Chair for the history of science. The Sarton Committee's decision is moreover a courageous one because it is the common, ineradicable belief that my inter-discipline, psycholinguistics, hardly has any history. Textbooks and handbooks concur in telling us that psycholinguistics took off half a century ago during the so-called "cognitive revolution" in the United States. However, nothing is less true. I am most grateful for this eminent opportunity to sketch a different story. It is based on research reported in Levelt (2013/2014). Inevitably, the present paper occasionally uses materials from that book.

## Psycholinguistics, its four epirical roots and its golden age

But first, what is psycholinguistics? It studies what we are doing right now. I am formulating my thoughts for you, transmitting them to you by means of amazingly rapid articulations, some 12 speech sounds per second. You are at the same time decoding the such produced stream of aerial vibrations hitting your ear drums, with a seemingly immediate interpretation of what I meant as a result. Psycholinguistics studies this amazing feat and the neural infrastructure on which it is based. It also studies the rapid acquisition of these skills during the first few years of life. There are clearly four disciplines involved in this enterprise: psychology, both experimental and developmental, linguistics, and neuroscience.

The empirical roots of this inter-discipline go back to the end of the 18th century. Let me begin by mentioning these four historical roots.

There was, first, the discovery of the Indo-European language family, first formulated in the famous 1786 lecture by Sir William Jones in Calcutta, who noticed the correspondences between Sanskrit, Latin and Greek and their probable relations to Gothic, Celtic and Persian. Apparently, languages had evolved from a common source that could be partly reconstructed, which raised the question: What had been the psychological origins of this primordial language?

There were, second, the beginnings of serious brain anatomy – pioneered by Franz Joseph Gall in *fin-de siècle* Vienna. It initiated the fascinating search for the localization of language faculties in the brain.

There was, third, Rousseau's plea in his *Émile* to systematically observe the developing child. It led to Dietrich Tiedemann's 1787 publication in Hamburg of a diary reporting among others on the early development of speech in his infant son, which was soon followed by other, similar diaries.

And there was, fourth, the first engineering approach to modeling adult speech production – Von Kempelen's cleverly designed speaking machine, built over a 20-year period in Vienna. It could produce complicated utterances such as *Leopoldus secundus*. It was described as a model of the human vocal tract in Kempelen's wonderful 1791 book on the mechanisms of human speech.

These four roots initially developed independently, but began interacting in the course of the 19th century and led to what I called "The first golden age of psycholinguistics", the topic of this lecture.

It can conveniently be dated as beginning exactly 150 years ago in 1865. In that year Marc Dax and Paul Broca independently published their discovery of the region in the left frontal brain controlling articulate speech, now known as Broca's area. It was also the year in which Franciscus Donders invented a way of measuring mental durations, "mental chronometry". The golden age covered an era of five decades, ending with World War I. Then a period of tragic decline set in. Many of the sophisticated tools, discoveries and theoretical notions of the golden age went into oblivion for half a century or more, leading to the general amnesia I already noticed.

### The Genetic Stance

Many pioneers of this prolific period shared a theoretical perspective, which I will call the "genetic stance". It was introduced by Wilhelm von Humboldt in 1827. By then already substantial knowledge existed about the Indo-European language family and it was obviously based on the analysis of written texts. Humboldt acknowledged that these texts were *products* of language, but they are not language itself. Language is not a product (*Ergon*), according to Humboldt, but an activity (*Energeia*). "Hence, its true definition can only be a genetic one. It is namely the ever repeated labor of the mind, to enable the articulated sound to express the thought." (1963-edition, p. 192). Language is what the speaker does, a process extending over time. I have called this rapid process the *microgenesis* of language. The measurement and analysis of this mental process became core business during the first golden age.

However, the genetic stance became much more encompassing than this. After the discovery of Broca's area neuroscientists began constructing *neurogenetic* models, explaining the neural processes involved in this microgenesis of speech. It led to intensive study of aphasics' speech and the post-mortem analysis of their brains. At the same time biologists, neuroscientists and developmental psychologists began studying the child's acquisition of speaking abilities, that is the *ontogenesis* of speech. And finally linguists and psychologists addressed what they considered the ultimate *phylogenetic* problem: how did language evolve in evolution? How did language emerge in the minds of primordial human beings?

The shared genetic stance naturally connected these four strands of research and daring steps were taken to develop unifying theories. The one monumental outcome of these efforts was Wilhelm Wundt's two-volume *Die Sprache* of 1900. It provided a unified account of the micro-, neuro-, onto- and phylogenesis of language.

I will now highlight these four strands of genetic research during the first golden age, in the following order: phylogenesis, neurogenesis, ontogenesis, and finally microgenesis, which was of amazing sophistication, but still went into total eclipse by the end of the golden age.

## Phylogenesis

How did the primordial human mind create language? The issue was hotly discussed all over the 19th century and linguists concurred in devising ever more colorful theories. They were somewhat successful in reconstructing the original roots, the *Urwurzel* of a language family and roughly their meanings. The famous Sanskrit scholar Max Muller, for instance, claimed to have reconstructed the 121 Sanskrit roots and their meanings. "These 121 concepts", he stated in 1887 (p. 406), "constitute the stock-in-trade with which I maintain that every thought that has passed through the mind of India, so far as it is known to us in its literature, has been expressed".

The logical next question had to be: how did these root words emerge in the minds of primordial *homo sapiens*? Here there was no limit to the inventiveness of linguists, especially because the explanations could not be evidence-based. No trace of the original speech sounds had been preserved. In order to check this limitless proliferation of theories, the Parisian Société de Linguistique, which was founded in 1864, stated in its bylaws that no communications would be accepted on the origins of language.

Charles Darwin expressed in *The descent of man* (1871) his sympathy for the "imitation theory", primordial man imitating the sounds of nature in order to make reference to their sources, such as calling a cuckoo 'cuckoo'.

"I cannot doubt that language owes its origin to the imitation and modification, aided by signs and gestures, of various natural sounds, the voices of other animals, and man's own instinctive cries." (1871, Vol. I, p. 56).

This had been proposed a century earlier by Herder (1772), who used the example of imitating the sheep's bleating to make reference to the wooly animal. Darwin also accepted the "interjection theory", expressive cries becoming referential to the events provoking them. And he added the new suggestion of language emerging from sexual selection, courting song as the origin of vocal communication.

"primeval man..., probably used his voice largely, as one of the gibbon-apes at the present day, in producing true musical cadences, that is in singing;... this power would have been especially exerted during the courtship of sexes, serving to express various emotions." (p. 57). Wilhelm Wundt reviewed this gigantic literature in the last chapter of *Die Sprache* and proposed from his genetic stance a still different psychological theory of language origins, the "gestural theory". The *explanandum* is this: how did expressive vocal sounds become symbols of conscious content, of thoughts and ideas? Wundt's answer consisted of a negative and a positive component. Here is the negative one: The relation between a speech sound and its meaning is hardly ever a direct one (as in "cuckoo" for a cuckoo). Language cannot have developed from such direct expressiveness. It is rather the *vocal gesture* which can be directly expressive of affect or meaning. The sound produced by that articulatory gesture is a mere, arbitrary by-product; it has no intrinsic relation to that affect or meaning.

The positive component is this: Expressive movements, including articulatory ones, *are* directly expressive of affect, meaning or thought. We still see this, according to Wundt, in the mimic and pantomimic gestures which universally accompany the speech of children and *Naturvölker*. Sign language is the universal, natural expressive means of *homo sapiens*. It arises spontaneously in any community, just because it is directly expressive of meaning, both in its referential deictic gestures such a pointing, and in its iconic, imitative gestures. Articulatory gestures are just part of these larger pantomimic patterns. They happen to produce initially meaningless sounds. The simultaneity, however, of the meaningless sound and the meaningful gesture creates the mental association between sound and gesture and from there between sound and meaning. This is the seed from which spoken languages developed and still develop.

Wundt had been the first to sketch a grammar of sign language. His contemporaries always denied that Deaf sign languages have a grammar. It took six decades before the grammatical analysis of sign language was re-initiated, without any reference to Wundt.

Gestural theories of language origins are still popular, though again without acknowledgement of Wundt's work. I have argued that a theory of gestural origins of language cannot explain the emergence of the spoken language mode (Levelt 2013, p. 203). But I do agree with Wundt and all of my colleagues that gesturing has always been a component in the phylogeny of language, as it is in the ontogeny of language.

### Neurogenesis

Let us now turn to the study of neurogenesis during the first golden age. The discovery of Broca's area in 1865 initiated a serious search for language processing in the brain. In 1874, Carl Wernicke, at the age of 26, published his 68 page master piece *Die aphasische Symptomencomplex*. *Eine psychologische Studie auf anatomischer Basis*. It proposed the first neurogenetic theory of speech processing. The booklet was revolutionary for two reasons. First, it published Wernicke's discovery of a left-hemisphere "sensory speech center", now called "Wernicke's area", near the projection site of the acoustic nerve in the first temporal gyrus. It reported on the symptoms of patients with a lesion in that area. It described and theoretically accounted for the aphasic symptoms of such patients, which we now call Wernicke's aphasics.



#### Figure 1.

(a) Wernicke's (1874) "reflex arc" with its centers and connections and the speech defects resulting from their disruptions.

a-a1: the incoming acoustic nerve from oblongata - deafness

a1: Wernicke's area – Wernicke's aphasia

a1-b: fibers connecting Wernicke's and Broca's area - connection aphasia

**b:** Broca's area – Broca's aphasia

**b-b1:** the centrifugal speech motor nervse – alalia

**(b)** Lichtheim's (1881) "house", adding a "conceptual center" to Wernicke's reflex arc. Disrupting its "transcortical" connections to Wernicke's and Broca's area will result in "transcortical sensory aphasia" and "transcortical motor aphasia" respectively.

Second, Wernicke took the theoretical step of anchoring the psychological centers and connections figuring in his psychological process model to the neural architecture of the brain (see Figure 1a). The discussion no longer centered on the faculty of articulate speech as in Broca's work, but on a componential model of language processing. The network, also called "reflex arc", can be disrupted in five locations, each causing specific speech disorders (see Figure 1a). When the auditory nerve is damaged you will be deaf. When the newly discovered sensory speech center is damaged, your recognition of speech will be affected – we now call this "Wernicke's aphasia". When the neural pathway between Wernicke's and Broca's area is damaged, you will be unable to monitor your own speech, which Wernicke called "conduction aphasia". When Broca's area is damaged, the ability to plan articulate speech will be damaged, which became referred to as Broca's aphasia. And when the motor connections between Broca's area and the articulatory musculature are damaged, you will suffer from dysarthria or "alalia"

Wernicke was the first to anchor the functional, psychological architecture for speech in the neural architecture. The neural network embodied the psychological processes going from auditory perception, to speech sound and spoken word perception, to spoken word planning and finally to speech articulation. This neurogenetic anchoring became a research endeavor of great and long-lasting significance. Wernicke's monograph triggered an industry of network models for over four decades to come (cf. my second Sarton Lecture). One of those neurogenetic models became highly influential: Lichtheim's "house" (see Figure 1b).

Lichtheim had been Wernicke's assistant in Breslau and extended Wernicke's diagram with a "roof", connecting Wernicke's speech sensory and motor centers, Wernicke's "reflex arc" with a *Begriffszentrum (B)*, a conceptual center (Lichtheim 1885). This became a crucial addition to the componential psycholinguistic model. It resulted in the addition of two types of speech disorder to Wernicke's five: You will suffer from "transcortical sensory aphasia" if the connection between Wernicke's area, the sensory speech center (A), and the conceptual center is disrupted; you will not *understand* the speech you perceive. And you will suffer from "transcortical motor aphasia" if the pathway from the conceptual center to Broca's area (M), the motor speech center, is disrupted. It will cause loss of volitional speech. Wernicke accepted Lichtheim's scheme almost

in full. Both Wernicke and Lichtheim stressed the impossibility to localize the conceptual center in a circumscribed region of the cortex.

Lichtheim realized that, as a psychological model, his theory could be tested without post-mortem examinations. It predicts the existence of seven clear cases of language disorder, each with an explicit phenotype. Discovering these clear cases became the grand challenge for the research community. Most cases of actual aphasias were, of course, cases of multiple distortion of 'the house', again with precisely predictable features. Here was Mendelejev's table for neurological language disorders.

The Wernicke-Lichtheim model of neurogenesis was the only highlight of the first golden age that was preserved to modern times. Refugees from Wernicke's school who fled for the Nazi's, transmitted the theoretical model to their American students and colleagues. Lichtheim's house became, almost till the present day, the textbook introduction to aphasiology. My second Sarton Lecture discusses the intensive fights over language in the brain from Franz Joseph Gall to the 1950s. Let us now turn to ontogenesis, the process of language acquisition in the child.

### Ontogenesis

In 1876 the French man of letters, Hippolyte Taine published in the *Revue Philosophique* the diary notes he had collected on his daughter's language development. Here he made ample reference to evolution theory:

"Speaking generally, the child presents in a passing state the mental characteristics that are found in a fixed state in primitive civilizations, very much as the human embryo presents in a passing state the physical characteristics that are found in a fixed state in the classes of inferior animals.".

The next year the new journal *Mind* published an English translation of Taine's paper (with the above citation on p. 259). This triggered Charles Darwin to publish, in the same year 1877 and the same journal, a 10-page *Biographical sketch* of his own son William's development as an infant. The sketch was based on copious notes Darwin had made between 1839 (upon William's birth) and 1841. Clearly, after reading Taine's paper, Darwin didn't want to repeat the Wallace affair. He had been the first to keep a diary, over 30 years before Taine, and the world should know. Celebrity Darwin's paper appeared the same year also in French, German and

Russian, not failing to promote on a grand scale the keeping of diaries on infants' and toddler's development. From now on, keeping diaries on child development was real science. A tsunami of diary keeping emerged, which reverberates till the present day.

Darwin's sketch includes some observations on the development of William's language skills, hardly more than the 15 observations Tiedemann had provided almost a century earlier. Darwin stressed in particular the invention of first words, such as *mum* to express the wish for food. He also noticed the "instinctive" use of intonation patterns, "voice modulation", to express various modes, such as interrogation and exclamation. Here he concluded, repeating what he expressed in *The Descent of Man*, that "before man used articulate language, he uttered notes in a true musical scale" (p. 293), the singing origins of language, which never stopped echoing in the literature.

The importance of Darwin's paper was not so much in its content. But in one swoop it made the study of child development a respectable branch of human biology. Diaries now appeared at an accelerated rate, and in various languages. Table 1 presents an overview of golden age diaries including and following the Taine and Darwin papers.

Baudouin de Courtenay (1869). Polish	Compavré (1893). French
Taine (1876, 1877). French	Balassa (1893), Hungarian
Darwin (1877). English	Frederic Tracy (1894), English
Perez (1878, 1886). French	Paola Lombroso (1894). Italian
Strümpell (1880), German	Prever (1896). German
Sikorsky (1883) Russian	Kathreen Moore (1896), English
Blagovescenskii (1886) Russian	Milicent Washburn (1898) English
Machado v Álvarez (1885-1887) Spanish	Ament (1899) German
Savce (1889) Arabic	Clara & William Stern (1907) German
Chamberlain (1890) Algonkin	O'Shea (1907) English
Gabriel Deville (1890/91) French	Gheorgov (1908, 1910) Bulgarian
Garbini (1892) Italian	Poniat (1913) French German
Garonn (1072), italiall	Konjat (1715), 1 tenen, Oerman

Table 1. Ontogenetic diaries published during the first golden age of psycholinguistics

The quarter century following Taine and Darwin was quite rich in its theoretical analyses of child language development. Much theory centered around Haeckel's so-called "phylogenetic" or "biogenetic law", as we already saw in the Taine citation. According to Haeckel "the mental development of every child is only a short recapitulation of that long phylogenetic process." (Haeckel 1874, p. 706). The child runs, so to say, an accelerated film of evolution, not only in bodily development, but also in mental and language development. This linked the study of language acquisition, ontogenesis, to the linguistic study of language origins, phylogenesis.

A major supporter of this theory was Haeckel's colleague at Jena University, William Preyer, who adored Darwin. It was a happy coincidence that Preyer's son Axel was born in 1877, shortly after Darwin published his *Biographical sketch*. It triggered Preyer to keep a careful, detailed diary on his son's development. That in turn became a major data source for his grand work *Die Seele des Kindes*, which appeared in 1882. This book became a classic text, going through four, ever updated editions during his lifetime and five more later.

But Preyer also forged another link in this book, namely between language ontogeny and neurogenetics. Three years earlier than Lichtheim, he had already conceived the idea of adding a conceptual center to Wernicke's "reflex arc", constructing a network diagram which was topologically quite similar to Lichtheim's "house".

**Figure 2.** Preyer's (1881) diagram of the language/speech architecture (left) and its topological mapping on Lichtheim's house (right). Wernicke's reflex arc is represented by o-a-K-M-h-z. It is the first to mature in the child. The connections to the conceptual center D(iktion) are acquired later through learning, imitation and association.



He then proposed a theory about the ontogeny of this network. The basic idea was "that every known form of adult speech disorder finds its complete reflexion in the child that learns to speak" (p. 375). Take any node or connection in the network. As long as the infant still lacks it, it should show the same symptoms as the aphasic patient who has lost that very node or connection.

Here is one example, out of some 50 which Preyer worked out in much detail: If Broca's area is damaged (M in Figure 2), you can understand, but no longer produce spoken words. This corresponds to the child in a stage where it understands and remembers words, which it cannot yet produce.

The general pattern of development is that Wernicke's reflex arc is the first to mature. That allows the child to imitate spoken words. But it doesn't mean that the child also understands them. That requires the development of the conceptual center *D*; it is slowly built up through imitation, explicit learning (see legend to Figure 2).

There was one further remarkable highlight in the study of language ontogenv during the first golden age. In 1907 Clara and William Stern published Die Kindersprache, which was based on the most extensive German diary data ever. Clara was first author. She had kept a detailed day-to-day diary on the speech and language development of their three children, Hilde, Günther and Eva. And together with William she had systematically collected experimental test data. This study set the new standards for decades to come, in terms of data collection and analysis and in terms of ontogenetic theory. The book provides the first, detailed evaluation of Haeckel's phylogenetic law. It also provides a definitive rejection of the dominant 19th century view that children exclusively acquire language by imitation. The Sterns showed that analogy formation is an important and highly productive alternative mechanism. The child will for instance keep saying getrinkt, in spite of the fact that it always hears getrunken. How come? Getrinkt is the regular form, as in gebaut and gehört. It is highly economical for the child to generally apply that past tense rule. The child actively discovers and invents grammatical rules.

Clara Stern was born in 1878, thirty years before German universities accepted women as students. She was entirely self-made as a scientist. But that was hardly appreciated in the male-dominant academic society. Her standard work was frequently cited, but usually as the work of second author William, such as here: "In his work *Die Kindersprache*, William Stern says..." (Röttger 1931; see for many more such cases Levelt 2013, p. 316).

The data base of the Sterns ended up in Harvard's Widener Library. It was literally never consulted. Stern daughter Eva then moved it to Hebrew University. Some 30 years ago the late Werner Deutsch of our Max Planck Institute had the complete hand-written diaries transcribed, assisted by Eva Stern, who was in her eighties, and whom I had the great pleasure to welcome in our Institute. The data base is now accessible through the Institute's website.

*Die Kindersprache* had completely passed into oblivion after World War II. The next great work on Language acquisition was *A first Language* by Roger Brown of Harvard University. It appeared in 1973 and makes no reference whatsoever to the epoch making accomplishments of Clara and William Stern.

Let us, finally, turn to microgenesis and consider two remarkable highlights in the study of mental processing in the production of speech.

### Micorgenesis – Mental Chronometry

In 1883 James McKeen Cattell arrived in Leipzig. He was 23 years old, had a master degree from Lafayette College in Pennsylvania and had decided to write a dissertation under the supervision of Wilhelm Wundt, who had established the world's first psychology laboratory in Leipzig just four years earlier. And so he did. He stayed in Wundt's laboratory from 1883 to 1887 and became, in 1886, the first American to obtain a PhD in psychology.

Wundt put him on a dissertation project on mental chronometry. It had long been the dominant view of philosophers and neurologists that mental processes are infinitely or at least immeasurably fast. But this common opinion had been recently undermined. In 1850 Helmholtz had published his measurements on the speed of nerve conduction in frogs, later reconfirmed in humans, which had turned out to be about 30 meters per second. Helmholtz's dear friend Franciscus Donders, ophtalmologist at Utrecht University, then invented a brilliant way to measure durations of mental processes, which he published in 1865.

Here is one of his original experiments. It is in fact the first chronometric experiment in psycholinguistics ever. Donders and his student De Jaager

would sit in front of their *phonautograph*. This was a hollow paraboloid device. You could speak into it at the wide open side. The other, narrow end was covered by a membrane. As soon as you speak into the wide funnel opening, the membrane starts vibrating. The vibrations are transmitted to a turning cylinder where they are recorded on soot-covered paper, together with the vibrations of a tuning fork.

Donders would now say *ki*! and De Jaager's task was to respond immediately by also shouting *ki*! By counting the number of tuning fork cycles between the two onsets of *ki*, De Jaager's reaction time could be determined. It was 250 milliseconds.

But now Donders took his epoch making step, by complicating the experiment somewhat. It was still the case that de Jaager should respond ki? when Donders said ki? However, Donders would also shout other syllables into the phonautograph, such as ka? or ku? De Jaager was instructed not to respond to any of the stimuli, except for ki? Under this condition it took de Jaager on average 338 ms to respond with ki? to ki? How come de Jaager was slower bij 88 ms (i.e. subtracting the original 250 milliseconds from 338)? It was because he had to perform an extra mental operation, namely identifying the relevant stimulus ki in the set of possible stimuli, discriminating it from the stimulus alternatives. In other words, the extra 88 ms was de Jaager's identification duration, recognizing ki? as ki?, a real mental duration. Donders' own mental identification duration also happened to be 88 ms. This so-called "subtraction method" of measuring mental duration soon conquered the world.

Young James McKeen Cattell brilliantly used this paradigm in analyzing the mental steps involved in the naming of pictured objects, colors, numbers, printed words and letters. For all of these now classical naming tasks, he did the first chronometric measurements. His procedure for all these tasks can be exemplified with the case of picture naming.

Which mental steps are you going through when you name the picture of, say, a bird? The main two steps, according to Cattell are, first, identifying the bird as a bird, exactly like identifying *ki*! as *ki*! in Donders' experiment. Cattell called this identification or "perception time". The second step is selecting the correct response word, i.e. *bird* for the picture of a bird, or *tree* for the picture of a tree. Cattell called this response preparation or "will time". How to measure these mental durations?

Here is what Cattell did. First he designed a far better chronoscope than Donders' phonautograph with its turning cylinder. It was a sophisticated electrical instrument with a "voice key", which would send an electrical impulse to an electrical time piece as soon as its membrane was set into motion by speech. It allowed for repeated chronometric measurements with millisecond accuracy.

Using this equipment he began by determining the identification or perception time. This required two steps, like in Donders' experiment. The first step was to measure the simple naming duration. The bird appears and you say "*bird*". And the bird is again flashed on and you say "*bird*". This is repeated several times. This is exactly what de Jaager had to do, time and again saying *ki*! when Donders shouted *ki*! into the phonograph.

After determining this simple naming duration for himself and for his colleague Berger, Cattell took the next step by measuring what he called the "discrimination duration". The subject would say *bird* each time a bird appeared, but nothing when another object, such as a tree or a candle was displayed. This again exactly followed Donders' procedure where De Jaager had to say *ki*! to *ki*!, but nothing when *ko*! or *ku*! was shouted by Donders.

The duration of identifying the bird as a bird could now be determined by subtracting the measured simple naming duration from the just measured discrimination duration. This identification duration turned out to be 117 milliseconds for Cattell himself and 96 milliseconds for Berger.

Next Cattell determined the "response" or "will time". For this it was necessary to measure the "choice latency". Here the experimental subject had to name each picture with its own name, i.e. *bird*, *tree*, *candle*, etc. This task clearly involved retrieving the appropriate response word. But it also involved the just measured full discrimination duration, i.e. from presentation of the picture to identifying the object to be named. Hence, Cattell subtracted that earlier measured duration from the now measured choice latency. That should be a true estimate of the will time, the mental duration of selecting the appropriate response. It turned out to be 278 milliseconds for Cattell and 231 milliseconds for Berger.

Many hundreds of measurements went into this picture naming paradigm. And then Cattell did the same for letters, for printed words, for numbers and for colors. Table 2 is his summary table.

	B	C
Reaction-time for Light	150	150
Perception-time for Light	30	50
"" a Colour	90	100
" a Picture	100	110
" a Letter	120	120
" a (short) Word	120	130
Will-time for Colours	280	400
" Pictures	250	280
" Letters	140	170
" Words	100	110

 Table 2 Cattell's chronometric averages for perception and will time in naming colors, pictures, letters and words by two observers, Berger and Cattell.

Notice that stimulus identification or perception time for colors, pictures, letters and short words are all in the short range of 90-130 ms. But response selection or "will-time" varies widely, letters and words being much faster than colors and pictures. Naming a chair, for instance, takes some 100 ms longer than naming the word "chair", because it activates an extra process, identifying the object.

All this wonderful work and much more appeared in three foundational papers, published in *Mind*, 1886-1887. And then it was all forgotten. It took almost a century before chronometric measurements of the same sophistication were taken up again and all this was rediscovered.

The following quote captures Cattell's epoch-making establishment of experimental psycholinguistics:

"I think these experiments show that it is possible to apply scientific methods to the investigation of mind. We have determined the times required for those processes which make up a great part of our mental life, and found these times to be constant; they are no more arbitrary, no less dependent on fixed laws than, for example, the velocity of light." (1887, p. 539).

And here is his optimistic view on mental evolution:

"If in the course of evolution, as is probable, the molecular arrangement of the nervous system becomes more sensitive and delicately balanced, we may suppose that the times taken up by our mental processes become shorter, and we live so much the longer in the same number of years." (1887, p. 534).

### Micorgenesis – Speech errors

Cattell's work on microgenesis considered the word as the unit of speech production. What is the time course of retrieving a word response such as *bird* or *candle*? But it is possible to go one step further. Consider this slip of the tongue: *denile Semenz*. It suggests that words are not retrieved as wholes, but as strings of speech sounds, vowels and consonants. Occasionally these elements end up in the wrong place, as do *d* and *S* in this case, which were exchanged in the slip of the tongue. Can such spontaneous speech errors tell us more about the underlying microgenesis?

The linguist Rudolf Meringer made it his life's project to answer this question. He was born in Vienna and held teaching positions there and, since 1899, in Graz. He was a confirmed empiricist: "one who cannot observe is not a researcher, but a bookworm" (Meringer 1909, p. 597). His grand empirical project became the systematic collection, analysis and psycholinguistic explanation of spontaneous slips of the tongue. He organized the collection of errors by involving the participants in a regular lunch time meeting. They agreed to stick to certain rules, such as speaking one person at a time and halting all conversation as soon as a tongue slip occurred. This would allow for proper recording of the error and for immediate introspection on the part of the speaker concerned. This procedure introduced an important methodological feature: all occurring speech errors were recorded, not just the remarkable, interesting, or funny ones as had been the tradition - and as would regrettably become the tradition again, masterminded by story teller Sigmund Freud (see Meringer 1923). The total corpus recorded by Meringer amounted to some 2500 slips of the tongue. Their analyses were published in two books, the first one in 1895, the second one in 1908.

Meringer distinguished three basic error categories, which are still in good use: exchanges, anticipations and perseverations and the core observation in all three categories was that the exchanged elements are functionally similar. In the exchange *denile Semenz*, for instance, two word-initial consonants are exchanged. The anticipation *lässen nämlich* (for *lassen nämlich*) involves two stressed vowels in word-initial syllables. And the perseveration *konkret und kontrakt* (for *abstrakt*) perseverates the first word initial syllable as the second word's initial syllable.

Meringer considered speech errors as resulting from the regular speech producing mechanism:

"Only attention fails in a speech error, the machine runs without a supervisor, is left to its own devices. And what makes speech errors instructive for linguistics, is the circumstance, that the clockwork's cover has been taken off in such moments and a view on the cogs is possible." (Meringer and Mayer 1895, p. vii)

Linguistic elements, not only consonants and vowels, but also syllables, roots, prefixes, suffixes, whole words or phrases, get ordered by the production machine. They should end up in particular target positions. This he depicted in the diagram reproduced in Figure 3, which shows the microgenesis, the process of ordering, which is run in the generation of a simple utterance such as *Etwas ist faul im Staate Dänemarks*:

#### Figure 3.

**Top:** possible exchanges of functionally similar elements in the preparation of *Etwas ist faul im Staate Dänemarks.* 

**Bottom:** for each planning position in the sentence the table lists all possibly competing sounds that are still active or already active. From Meringer and Mayer (1895, pp. 53, 164).



Etwas ist	f	a	u  1	im	St	aa	te	D	ä	ne	m	ar	ks
	st, -	aa,-	- te,-		D, 1	ä.au	ne, l	m,St	ar,aa	ks,te	-, D	—, ä	-,ne
	D,-	ä,	- ne,-		m,-	ar,-	ks,-	-, f	-, au	-, 1	-,st	-,aa	—, te
	m, -	ar,-	- ks,-			1935		1200		1.155	-, t	-,au	-, 1

When we generate such a simple utterance, there are always multiple elements simultaneously conscious in our "inner speech". Occasionally an active element ends up in a wrong, but functionally similar target position, with an ordering error as outcome. He worked this out in much detail for the example in Figure 3. Elements targeted for a stressed-vowel position, for instance, may end up in the wrong stressed-vowel position. This could cause an error such as *Etwas ist faal im Staute Dänemarks*, and so on. Target positions differ in weight. Word initial consonants, for instance, such as the *f* of *faul* and the *D* of *Dänemark* are heavy. Vowels in unstressed syllables, such as *e* in *Staate* are light. Heavy elements have better access to consciousness than light elements and hence are better intruders into functionally similar target positions. This weight hierarchy is a good predictor of the frequency distribution of sound errors he had observed.

We will not go into the further details of the "cogs" in Meringer's "clockwork", but they have stood the test of time. They figure in one way or another in all modern theories of error generation. But all of this brilliant work went into oblivion till around 1970. Only then the study of speech errors started booming again till the present day.

The first golden age of psycholinguistics shared the fate of the German and Austrian empires, where it had so exuberantly blossomed. It disappeared during World War I. The scientific point of gravity in this interdiscipline began shifting to the United States, where precisely then Watson's 1914 book introduced the radical extermination of everything mental in psychological, linguistic and neuropsychological theory, which would debilitate the field for almost half a century. This aberration in science was almost entirely local to the United States, as Brysbaert and Rastle (2009, p. 212) correctly argued. It is a fascinating case of self-imposed isolation in science, which has never been fully explained and deserves thorough historical analysis.

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# Localism versus holism. Historical origins of studying language in the brain

### Willem Levelt

I need not tell you that Flemish Andreas Vesalius was the first serious brain anatomist. Book VII of his great anatomical work *De humani corporis fabrica* (1543) concerns the brain. The brain is the organ where the animal spirits/fluids are refined and then delivered to the relevant bodily organs. Whereas Galen and many scholars<sup>1</sup> after him had adduced an essential role to the ventricles – the "ventricle localization theory" – Vesalius criticized that theory because the ventricles in humans and animals are unexpectedly much alike. They generate the animal spirits only, not our rational spirit, which we share with the angels and which, no doubt, includes language.<sup>2</sup> The ventricles are carefully depicted in Vesalius' diagrams, as opposed to the less relevant convolutions, which "were drawn like intestines rather than the way the brain really looks" (Brysbaert and Rastle 2013, p. 225).

Many, often detailed case studies of aphasia reported in the following centuries raised the awareness of the role specific brain injuries play in the causation of a variety of speech and language problems (see, for instance, Tesak and Code 2008). But coherent theorizing about the localization of language functions in the brain did not arise before the end of the 18th century. Since that is the topic of the present Sarton Lecture, let us begin with Franz Joseph Gall, who provided the foundations for the cerebral localization theory which reverberates till the present day.<sup>3</sup>

<sup>&</sup>lt;sup>1</sup> But not all. O'Neill (1993) demonstrated a preponderance of "meningeal localization theories" during the Middle Ages. See also Whitacker (2007).

<sup>&</sup>lt;sup>2</sup> See Catani & Sandrone (2015), p. 98.

<sup>&</sup>lt;sup>3</sup> Unavoidably, some of the materials in this article have their source in my *A history of psycholinguistics*. *The pre-Chomskyan era* (2013).

Gall received his MD in 1785 in Vienna and then established himself in medical practice. He began lecturing and publishing on his nativist and comparative theory of mental faculties and he began measuring the shapes of skulls, in the conviction that they would reveal something about pronounced mental capacities and features of their bearers. Then, around 1800 onwards, he started his grand anatomical project, dissecting brains of man and animal, drawing magnificent plates and lecturing famously on brain anatomy and on the corresponding mental faculties.

In 1805 Gall left Vienna, together with his assistent Casper Spurzheim. In 1801 he had become conservative Kaiser Franz's *persona non-grata* because of his materialistic views on the human mind. During 2 years Gall roamed all over Europe, teaching, visiting clinics and examining patients. In 1807 he settled in Paris as a private practitioner. His dissection classes and his lecturing attracted some of the best medical students, such as Pierre Flourens.

In Paris, Gall set out to write his magnum opus, initially assisted by Caspar Spurzheim, and written in his rather elementary non-native French. The four books, beautifully edited in two folio-size volumes, plus an atlas with exactly one hundred plates, appeared from 1810 to 1819, all privately paid by Gall.

Gall made the idea of discrete localization of functions fully explicit by relating the functional architecture of mind, its 27 faculties, to the neural architecture of the brain, which he had so thoroughly studied over the years. "Show me the basic forces of the soul, and I will find the organ and the seat thereof", Gall wrote in 1818 (vol. III, p. 42). It had become a systematic empirical project, based on two sources of evidence.

There is, first, the evidence from brain damage related to loss of a faculty. His books are full of cases of this type. Gall, for instance, was probably the first to both describe and localize Broca's aphasia. Here is my translation of the relevant text in Book IV, pp. 53-54.:

The patient was an officer, hit by a foil "in the midst of left canine tooth region, close to the nostril, in oblique direction from below up", penetrating some 3.5 inch "into the internal posterior of the left frontal lobe, in such a way as to reach the anterior part of the mesolobe." The patient was right hemiplegic and "the memory for words had totally extinguished".
However, rarely would such damage have affected the region of a single faculty. There is, instead, a second, much more promising way of going about testing mental faculties and localizing their organs in the brain. The more outspoken a faculty, such as memory for language, the larger the size of the corresponding region in the brain. These innate brain protrusions would not only show on the inside cavity, but also on the face of the skull. The procedure was to select your clear cases, such as a verbally or musically gifted person, make a cast of their skulls and run your comparative measurements. Gall could have been right about his protruding organs of mind. In fact, the idea never disappeared entirely. But his idea of there being visible marks of faculty-related brain protrusions on the face of the skull was, regrettably, an empirical bridge too far.

Gall distinguished two language faculties, the memory for words and the philological faculty. He localized them, closely together, in the anterior cortex somewhere behind the eyes. This became a topic of fierce controversy in the decades to come. Also, Gall proclaimed all faculties, including the language faculties to be symmetrically localized in both hemispheres: "All specific systems of the brain are double, like those of the spinal chord and of the senses." (Gall's italics, Vol. I, p. 225). This was known as "Bichat's law"; it was dogma during the first half of the 19th century, but would also become a topic of controversy.

Gall died in 1828. A 1823 cast of Gall's own head went to the National History Museum in Paris. Gall's friend Dr. Fossati, provided the following cranioscopic diagnosis: "... locality, sense of persons, language, number, order, tune, colour, constructiveness, were all feebly developed; whilst comparison, causality, individuality, eventuality, and firmness were uncommonly large." (Hunt 1869, p. 204).

Gall's theory, including his theory of language, became the prototype of *localism* in cognitive neuroscience. In this talk I will contrast it with *holism* and the prototypical holist theory was not far away. Pierre Flourens, who had studied in Paris among others with Gall, praised Gall for his outstanding dissection skills. But he also became one of Gall's fiercest opponents. From his ablation experiments on a variety of animals he concluded that the grand regions of the brain corresponded to the grand regions of mind. The hemispheres, in particular, are exclusively involved with intellectual functions; they do not perform any other function, such as voluntary movement. And their functioning is equipotential:

My experiments demonstrated it: one can dissect a rather extensive portion from the cerebral hemispheres, be it on the front, in the back, on top or on a side, without loss of intelligence. A fairly limited portion of those hemispheres thus suffices for the exercise of intelligence. (Flourens 1842, p.18).

Localizing faculties was a dead-end street, according to Flourens, and ultimately to the majority of established French neurologists. It still reverberated a century later, on the basis of similar experiments, in Karl Lashley's 1929 theory of equipotentiality and mass action in the associative areas of the brain. The term equipotentiality, he stated,

I have used to designate the apparent capacity of any intact part of a functional area to carry out the functions which are lost by destruction of the whole. (Lashley 1929, p. 25).

And on mass action:

the efficiency of performance of an entire complex function may be reduced in proportion to the extent of brain injury within an area. (Lashley 1929, p. 24).

These are holistic principles. In the following I will collect a number of them. They are summarized in Table 1 below. The issue of localism versus holism would remain a major controversy in the study of brain and language. In the following I will distinguish three grand phases in the history of this field preceding World War II.

#### Table I.

Some holistic principles/functions proposed during the three phases of studying language in the brain.

- Equipotentiality (Flourens, Lashley)
- Mass action (Lashley)
- Network functioning, disconnection syndromes (Wernicke, Lichtheim)
- Propositionizing and devolution (Jackson)
- Volitional left-hemisphere control (Jackson)
- Diaschisis (Monakow)
- Kinetic melody (Monakow)
- Electrical vibration theory of cerebral functioning (Marie)
- Gestalt formation (Goldstein)

## PHASE I. Localizing the brain region for articulate speech as a litmus test for a localist mind/brain theory (1800-1870)

With Gall, Phase I was introduced. Localizing the faculty of articulate speech became the litmus test for Gall's general localistic theory. Loss of articulate speech was a well-defined, often sudden loss of function. If it could be adduced to a defect in a particular brain region, the principle of localization was upheld. Performing this litmus test became a dominant theme in French neurology over four decades following Gall's death in 1828. Here are some of the highlights of that controversial discussion.

Jean-Baptiste Bouillaud also studied with Gall in Paris, but different from Flourens, he continued Gall's localistic theory of mental faculties. In 1831 he established the Paris Society of Phrenology. But he gave up on measuring protrusions, either on the skull or on the cortex. In 1825 he published a paper which is still modern in its approach. In order to verify Gall through the localization of articulate speech, he argued that autopsies of patients with loss of articulate speech should show damage to the anterior lobes (positive evidence). If autopsy shows damage to the anterior lobes, there should have been loss of speech (negative evidence). If autopsy shows damage to another brain region, there should not have been loss of speech. Harry Whitaker (2006, p. 604) noticed that this introduced the principle of double dissociation in cognitive neuroscience. The paper presents 47 cases, all claimed to support these hypotheses (but see Luzatti and Whitaker 2001).

In 1848, 23 years later, Bouillaud presented more evidence in a paper (published as a monograph) for the Medical Academy of which he was a member like Flourens, and then offered a premium of 500 francs for any counterfactual case submitted. The award was never claimed.

Before we follow this up, we must consider another, independent line of research, which put in doubt Bichat's law of symmetry. Marc Dax, home doctor at Montpellier, had collected statistics on patients in his practice with loss of speech. He had noticed that they were usually right-sided hemiple-gic. In 1836 he wrote a paper on this, which, however, was not published. His son Gustave Dax, physician in Sommières, continued the statistics and decided to submit, in 1863, to both the Academy of Sciences and to the Medical Academy, his father's paper and his own and Lallemand's statis-

tics, now encompassing 370 hemiplegia cases. The Academy of Sciences' set-up committee, with Flourens as a member, never responded. The Medical Academy's committee, or rather its chairman Lélut, responded after almost two years:

my opinion can no longer be changed, nor modified [...] the relation one wanted to establish between some fact or faculty of mind, and some part of the central nervous system [is] no less and no more than phrenology [which is a] pseudo-science. (Lélut 1865, p. 173).

These are the words of a rabid equipotentialist. It is also an early case of peer review failure. Only then, Gustave Dax took the sensible move to submit his joint paper to the Gazette, where it appeared on April 28, 1865 – a date to remember. It was the definitive refutation of Bichat's law of symmetry. And more: Gustave Dax concluded that the seat of articulate speech is in the

external anterior part of the medial left lobe [...] Hence, the cerebral organ of speech has been found. (Dax 1865, p. 262).

Let us return to Bouillaud. He had a son-in-law, also neurologist and localisationist, by the name of Ernest Auburtin. In 1861 Auburtin and Pierre Gratiolet organized a meeting on the topic of localization in the Anthropological Society of Paris, which young anatomist and surgeon Paul Broca had founded two years before. Against Gratiolet, Auburtin defended Gall's and Bouillaud's thesis that the faculties of language are localized in the anterior lobes. Broca was, as a Flourens student, at heart an equipotentialist. But he was open to dissenting opinion. Only days after Auburtin's communication, Broca's attention was called to a patient who had not been able to speak since 21 years, but who otherwise seemed to be in the possession of his mental powers. Broca realized that this could be a test case for Auburtin's challenge. Broca invited him to come and diagnose the patient for himself. Auburtin did and agreed to accept the outcome of a future autopsy as conclusive; the patient's brain should show frontal lobe damage.

The famous story has been often told. Mr. Leborgne was kind enough to die within two weeks. His "softened" left hemisphere showed an old infarct in the third convolution (Broca 1861a). However, most textbooks are wrong. In 1861 Broca did not discover the brain region controlling articulate speech. He was not even interested in it. Broca was fully explicit in the three papers he published that year: He was performing the litmus test for Gall's principle of localization. "localization of a single faculty

suffices to establish the veracity of that principle." (1861b, p. 336). In this paper he conceded that the anterior lobes are involved with the faculty of articulated speech. Bouillaud had "saved from shipwreck" Gall's original claim (p. 330). However, he declared "precise localization of functional organs unsolvable in the present stage of science." (p. 338). And "the grand regions of the mind correspond to the grand regions of the brain" (p. 338), still following Flourens. It was not different for the third paper that year, which discussed another autopsy, with damage in the third frontal lobe. Broca concluded. "I am thus inclined to attribute to a pure coincidence, the absolute identity of the lesion site in my two patients." (1861c, p. 407).

It was again not different for his 1863 paper, which discussed six more loss-of-speech autopsies, all showing damage to the left third convolution. This is what Broca concluded: "I don't dare to draw a conclusion from that and I wait for new facts" (1863, p. 202). Have you discovered anything if you don't dare to draw the conclusion?

However, the new facts were there already. Gustave Dax had submitted his papers to the two Academies just 10 days before. Clearly Broca had not seen them yet. Only after the Dax papers finally appeared on April 28, 1865, and clearly triggered by them, Broca quickly claimed his discovery in the *Bulletin of his Anthropological Society* (on June 15):

I persist in thinking, till more amply informed, that real aphémie, that is loss of speech without paralysis of the articulatory organs and without destruction of intelligence, is connected with lesions of the third frontal gyrus. [and with] the singular predilection of aphemic lesions for the left hemisphere of the brain. (1865, p. 378).

"I persist in thinking" – that was not entirely honest. And about Max Dax's paper he said: "I don't like priority discussions." (p. 379). In spite of much checking, he had not found evidence for an earlier publication of father Dax's paper.

Clearly, the Daxes should be granted priority of localizing the organ of articulate speech in the left perisylvian area. Reluctant Broca, with his superior brain anatomy, further confined that region to the foot of third convolution of the frontal lobe. These were the highlights of Phase I. Its upshot was that Gall's principle of localization was upheld, as demonstrated for the case of the faculty of articulating speech. Let us now turn to Phase II, which moves us from France to Germany.

### PHASE II. Relating the language faculty as a network of functions to neural networks in the brain. The "diagram makers" (1871-1905)

In 1874 Carl Wernicke, 26 years old, published his classic 68 page monograph The aphasic symptom complex. A psychological study on anatomical basis. My first Sarton Lecture mentioned two reasons why this document became epoch-making. It firstly reported Wernicke's discovery of a left-hemisphere "sensory speech center" near the projection site of the acoustic nerve in the first temporal gyrus. It discussed patients with a lesion in that area and it proposed a theory about the symptoms of such "Wernicke patients".<sup>4</sup> Wernicke, secondly, anchored the psychological centers and connections of his psychological network model in the neuroanatomy of the left hemisphere. The network, also called "reflex arc" can be disrupted in 5 locations, each causing specific speech disorders: deafness, Wernicke's aphasia, conduction aphasia, Broca's aphasia, and dysarthria or "alalia" (cf. Figure 1a in my Sarton Lecture I). Notice that Wernicke introduced, with his "conduction aphasia" the notion of disconnection as an explanatory principle – in this case the disconnection of nerve conduction between Wernicke's and Broca's area.

Wernicke's explicit anchoring of the psychological process network for speech in the neural architecture became a source of great inspiration for neuroscientists working on speech, language, reading and writing. Dozens of process diagrams during the entire "first golden age of psycholinguistics". Figure 1 represents some of them. Notice especially Baginsky's 1871 diagram, to which Wernicke makes reference in his monograph and which had certainly inspired him in proposing his "anchoring". Moutier (1908) presents many more cases.

As discussed in my first Sarton Lecture, the most important diagram of all was Lichtheim's "house" (center diagram in Figure 1). By adding a "roof" to Wernicke's reflex arc Lichtheim connected Wernicke's and Broca's area to a hypothesized, though not localized, "conceptual center" in the brain. It added two further disconnection syndromes to the typology of aphasia's: transcortical sensory and transcortical motor aphasia, – in short loss of

<sup>&</sup>lt;sup>4</sup> Later, Wernicke (1903, p. 493) admitted that Bastian and Schmidt had already correctly described the symptoms of sensory aphasia in 1869 and 1871, respectively.

speech understanding and loss of volitional speech. Lichtheim's house was a theoretical network model, which not only predicted the existence of seven precisely defined types of speech/language disorder, but also a much larger number of "mixed" syndromes in cases of multiple disturbances in the network. It was, in fact, the quadrature of Bouillaud's double dissociation. With it, the most important holistic principle had been introduced: language functioning as a network in the brain (cf. Table 1). The principle tolerates different degrees of localism. In the Wernicke-Lichtheim model for instance the nodes and connections in the "reflex arc" could be precisely localized, but the conceptual center could not.



Five examples of neuropsychological language/speech diagrams produced between 1871 and 1917.



Wernicke's theoretical move of anchoring the psychological network architecture into the neural architecture was by no means uncontroversial. A powerful opponent of this move was Adolph Kussmaul, Wernicke's senior by 26 years. In 1877, that is eight years before Lichtheim's paper, Kussmaul published an ever reprinted text on speech disorders. It included a complex, multi-colored network diagram, which already featured a conceptual center. But Kussmaul eschewed localizing its centers and connections in the brain. His was a psychological process model in the first place. Kussmaul doubted in particular Wernicke's evidence for the localization of a "sensory speech center" and for the insula's role in connecting such a center to Broca's area. It was all "modernized Gall doctrine" (Kussmaul 1883, p. 311). Details of this fierce confrontation between Kussmaul and Wernicke are presented in Levelt (2013), pp. 86-87.

Kussmaul's elegant and humorous text is not, however, an elaboration of this diagram; it is in fact almost a "Fremdkörper" in the book. The more important theoretical basis for his treatment of speech disorders was the conception of a true stage theory of speech production, a theory not very different from my own in Levelt (1989). It is the most detailed and thoroughly argued psycholinguistic model of the era. The generation of speech proceeds through three stages. There is first a stage of "preparation in mind and mood", with as outcome the "thought that we have conceived, and an affective urge which drives us to express it." There is, second, the stage of "diction", or the "building of internal words, together with their syntax" and there is, third, "the articulation or the composition of overt words or expressions, irrespective of their coherence in the expression" (Kussmaul 1877, p. 14). In working this out Kussmaul was far ahead of Wernicke before him and Lichtheim after him, who had entirely limited their models to the production and comprehension of words. And then, the book is comprehensive. It treats absolutely any known speech disorder.

Still, by the end of the nineteenth century, a broad consensus had been reached on the componential nature of language and its network-like representation in the brain. This is how William James (1890) summarized that happy situation:

Meanwhile few things show more beautifully than the history of our knowledge of aphasia how the sagacity and patience of many banded workers are in time certain to analyze the darkest confusion into an orderly display. (James 1890, vol. I, p. 56).

However, this orderly display soon fell apart in the new century.

## Phase III. "De-modularizing" language. Relating language as an "intellectual function" to holistic brain action (1906-1939)

The trigger of Phase III was a set of no less than 11 papers published during 1906/7 by Pierre Marie, professor of pathology at the University of Paris (and which he later collected in Marie 1926). They formed a ferocious attack on what had indeed become the standard localist network view in aphasiology. Marie became the iconoclast who triggered the new holistic movement and Hughlings-Jackson was canonized as its saint. Let us begin with Pierre Marie.

Here are some of the claims Marie expressed in his papers: There is only one kind of aphasia, an intellectual disorder. The critical location is Wernicke's area. Broca's area plays no role whatsoever in language function. There are no verbal images. Word blindness (predicted by Lichtheim) does not exist. Word mutism does not exist. There are no regions that store sensory or motor word images. Associationist accounts of aphasic syndromes make no sense. Broca's aphasia is just aphasia complicated with anarthria. Anarthria is caused in the lenticular zone. The whole Broca story had become a fad, the ultimate victory of Gall and his

army of followers. It was the *crowd*, the crowd with its instinct for guessing and its deep ignorance, the crowd both incredulous and believing, especially if the object of its belief is something extraordinary and miraculous. (Marie 1911/1926, pp. 89-90).

Such was Marie's collegial tone in his papers.

After the first few papers, this became too much for Jules Dejerine, who was not only the discoverer of word blindness, but more generally a leader of French aphasiology, also professor at the University of Paris. Not only did he immediately publish responses to Marie's papers (Dejerine 1906 a,b), but he also moved the Neurological Society of Paris to act. And indeed, the Society set up a series of three meetings to settle the debate among its quarreling members. There were some 25 participants, among them Marie and Dejerine, but also Dejerine's wife Augusta Klumpke, a top neuro-anatomist and the first woman MD in France.

The meetings were painstakingly prepared, chaired and recorded. I grate-

fully spelled out the heated discussions in Levelt (2013), pp. 371-373. Eventually, neither opponent had budged an inch. In summary holist Pierre Marie had gone all out in his attack on standard theory. It is all just "dogma" in the majority of leading minds. There is no network of language functions in the brain, there is just Wernicke's area. And psychologically aphasia is one, an intellectual disorder. Marie hated psychology, but pressed to characterize the intellectual disorder, he suggested a loss of "things learned by didactic procedures," – such as doing arithmetic. That was his entire contribution to the neuropsychology of language. Marie did not introduce any interesting principle of holistic functioning, except much later, when he speculated about an electrical vibration theory of brain functioning. (Marie 1922).

Marie's influence remained limited. There were some followers in France, among them his brilliant "intern" (as he always called him) Francois Moutier, who in 1908 produced the book Marie should have written himself and whose career was sabotaged by Marie (cf. Lecours and Joanette 1984). In Germany Wernicke's students continued, extended and revised their master's largely localist network paradigm, but nobody revolted. Wernicke's student Liepmann published an extensive reply to Marie, wondering "where is the rigid dogma, which embraces the majority of the leading minds?" (Liepmann 1909, p. 450).

In England the one outspoken sympathizer with Marie's ideas was Henry Head in London, to whom we will turn shortly. In 1915 Head republished Hughlings Jackson's papers on aphasia. Jackson did introduce interesting holistic principles and slowly but surely he became the patron saint of holism.

There are no references to Wernicke or Lichtheim in any of Hughlings Jackson's writings. His functional brain map shows Broca's area, but not Wernicke's area. He sympathized with his near contemporary Kussmaul, especially his theory of speaking, which has conceptualizing, or in Jackson's terms "propositionizing" as its first stage. Aphasia is, according to Jackson, a disorder of propositionizing, a broad intellectual disorder. Jackson introduced the holistic principle of "dissolution": later acquired volitional processes of the mind give way to the older, more primitive automatic processes. Volitional control of speech proceeds from the left hemisphere. It is the leading hemisphere. Damage to that hemisphere frees the emotional automatic processes of the right hemisphere from volitional control. The speech becomes more phrasal, emotional and "inferior" to the degree of the left hemispheric damage. It is by no means a loss of words. And then specifically about the localization of speech, Jackson expressed his famous dictum:

I do not localize speech in any such small part of the brain. To locate the damage which destroys speech and to locate speech are two different things. (Hughlings Jackson 1874, p. 130).

In other words, local damage will affect the functioning of other, larger regions in the brain. Damage to but one hemisphere will make a man speechless and "free" the automatic regions in the other hemisphere. These are noteworthy additions to holism, see Table 1.

Other contributions to holism had come from Constantin von Monakow in Zürich, who expressed a similar holistic principle within his otherwise localistic theory of aphasia as "diaschisis". It is the loss of function, caused by a fresh lesion, in other more distant parts of the brain, with temporary but complicated symptoms as a result - a global "systems" effect. Diaschisis disturbs in particular the temporal coordination among brain regions, which Monakow calls a loss of "kinetic melody" (Monakow 1905).

Turning now to Henry Head, it should first be noted that he had coined the term "diagram makers" and used it as an invective. They were the detested "localists". They were all wrong he writes in his 1926 mongraph. Diagrams are detestable, also data tables are detestable.

There are no 'centers' for the use of language in any form, but solely certain places where an organic lesion of the brain can disturb speech in some specific manner. (Head 1926, p. 140).

Instead,

An act of speech comes into being and dies away again as an alteration in the balance of psycho-physical processes: a state, never strictly definable, merges into another inseparable from it in time. (p. 509).

And

The processes which underlie an act of speech run through the nervous system like a prairie fire from bush to bush; remove all inflammable material at any one point and the fire stops. (p. 474).

These are "impressive" statements, but that is all there is in Head's psy-

chology. Head fully ignored the psychological literature on these processes (such as writings by Wundt, Sechehaye, Selz, Bühler, Pieron). And in all of his work he refers to precisely one linguistic paper, by Gardener (1922). In addition Weisenburg and McBride of Philadelphia regrettably demonstrated in 1935 that Head's aphasia tests did not discriminate and worse, many tests from Head's aphasia test battery were performed no better by people not suffering from aphasia.

In short, Head's rather bombastic holism did not add anything to Jackson nor to aphasia diagnostics. It showed a general decline in rigorous theorizing. But Head applauded the holistic approach in the work of Kurt Goldstein, who sometimes acknowledged that, but no more. Let us consider Goldstein's holism. It contrasted interestingly with the other Wernicke student Karl Kleist's extreme localism as we will see.

Kurt Goldstein added one further feature to holism: Gestalt formation (see Table 1). Goldstein had obtained his MD with Wernicke in Breslau in 1903 and he lived on to see the cognitive revolution, as an American citizen in New York. When he published his major 1927 paper, he was directing the Frankfurt clinic for war veterans. There he did some of his most important experimental work together with Adhémar Gelb.

Let us consider one such study (Gelb and Goldstein 1920), because it reveals their innovations in a nutshell. To begin with, it was a single-case study. Their innovative paradigm was to perform in-depth experimental studies of single cases, to develop and test a theory of this one individual patient's cognitive functioning. The patient in case was a classical one of "pure alexia". Like in Dejerine's cases the patient could not read but was able to write, speak and understand speech. But then, their in-depth experimentation revealed a much broader functional disorder. The patient could not "grasp" figures or copy them. He could not subitize. He had great difficulty recognizing objects from touch, he could not recognize musical intervals, etc. The functional disorder, Gelb and Goldstein conjectured, was one in Gestalt formation. The sensory elements were all there, but they could not be simultaneously grasped as a whole. The total impression remained amorphous, without "Gestalt pregnancy." This case demonstrated, according to the authors, that the most conspicuous symptom of a patient, in this case alexia, need not be the patient's essential disorder. Or as Goldstein (1927, p. 68) put it: "The single can only be understood at all from the whole "

Underlying aphasic disorders is a more general, holistic dysfunction, in particular one of degraded Gestalt formation generally, a loss of "abstract attitude".

Every individual speech-performance is understandable only from the aspect of its relation to the function of the total organism in its endeavor to realize itself as much as possible in the given situation. (Goldstein 1948, p. 21 - his italics).

As Goldstein grew older, this whole-person perspective got a somewhat mystic aura.

But Goldstein never became a holist as far as the neural architecture was concerned. He kept quite close to Wernicke in maintaining that the "instrumentalities of language", such as speech sound perception and word formation depended on intact well-localized regions of the brain. Wernicke himself had always refused to localize the higher, intellectual functions of language. And those were precisely the functions mostly studied by Goldstein. In other words, Goldstein's holism was nicely complementary to Wernicke's localism. There was no real conflict here. Still, Goldstein was mistrusted by his former colleagues, as was Head. Let me mention two of them.

Max Isserlin, who had after World War I established a war veterans clinic in Munich, also worked on the higher language functions in aphasics. He provided the now classical explanation for the phenomenon of telegraphic speech in agrammatic patients, the adaptation theory. Broca patients have a diminished ability to excite the appropriate syntactic schemata for the expression of complex thought. This creates a permanent state of "speech need". In order to avoid this, patients often resort to telegraphic style. This is a lawful style, mastered by any native speaker. But its syntactic schemata are far simpler and much easier to keep active. As one of his patients expressed it: "Speaking no time - telegram style." It is a free choice, an adaptation of the patient. This is the kind of total-organism response Goldstein discussed, but this is what Isserlin had to say about holists such as Head and Goldstein:

However, a monistic holism is, also in brain pathology, unjustified. And it cannot be concluded that theoretical-holistic 'iconoclasts' (Head) have succeeded in overthrowing localizationist doctrine. Rather, the principles of classical localizationist doctrine appear untouched in their essential features. (Isserlin 1936, p. 641). That was also the view of Wernicke's very last assistant, Karl Kleist, a superb neurologist. In his 1916 paper, Kleist had introduced the notion of "paragrammatism" as opposed to agrammatism. Whereas agrammatic speech is often telegraphic, in paragrammatic speech phrases are ill-chosen and they often contaminate. Syntactic constructions are left incomplete, but there is no simplification of syntax, as in agrammatism. Kleist relates paragrammatic speech to affections of the temporal speech zone. But Kleist disagreed with Goldstein's invoking holistic explanations for well-circumscribed aphasic phenomena:

it is not true, that there is always a general, conceptual (categorial) defect involved in amnestic aphasia, as Goldstein taught. (1936, pp. 338-339)

And it is wrong to conclude from the (acknowledged) adaptability of the brain that

always the whole nervous system is involved with each single performance/function [Leistung], so that there is always a total function [Ganzheitsfunktion] involved (p. 338).

This is rejecting Lashley's mass action as well.

Kleist published in 1934 the most detailed functional brain map since Franz Joseph Gall, based on Brodmann's brain histology. It contains six regions involved in language functions (see Figure 2). He even revived Gall, measuring and confirming the larger size of relevant Brodmann areas in talented speakers. Kleist aligned himself with the detailed localist analyses published by Samuel Henschen (1920-1922).

So far I have hardly mentioned the American scene in this three-phase story. At the turn of the century American aphasiology largely shared in the Wernicke-Lichtheim-Dejerine "standard theory", as is apparent from Meyer's 1905 paper and from Charles Mill's 1907 paper in response to Marie's attacks on standard theory. But with the advent of behaviorism, Lashley's equipotentialism became the default assumption. His influential 1929 book *Brain mechanisms and intelligence* approvingly referred to the holism of Marie, Goldstein and Head. Lashley did not deny that the left brain has a region for language functions. But within that region equipotentiality reigns.



#### Figure 2.

Karl Kleist's (1934) functional brain map. The six added arrows denote regions involved with speech and language.

The interest in localization of language (and other) functions waned correspondingly in the era of behaviorism. Johannes Nielsen, for instance, could not even find a publisher for his eventually self-published 1936 book which carefully reviewed the evidence for localization and which concluded that his data were "confirmatory of the old doctrines" on localization. His voice was ignored. Weisenburg and McBride, for instance, in their 1935 book claimed that "It is impossible to localize language" "That it is the result of the entire brain, however, there is no doubt" (p. 467). Still they also rejected the holistic theories of Jackson, Marie and Head: "aphasia cannot be understood as unitary disorder", an intellectual disorder (p. 430). Aphasia-types are many. They also rejected Hughlings Jackson's regression theory, as well as Goldstein's Gestaltist version of it. "The aphasic patient is not more primitive in his behavior as a whole, nor in many of his specific responses." (p. 459-460).

By the end of Phase III, the beginning of the Second World War, there was no standard view on language in the brain. In Europe, and Germany in particular, Wernicke's students continued, refined and qualified the Wernicke-Lichtheim network approach. The holistic upheaval initiated by Marie in Paris created a mixed scene in French aphasiology and found

a grandiloquent supporter in British Henry Head. In the United States, Lashley's equipotentialism became an excuse for losing interest in localizing language functions in the brain. Phase III added a number of holistic features in theorizing about language in the brain, such as Jackson's devolution and Goldstein's field theory.

Was there a Phase IV to come? There certainly was. During and after the second World War the terrifying number of brain injuries to take care of forced veteran researchers in the Soviet Union, in the United Kingdom and in North-America to thoroughly reconsider the issue of localization. Leaders such as Alexander Luria, Ritchie Russell and Harold Goodglass largely returned to Phase-II network theories, ultimately making due reference to Wernicke and his school.

And then, in 1959, the Penfield and Roberts book introduced, one could say, our new era of brain imaging, allowing for entirely new approaches to the brain's linguistic functioning. Here, for the first time, the functioning live brain was mapped and the activation patterns involved with speech and language were recorded. Twenty years later this was followed by PET and then MRI scanning technology. This has, over the last quarter century deeply changed our theorizing on language in the brain. That fascinating history is still to be written.

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SARTON MEDAL LECTURES

# Laudatio Jean-Louis Halpérin

# Dirk Heirbaut

Jean-Louis Halpérin has written so much, that one may be forgiven for thinking he is not just one person, but a whole army of researchers, who are hidden somewhere in a Parisian building and all use the same name. Any presentation of his work can only mention a few highlights, as even those who have been following his career for a long time may still miss out on something. Our esteemed French colleague was born in 1960 in Paris. Already as a high school student he was awarded several national prizes. He studied history and law at some of the most prestigious French universities and Great Schools and received the University of Paris II's doctoral thesis prize in 1985. As of then, his career has been a very distinguished one. First he was a professor in Lyon, and then in Dijon, where he was also dean of the law school. Since 2003 he is professor at the École Normale Supérieure, an elite institution of higher education in France, which, for example, has produced 13 Nobel Prize winners. He is also a senior member of the Institut universitaire de France, an honour awarded to about one percent of French university professors. Jean-Louis Halpérin is also extremely admired outside France. Universities from all over the world have invited him for conferences and particularly noteworthy are his many visits to Japan. He has held so many academic positions that it is impossible to mention them in this short survey, though one may draw particular attention to his work as editor in chief of the review Clio@Themis, one of the most innovative reviews in legal history today. Looking at Jean-Louis Halpérin's publications, one immediately notices that he is the great historian of French law from the Revolution until the present. He started with his Ph.D. thesis on the Tribunal of Cassation during the French Revolution, the name tribunal already indicating that there are major differences

between this institution and the current Court of Cassation. In 1992 he contributed another book to legal history, with a title masterfully summarising its theme, *L'impossible code civil*, explaining how finally France got its Civil code in 1804. The aftermath thereof was explored in his *Histoire du droit privé français depuis 1804*, published in 1996 and revised twice later, just as another book he wrote on the French civil code, which was translated in English. More recently, in 2013, Jean-Louis Halpérin published a book together with Frédéric Audren on the myths and realities of French legal culture during the nineteenth and twentieth centuries. To these monographs on French legal history, one should add the collective works Jean-Louis Halpérin edited or co-edited, on legal life in Paris from 1804 until 1950, French law under the third republic, Napoleon's civil code and, especially, the great dictionary of French jurists, of which a new edition of more than a thousand pages was published in 2015.

Unlike many other French legal historians, however, Jean-Louis Halpérin is also a truly international scholar as he proved in his 1999 book on the history of private international law, in his 2006 book Histoire des droits en Europe de 1750 à nos jours and in the books he edited on advocates and notaries or his Interpretation of the law in the Age of Enlightenment, co-edited with Morigiwa and Stolleis. The most recent trend in legal history is global legal history. Jean-Louis Halpérin had anticipated this, by producing an impressive body of studies on the topic. In 2009 he studied in his *Profils des mondialisations du droit* the idea of legal transfers in legal history, which is also a great example of what a truly global legal history can achieve. Needless to say, when he and Olivier Cayla set up a team to write on the great books of law, this was a global enterprise, which did not limit itself to Western legal history. Thanks to his many visits to Japan, Jean-Louis Halpérin is also the co-author, with Naoki Kanayama, of a 2007 comparative study of the way Japanese and French law have faced the challenges of modernity. In 2012 Jean-Louis Halpérin surprised his colleagues with his impressive Portraits du droit indien. Others may go to India for a few months and return with some pictures, Jean-Louis Halpérin returned with a complete manuscript on the law of India since its independence. The reader may now think that I have mentioned every book Halpérin wrote or edited, but this survey has left out his monograph on the history of property law or the collective volume he published on discrimination. Moreover, as of the date this text was written, he had also been responsible for more than 170 articles and book chapters. Even the

avid reader of his work will find something in this long list that has escaped his or her notice. For example, Belgian jurists should be aware of an extremely interesting article on their law: *Oue peut-on apprendre de l'his*toire des manuels belges de droit civil?, which appeared in 2015. Needless to say, in these smaller publications Jean-Louis Halpérin deals with some of the themes already mentioned, as well as with a host of others. Those who assume that he is only interested in legal history since the French Revolution, will be surprised to hear that, as early as 1984, France's leading review of legal history accepted his article on the tribunes of the Roman people. In fact, Jean-Louis Halpérin is also a great specialist of French law during the Ancien Régime and he wrote several articles on seventeenth and eighteenth century French law. It may be that Jean-Louis Halpérin has, in his books, worked mainly on private law, but his bibliography also lists many articles on the history of criminal law and criminal procedure, on commercial law, constitutional issues and the European Union or subjects like lawyers' fees, legal iconography and rituals. Some of these articles are pioneering texts, which have started new fields of study, like his 2001 article on the history of consumer law. As if Halpérin wants to make sure that no part of the world is left untouched by him, we can also find forays into Latin American legal history amongst his articles.

In short, anyone wanting to discover the work of Jean-Louis Halpérin is confronted with what his countrymen call *l'embarras du choix*. Normally, with prolific authors a sound advice is to go for the best publications assuming that in such a mass of publications, many will not be of the highest level, but in Halpérin's case that is not the case. His work is even more astonishing by its excellent quality than by its quantity. Nevertheless, one can point out to the reader a recent book which brings together many strands of his research and which is a great way for starting with Jean-Louis Halpérin's oeuvre, his *Five legal revolutions since the 17th century*. However, those who cannot wait for that, only have to turn to the next page.

# Returning to the primacy of statutory law in legal history?

# Jean-Louis Halpérin

It is an unique, a tremendous honour to receive the Sarton Medal and I am sincerely grateful to the Sarton Committee and to the Ghent Colleagues for imagining to put my name after the ones of so estimated predecessors. I am afraid now that it is a real challenge to make a lecture that could be a little consistent with the excessive reputation Professor Dirk Heirbaut has attributed to me with a so friendly generosity. An international award, like the Sarton Medal, should not be an aliment for personal vanity but the opportunity to discuss with colleagues and with students beyond the current web of national relationships. What I am looking for as a legal historian? Which are the problems I am trying to resolve with historical and legal documents and which are the provisory answers I am convinced of? These interrogations, and even these opinions and these doubts, are not properly mine, there are contemporary concerns shared by other researchers and expressed in our language of the twenty first century. Every new generation investigates history with its own problematic that finds its origins in its political, social and cultural environment.

I belong to the generation that has approached the field of legal history in the context of the Europeanization, then the globalization, of law, of the so-called crisis of the statutory and state law and of the growing impact of courts rulings, either of the constitutional courts or of the supranational courts. Since my legal education, the primacy of national statutory laws was questioned and it seemed to be abandoned. In the same time, legal history knew a transnational turning point, notably in Europe. What I am saying about legal history has been also strongly influenced by the thoughts of senior or junior legal historians. I am indebted to my master Gérard Sautel (a specialist of the history of French public law), my mentor Jean Hilaire (who has opened the history of private law in France to the apprehension of the living law, for example through notarial acts), the great writers of European Legal History, the late Adriano Cavanna, the always active Paolo Grossi, my German friends Reiner Schulze and Michael Stolleis, without forgetting the Belgian colleagues, Serge Dauchy, Dirk Heirbaut, Georges Martyn and all the associates of the European Society for Comparative Legal History. I would like to express my gratitude towards all these colleagues and my admiration for the models of academic values we are trying to promote among the students in Europe and outside Europe.

My doctoral thesis dealt with the creation of the Tribunal de Cassation and was written when the preparation of the commemoration of the two hundred years of the French Revolution stimulated acute debates about the tension between the 1789 Declaration of Rights of Man and Citizen and the 1793-1794 Terror. It concerned already the subject of this lecture. Was not the Tribunal de Cassation the first *Tribunal de la loi* in the world, a court to which the adjudication of facts was prohibited and that was created only to make the judges respect strictly the statutory laws<sup>1</sup>? There was no innocence in choosing my first research, perhaps the naïve idea that a court could implement the so-called 'rule of law'.

Working some years later about the failures of the revolutionary assembly to enact a Civil Code, later about the factors of the success of the Napoleonic Code led me to new questions about the relationship between law and politics, between statute law and case law, between codification and professional interests of lawyers<sup>2</sup>. One of my arguments has been that Portalis, in his famous *Discours préliminaire* introducing the draft of the Civil code in 1801, theorized what the Tribunal de Cassation has made during the ten previous years. The new French legal order would not be based upon statutory and, if possible, codified laws, but it would be also developed by a strong case law, constructed by the Court of Cassation according to the model and with the language of the statutory law. *On ne peut pas plus se passer de jurisprudence que de lois* wrote Portalis<sup>3</sup>.

<sup>&</sup>lt;sup>1</sup> Jean-Louis Halpérin, *Le Tribunal de cassation et les pouvoirs sous la Révolution française* (Paris: LGDJ, 1987).

<sup>&</sup>lt;sup>2</sup> Jean-Louis Halpérin, *L'impossible Code civil* (Paris: PUF, 1992).

<sup>&</sup>lt;sup>3</sup> François Ewald (ed.), *Naissance du Code civil* (Paris: Flammarion, 1989), 47.

Writing an history of the French private law since 1804 has been the opportunity to give a greater scope to this hypothesis: the mean feature of private French law, since the beginning of the nineteenth century, would not be the sole codification, it would be the combination of an epigrammatic codification with great constructions of case law achieved by the Court of cassation. The French word doctrine was applied to legal writers and their literature, from the 1820s and 1830s years, at the exact moment of publishing legal reviews and dictionaries, like the *Répertoire Dalloz*, gathering legislation, jurisprudence (which was no more the science of law but the case law made by sovereign courts) and what remained for the discourse of professors and lawyers about these rules<sup>4</sup>. The doctrine was not the best guideline to understand the evolution of French law during the nineteenth and the twentieth century, as showed the increasing critics of the notion of an Exegesis school. The doctrine was not the neutral image of the legal order, but a set of ideological schemes used to justify, and sometimes to criticize, the positive rules decided by the legislators and the judges.

My *Histoire des droits en Europe de 1750 à nos jours* has been an attempt to analyse the European legal history in the nineteenth and in the twentieth century through the main currents of the legislation and of the judgemade law and not through the succession of legal theories of great jurists, as Franz Wieacker has made in his *Privatrechtsgeschichte der Neuzeit<sup>5</sup>*. Beginning with the period of the publishing of Montesquieu's *Esprit des lois* and with the first intervention of the British Parliament in the law of marriage (the 1753 Hardwicke's Act), this history of European legal systems evaluates the impact of the French Revolution and of the movement in favour of writing down codes and constitutions<sup>6</sup>.

Belgium was an archetype of these trends. The country, which was subjected to French laws from 1795 to 1814, acculturated the French institutions, like the Napoleonic Code and the criminal jury and defended them during the period of the Dutch domination. After the 1830 revolution, the criminal jury and the French codes (as a provisory legislation) were inscribed in a liberal constitution, which was itself a model to be exported. Belgians were

<sup>&</sup>lt;sup>4</sup> Armand Dalloz, Dictionnaire général et raisonné de législation, de doctrine et de jurisprudence en matière commerciale, criminelle, administrative et de droit public (Paris, 5 vol. 1835-1841); Désiré et Amand Dalloz, Répertoire méthodique et alphabétique de législation, de doctrine et de jurisprudence en matière de droit civil, commercial, criminel, administratif, de droit des gens et de droit public (Paris, 44 vol., 1845-1870)

<sup>&</sup>lt;sup>5</sup> Franz Wieacker, *Privatrechtsgeschichte der Neuzeit* (Göttingen: Vandenhoeck & Ruprecht, 1967).

<sup>&</sup>lt;sup>6</sup> Jean-Louis Halpérin, *Histoire des droits en Europe depuis 1750* (Paris: Flammarion, 2004).

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more respectful of the Napoleonic Code than the French people, keeping for example the law of divorce, whereas it was abolished in France from 1816 to 1884. The Belgian Court of Cassation, which added new competences to the French model, developed its own constructions of the articles of the Civil Code, especially about liability. The interpretation of the separation of powers was also different with the possibility for judges to set aside administrative acts they deemed illegal and a specific borderline between administrative and private law. The Belgian Parliament replaced the Napoleonic Penal Code by a new code a long time before France and the Belgian legislation was pioneering in the field of mitigating the penalties and creating special rules for juvenile offenders.

Italy, Germany, Spain or Portugal were other fields for original statutory laws, codifications and constitutions. Even the common law was deeply transformed by numerous statutes voted by the British Parliament about penal law (with important consolidation Acts despite the lack of a codification), contract law (the 1893 Sales of Good Act), factories law and company law. Specially in this field, the statutory laws allowing the free creation of joint-stock companies were a model for the whole Europe. The mutual influence between legislations of the different European countries. for example about labour law, competition law, intellectual property law or consumers law, was a decisive fact of the development of European legal orders from the end of the nineteenth century until today. Some forms of a common legislative law have appeared a long time before the European Union. It can be said that the nineteenth century saw, on one hand a shift between the civil law systems that were codified and the common law system that remained un-codified in Great Britain and the beginning, on the other hand a conjunction of reforming laws in order to resolve similar problems in all European societies, many of the problems being linked with the process of industrialization. It is not a hazard if the science of comparative law developed during the turning point of the nineteenth and of the twentieth century, with the creation of societies of 'comparative legislation'.

At the famous international congress, organized in Paris in 1900 during the universal exhibition, the French jurist Édouard Lambert proposed to extend the comparison from legislative laws to judge-made laws<sup>7</sup>. While

<sup>&</sup>lt;sup>7</sup> Édouard Lambert, Études de droit commun législatif ou de droit civil comparé. Première série. Le régime successoral. Introduction. La fonction du droit civil comparé (Paris: Giard et Brière, 1903).

discussing the idea of 'legal revolution' popularized by Harold Bermann<sup>8</sup> in a more recent book, I have proposed to reconsider the comparison between the French and the British models of relationships between statutory and case law<sup>9</sup>. Are we sure that there are two antithetical systems, the one of French law based on codification and on a subjection of the judges to a strict, quasi-religious, respect of statutory law and the one of English law, as a judge-made law letting a very small room for statutes, that were interpreted strictly as exceptional rule?

This traditional point of view under-evaluates several phenomena:

1) The early combination in France of codification and of case law. More exactly the development of two corpus of case law: a private (what means, civil and even criminal) case law of the Court of Cassation kwon by an official *Bulletin* and an early developed web of private law reports with notes and commentaries; an administrative case law, issued by the Council of State, linked with the absence of Code in administrative matters, with a private (but quasi-official) law report, the *Recueil Lebon*. These two sets of case law were published by standardized methods since the first half of the nineteenth century and nobody could contest the authority of the Court of Cassation and of the Council of State.

2) During the same period, English law knew a long process to replace sparse and discontinuous law reports published by individual private lawyers by the Official Law reports created only in 1865. That was also a process of developing the written opinion of the judges (except for the rulings of the Privy Council concerning the colonise that were unanimous) as a characteristic feature of the British judicial style, a means for standardizing the rulings based on a general rule (the so-called *ratio decidendi*), with the consequence to impose the rule of precedents in a strict manner from 1898 to 1966<sup>10</sup>. Only, in this relatively short period, the House of Lords was, in principle, constrained by its own precedents. In fact, the effects of the *stare decisis* were not so different that the ones of the authority of sovereign Courts in France.

<sup>&</sup>lt;sup>8</sup> Harold J. Bermann, Law and Revolution, the formation of the Western legal tradition (Cambridge: Harvard University Press, 1983) and Law and Revolution II: the impact of the Protestant reformations on the Western legal tradition (Cambridge: Harvard University Press: 2003).

<sup>&</sup>lt;sup>9</sup> Jean-Louis Halpérin, Five legal Revolutions since the 17<sup>th</sup> century. An Analysis of a Global Legal History (Heidelberg: Springer, 2014).

<sup>&</sup>lt;sup>10</sup> Rupert Cross, *Precedent in English Law* (Oxford: Oxford University Press: 1977).

3) British judges respected statutory laws. One has to remember that the British judges adhered completely to the theory of the Parliament's sovereignty and refused any judicial review of statutes voted by the Parliament. Here again, there is more similarity than differences with the reject of any constitutional review of statutes by French judges.

4) British lawyers made great efforts, for pedagogical goals, to use legal definitions, to bring together common law and equity, to rationalize English law in the forms of general rules based on leading cases. Was the result so different from the method of French jurists, for example in liability or administrative cases?

With this focus on general rules, as well the ones created by the statutory law than the ones created by the case law, you have understood that I claim to be a 'positivist'. Of course, there are different meanings of positivism: I am following here the three kinds of positivism proposed by Norberto Bobbio<sup>11</sup>. Positivist is first the conviction that legal phenomena, like other social phenomena, can be empirically observed and analysed with a rigorous method. Positivism is secondly a theory according to which legal rules are conventional artefacts and law a human technique, like writing or coining. Positivism is thirdly an ideology that orders citizens to obey the laws without discussing them. As many other colleagues, I am positivist in the two first meanings, not in the third one. Legal historians, if they are positivist, have not to be afraid to draw all the consequences of the positivist theory. Law, as a technique, was invented at some periods of history and in some places of the world, they were polities without law, the invention of law can be testified, according to Herbert Hart's scheme, by the apparition of secondary rules of recognition, change and adjudication. In an intuitive manner, we associate these secondary rules with statutory and written laws. And here the doubts appear about the bias and the possible errors of this intuition.

1) Is not this method too determined by a French education in a centralized state, which is until today the world champion of the codification of law?

2) Do not positivists, following Kelsen's schemes, exaggerate the role of statutory laws and the hierarchy of norms? Was not Kelsen himself led to change his point of view, after World War II and his exile in the USA, by recognizing the importance of case law, in common law systems and more generally in all systems to transform individual norms into general norms?

<sup>&</sup>lt;sup>11</sup> Norberto Bobbio, *Il positivismo giuridico* (Torino: Giappichelli, 1961).

3) Is not this monist and state-centred theory unable to take account of the plurality of legal orders, and of the increasing role of infra-national or supra-national rules? A debate that concerns principally our contemporary situation and that legal historians are not obliged to resolve, even if the discussion of legal pluralism is linked with the one of the definition of law, which is a necessary discussion for all lawyers.

4) And, last but not least, a question that is decisive for legal history: is not this primacy given to statutory laws an anachronism, transplanting nineteenth century conceptions in more remote periods? Are there good reasons to abandon one of the postulates of the Historical School of Law affirmed so clearly by Savigny, the postulate of law considered to take its birth in the popular conscience, to appear in the form of spontaneous customs and to develop because of the works of jurists? I would like to show that are some reasons to reject Savigny's scheme, to re-affirm the primacy of statutory laws (I), what does not mean to reduce legal history to the history of legislative norms as thought some legal historians of the nineteenth century (II).

I. My point of departure takes place in the Antiquity very far from France and Belgium. The 2005 book of Aldo Schiavone Ius: l'invenzione del diritto in occidente translated in English in 2012<sup>12</sup> helps me to defend the idea that the "invention of the law" began with statutory laws in Rome, in China and in the Jewish world. These three situations, that are independent from each other, are perfectly consistent with Herbert Hart's scheme about the secondary rules of recognition, change and adjudication. In Rome, the Law of Twelve Tables, the authenticity of which is not contested today, has established through its 146 verses a set of primary rules, which is completed with rules of recognition (the use of a specific vocabulary about jus and the small number of references to religious commands), of change (the possibility that a new statute law could reform one point of the Twelve Tables) and of adjudication (several rules about the judges and the legis actiones). The fact that this law was maintained without great changes (but with some amendments, as the authorization of marriages between patricians and plebeians that occurred only five years after the enactment of the Twelve Tables according to the tradition) and was abrogated only in Justinian's

<sup>&</sup>lt;sup>12</sup> Aldo Schiavone, *The Invention of Law in the West* (Cambridge: Harvard University Press, 2012).

times shows how it was important, as "fons omnis publici privatique juris" (Livy, XII, 34), for the development of Roman Law. Of course, the Law of Twelve Tables comprised many differences with modern codes and let many gaps that were likely to be filled by the responsa of the jurists. But the blossoming of the Roman literature and jurisprudence, we know essentially through the lens of the Digest, must not hide that the invention of law, the origo iuris, in Rome is located in a fundamental statutory law. The recent works from Jean-Louis Ferrary and Dario Montovani have shown that the role of statutory law in the history of Roman jurisprudence must not be under-evaluated<sup>13</sup>.

In China, the excavations of bamboo texts and of manuscripts during the four last decades have proved the existence of a penal Code in the principality of Qin in the third century BC (and probably in other small kingdoms before this date), the extension of this penal Code under the authority of the first emperor (Shi Huangdi) and its keeping with some changes towards the mitigation of penalties during the successive dynasty of Hans. These documents also testify some rules of change (the officials were discussing about the effects of new statutes in comparison with older statutes) and of adjudication (with the publishing of same cases to help the structuration of the procedure) in these first stages of development for Chinese law<sup>14</sup>.

Concerning the Jewish law, it exists some consensus to admit that the *Torah* was written in an organized form after the return from the Babylonian exile, under the authority of Ezra, the "reader of the Law" during the fifth or the fourth century BC. Of course, the text of the Torah is a combination of divine commands and of stories about the Jewish people, it is purported to be the work of God (giving the Ten Commands) and of Moses (writing his own story including his death at the end of the Deuteronomy). But it is also a statutory law, notably developed in the Book of Leviticus and Deuteronomy. The word *mitzvah/mitzvoth* used in 176 verses, can be translated by commands and could correspond to legal rules. Some of these rules are likely to change, as show the story of the double version of the Decalogue (before and after the episode of the Golden Calf), then the idea of a transmission

<sup>&</sup>lt;sup>13</sup> Dario Montovani, Legum multitudo e diritto privato. Revisione critica della tesi di Giovanni Rotondi in Jean-Louis Ferray (ed.), Leges publicae. La legge nell'esperienza giuridica romana (Pavia: IUSS Pres, 2012), 707-767.

<sup>&</sup>lt;sup>14</sup> Yongping Liu, Origins of Chinese Law: Penal and Administrative Law in its Early Development (New York: Oxford University Press, 1999); Maxim Korolkov, "Arguing about Law: Interrogation Procedure under the Qin and Former Han dynasties", Études chinoises 30, (2011), 37-71.

of "oral law", later written down with the *Mishnah*. Jewish law admits the possibility for human interpretation and evolution of the rules given by God. There were also, at least from the Hasmoneans (second and first century BC), Jewish judges and courts to apply this law as the personal status of Jews submitted to foreign powers during the larger part of the history<sup>15</sup>.

The fact that these three civilizations knew a repetition of statutory laws (even in a restricted manner after the enactment of the first fundamental text) and a proved adjudication of cases through the use of these laws is the main criterion to distinguish Roman, Chinese, and Jewish laws from so the so-called Greek, Hindu or Mesopotamian laws. Whereas Hart's secondary rules<sup>16</sup> cannot be found in Mesopotamia, in the Hindu tradition of dharmasastras and even in the Greek cities before the end of the fifth century BC (what means, after the invention of law in Rome)<sup>17</sup>, the three moments of the invention of the law gave to written statutory laws the first place in the creation of a technique comparable to writing or coining. Customary rules could be able to regulate social relationships, but only a written law depending from the authority of rulers could impose this new technique of ordering human conducts. It is meaningful that neither Roman law, or Chinese or Jewish Law gave any importance to custom in their origins. The developments of the interpretation of statutory laws, through the jurisprudence of Roman lawyers or the arguments of rabbis transmitted through the two Talmud, do not prove that other "sources of law" have superseded legislation during the long history of Roman and Jewish Law. It is even truer for the history of Chinese law, which was dominated by codes until the collapse of the Empire at the beginning of the twentieth century.

My task seems to be more difficult with the Middle Ages, especially in Europe before the rediscovery of the Justinian's compilation and the socalled Bologna revolution. However, the laws of the Barbarian kingdoms from the sixth to the eight centuries, then the capitularies of the Carolingians, were inspired by the model of Roman laws. Even the Anglo-Saxon laws followed the model of Moses as lawgiver, in the works of the late Patrick Wormald<sup>18</sup>. If the substantive law could refer to Germanic customs, the

<sup>&</sup>lt;sup>15</sup> N. S. Hecht, B. S. Jackson, S. M Passamaneck, D. Piatelli, A. M. Rabello (eds.), *An Introduction to the History and Sources of Jewish Law* (Oxford: Oxford University Press, 1996).

<sup>&</sup>lt;sup>16</sup> Herbert Lionel Adolphus Hart, *The Concept of Law* (Oxford: Oxford University Press, 1961), 81-96.

<sup>&</sup>lt;sup>17</sup> Michael Gagarin, David Cohen (eds.), *The Cambridge Companion to Ancient Greek Law* (Cambridge: Cambridge University Press, 1995).

Patrick Wormald, The Making of English Law: King Alfred to the Twelfth Century, Legislation and its limits (Oxford: Blackwell, 2001).

frame was a statutory legislation imitating the Roman and canonical precedents. One has to remember that the whole canon law, developed from the canons of the councils, then from the Decretals of the popes and spread through legislative collections was based on statutory laws. The pontifical revolution, according to Harold Berman's expression<sup>19</sup>, has preceded and triggered the Bologna revolution.

The Roman model of legislation, which was made of some general edicts but also of many special rescripts, was of course reactivated by the study of Justinian's compilation, especially by the Code. This statutory model was imitated by the Holy Roman emperors, from Frederic Barbarossa the first to Frederic the second with his 1231 Constitutions of Melfi composed with no less than 253 clauses<sup>20</sup>. It was used also in the kingdom of Sicily, in the county of Barcelona (with the writing down of the Uses of Barcelona, a compilation of customary rules through enacted statutes), in the kingdom of Jerusalem or by the counts of Flanders (the two 1200 Charters enacted by Baudouin), the duke of Brabant or the count of Hainaut. Concerning the kingdom of France, the research works from Albert Rigaudière (1988) and Gérard Giordanengo (1989)<sup>21</sup>, as those of André Gouron and Jacques Krynen<sup>22</sup> have re-evaluated the importance of the statutes enacted by Louis the Ninth or by Philippe the Fourth. These statutes have tried to reform deeply the judiciary, to impose duties to royal officials and to quash the 'bad customs', as the private wars or some points of private law. They were written down, with the help of legists, in an imperative style, which was evidently a reaffirmation of the legislative power of the prince according to Roman sources.

It has been noticed for a long time that the legislation of the English kings, especially the one of Henry II, belonged to the same movement of rebirth of the royal legislation. Beginning with the 1164 Constitutions of Clarendon and the 1166 Assizes of Clarendon, the legislation of Henry II is even pioneering in comparison with the one of the kings of France. However these

<sup>&</sup>lt;sup>19</sup> Berman, *op. cit.* (note 8).

<sup>&</sup>lt;sup>20</sup> Armin Wolff, Gesetzgebung in Europa 1100-1500: zur Entstehung der territorialenstaaten (München: Beck, 1996).

<sup>&</sup>lt;sup>21</sup> Arbert Rigaudière, « Législation royale et construction de l'État dans la France du XIII<sup>e</sup> siècle », *Renaissance du pouvoir législatif et genèse de l'État*, éd. André Gouron, Albert Rigaudière, (Montpellier: Société d'Histoire du Droit et des institutions des anciens pays de Droit écrit, 1988), 203-236 ; Gérard Giordanengo, « Le pouvoir législatif du roi de France (XI<sup>e</sup>-XII<sup>e</sup> siècles), travaux récents et hypothèse de recherche », *Bibliothèque de l'École des chartes* 147 (1989), 283-310.

<sup>&</sup>lt;sup>22</sup> Jacques Krynen, « Voluntas domini regis in suo regno facit ius. Le roi de France et la coutume », El Dret comú i Catalunya (1998), 59-89.
texts are often considered as respecting the old customs or enactments for previous kings (like Henry I), they seem to be restricted to specific matters and the common law of England is traditionally analysed as a judge-made law, letting little room for statutory laws. All these arguments are questionable. If the Constitutions of Clarendon referred to the 'customs, liberties and dignities' of the king's ancestors, it was a rhetorical argument used by many legislators to introduce innovations in a cautious manner. The statutory law decided a very important point: the frontier of competence between ecclesiastical and royal courts, what means the definition of the royal legal order towards canonical law. The legislation of Henry II created and developed royal courts and without this legislation the history of common law, as a royal law imposed to all persons subjected to royal courts, cannot be explained<sup>23</sup>. Of course, the common law of England was not exposed in exhaustive statutory laws, but it needed a legislative frame, given by Henry II, to blossom through the rulings of courts, which were not known by a large group of persons. The hundred years anniversary of the Magna Carta reminds us the impact of this text: although it was a symbol of the royal weakness towards the barons, although it did not give 'vested rights' to all the subjects of the king, it could be compared to the Law of Twelve Tables, as made Viscount Bryce in 1915<sup>24</sup>. It was a masterpiece of legislation, confirming that the common law of England was embedded in a legislative cradle.

I anticipate the objection you can give to this historical scheme that seems too favourable to statutory laws. How can we explain that this legislative power of the princes was really effective only from the sixteenth century onwards? How can we justify the importance of customary law (in continental Europe) and of case law (in England), if the point of departure of these new legal orders was found in legislation?

Concerning the first question, the one of the failure of the medieval legislations to develop a coherent and effective corpus of applied rules, one has to remember different facts. First, that the audacious claim of legislative sovereignty from some medieval princes encountered strong obstacles from the Papacy or the barons, these phenomena explaining different periods of weakness of the royal power. Before the creation of modern

<sup>&</sup>lt;sup>23</sup> John Hudson, The Oxford History of the Laws of England, vol. II (Oxford: Oxford University Press, 2012), 145-175.

<sup>&</sup>lt;sup>24</sup> Viscount James Bryce, Preface, in Henry Eliott Malden, Magna Carta. Commemoration Essays (Royal Historical Society, 1917), 14-15.

states, especially in the seventeenth century, there were many "breaks" or "discontinuities" in the exercise of the royal authority. Then, the practical means to make the statutory laws to be known and obeyed were limited. Before the invention of printing, it was necessary to make and to keep copies of statutes that were addressed to judges. This situation can explain why lawgivers were obliged to repeat the same rulings (as if the statutes of their predecessors felt in caducity), why the writing of books compiling statutes was so difficult (but very present paradoxically in the common law tradition) and why the law professors were hardly interested in this statutory laws. The situation began to change at the end of the fifteenth century and at the beginning of the sixteenth century, as Patrick Arabeyre has shown recently about France<sup>25</sup>. At this time, some law teachers began to comment legislative texts (like the Pragmatique Sanction, then the Concordat about ecclesiastical law), to compose ordered and chronological collections of statutes (following the model of collections of decretals) and the invention of printing facilitated the task of royal rulers to spread the statutes before the courts and in all the territory. These technical changes accompanied the development of a more general legislation, decided motu proprio by the princes, instead of individual privileges decided at the request of some persons. The great monuments of legislation like the imperial ordinance of Charles the Fifth or the royal ordinances of Louis the fourteenth in France, were also the outcomes of this very progressive change from a discontinuous to a planned legislation.

Concerning customary rules in Middle Age and in Modern Times, the research trend since three decades is also for reinforcing the link between the writing down of customs, the influence of Roman law and the first developments of the statutory power of princes or other legislative authorities. The movement of writing down customs begins in the twelfth century and cannot be understood without the renaissance of learned law. It also supposes an authority to decide and to approve this written text, which transforms social rules into legal ones. It could be the decision of a bishop, of a city or of a prince. One can presume, in many cases, that the rules contained in these texts are new rules, what is the clue for a rule of change linked with a legislative act. This is the case for example for one of the oldest franchise charters, the one of Lorris en Gâtinais, which was 'conceded' by the king

<sup>&</sup>lt;sup>25</sup> Patrick Arabeyre, « Le premier recueil méthodique d'ordonnances royales francaises: le *Tractatus ordinationum regiarum* d'Etienne Aufréri (fin XVe - début du XVIe siècle) », *Tijdschrift voor Rechtsgeschiedenis* 79 (2011), 391-453.

of France Louis VII in 1155. During the 13th century, the kings of France have approved a lot of customs (as the one of Toulouse) or quashed what they considered as 'bad customs'. The law books we call 'coutumiers' were written down by royal officials and encouraged by the royal power. Then, for a long time, the French kings considered as more opportune, perhaps to avoid some conflicts with the populations of the annexed territories, to let the royal courts declare what was the content of the custom. Finally, the official policy to write down customs was reinstalled in the second half of the 15th century and led to the great vague of customary codes (for about 65 'general' customs) of the 16th century. All these customary codes were homologated by the king, who gave them the force of a statutory law.

The same phenomena can be observed in the Low Countries, as it was described by John Gilisssen<sup>26</sup>. The 1056 charter of Huy was approved by the bishop of Liege. The 13th and 14th century books about customs were organized in articles, according to the model of statutory laws; they were often linked with judicial rulings and approved by the municipal authorities. The official writing down of customs was decided by Charles the Fifth at the beginning of the 16th century was even more authoritarian than in France. The customs were written down by officials without the consultation of inhabitants, homologated as laws and considerably reduced in number: from more than 700 written customs, only 88 were approved, in a conscious policy to unify customary law. Of course, the content of these customary rules were not decided arbitrarily by the royal power, but they were transformed in legal rules by the force of statutory law. One can say that customary law was a special way to legislate during the Middle Age and the Modern Times in order to maintain privileges of the provinces or of the cities under royal authority.

II. Let us sum up the methodological lessons I dry from these few examples. I do not contest that in some periods of the history, especially during several centuries of the Middle Ages, legislative statutes were rare and did not create a lot of new rules. But even in these periods, which for one part corresponded to a weak and badly documented range of legal rules inside the society, the statute law remained as a frame – the one given by

<sup>&</sup>lt;sup>26</sup> John Gilissen, Introduction historique au droit: esquisse d'une histoire universelle du droit, les sources du droit depuis le XIIIe siècle, éléments d'histoire du droit privé (Bruxelles: Bruylant, 1979), 392-406.

the Roman legislation in the European Western world – and as model. If a great part of the legal regulation was 'abandoned' to customary rules or, more radically, to judicial ruling that were arbitrary decided case by case, the statute law remained as a reference to write down fixed norms. Furthermore, the substantive development of customary rules, between the twelfth and the fifteenth century, was deeply linked with the development of the judicial and legislative power of public authorities, the one of towns and after all of princes. The territoriality of customs was decided by these authorities and by judicial rulings associated with the idea that the prince was the supreme legislator.

It does not mean that the history of the legislative power was linear and motionless, as a continuous progress of the scope and of the quantity of statute laws. At the end of the fifteenth century and at the beginning of the sixteenth century the kings of France (Louis the eleventh or Francois the first) and of England (Henry VIII) have enacted more than one thousand 'statutes' during their reigns. But many of these statutes were confirmations of privileges or confirmations of past and forgotten acts, a lot of the them can be classified as private acts with an effect limited to some parties and not as public acts. It needed several decades and centuries to impose the principle 'lex posterior priori derogat', to keep the memory of all laws, to develop comprehensive ordinances of reformation (as the 1530 Constitutio criminalis Carolina or the French 1579 Ordinance of Blois), then ordinances organizing systematically a whole domain of law as the ordinances of Louis the fourteenth about procedure. For a long time, judges were royal agents, endowed with the function to develop a royal common law, but free to use Roman law or customary law, without being subjected to a strict respect of statutory laws. Then, the development of royal absolutism and of enlightened despotism supported statutory laws prohibiting the violation or the unchecked interpretation of legislation. This trend towards a stricter legalism prepared and explained, in the European continent, the waves of codification that led to the Napoleonic Code I have spoken about at the beginning of my lecture. And it was also the time for a standardized and publicized case law with judicial rulings written down according to the model of statutory laws. Even in the nineteenth and twentieth centuries, there were new stages of this legislative history: with different rhythms in diverse countries, the number of statutory laws continued to evolve (private bills remained important in some domains, whereas public acts consisted in acts of the Parliament and in governmental regulations as

'material statutory laws'), the style of the laws changed, new hierarchies appeared with the written constitutions, new domains were concerned by legislative interventions of the State and the combination of statutory law and case law obeyed to various configurations according the legal systems.

It is not the case to say that the whole legal history is contained in this normative history. But there is no legal history, without an object consisting in rules, in norms that are depending of a legislative frame and model. Rules-scepticism, as defended by some American realists, denies all possibility to analyse legal systems and is contradicted by the structure of all legal orders, including the one of the Church, through legislative power. One cannot consider all the rules as law in books, an artificial creation of legal writers, which would be inconsistent with law in action, the real law purported to be undetermined and without rules. Kelsen has shown how questionable is the traditional distinction between creation and application of norms. Legal history is necessarily a history of the creative processes of rules, including the application and interpretation of these rules by the judges and generally by persons subjected to a legal order. The normative history, combining the study of the processes to create statutes, judicial rulings and customary rules, is also the history of the application of these norms and of their impact in the different groups of the society.

There is not, on one side, an inert story of 'paper law' concentrated only on the rulers and, on the other side, a social history of a 'living law', as practised by the private persons. The creation of statutes involves both the rulers and the ruled, as the application of the statute. As well as there is no complete separation between State and Society, legal rules are not external phenomena that would need to be 'receipted' in the social web. Legal rules are part of this social web, they create and embed social relationships (notably through classifications that attribute to different persons a status and a social function) and the ruled 'subjects' participate in one way to another to the 'manufacturing' of the law. The research field of legal historians has to include all these forms of law in action, from the legislative top to the bottom of judicial routine or repeated private acts. In the same manner, we are trying to analyse why some judgments became a ruling and gave birth to a normative case law, we study contacts or notaries' acts to look for creation of new norms. Even for the statutory laws, one has of course to take account of their impact, what means of their real application by courts and their less or more deep reception in the practice. The question is not, or not only, to evaluate the phenomena of illegality, delinquency, or resistance to legal orders, but to analyse how statutory laws were implemented. I dare say that we have to examine, about every statutory law, if this text has been transformed in a true norm, with a range of meanings and of effects through a long period, or on the contrary if the legal statement has been ignored, forgotten or transformed in a useless truism. The question could be: has the statutory law been fruitful for cases and social practises, "la loi a-t-elle fait jurisprudence?" one could say in French, as a parallel to the question "l'arrêt a-t-il fait jurisprudence?".

Following this perspective, I continue to plea for a plurality of legal histories or of points of view inside the legal history. Again, it is not the case to oppose social, economical or political history to our discipline of legal history. The science of legal history has a legal object; the norms of the past remain as normative phenomena, even if they are no more in force, as Weber has said in the 1910 Frankfurt Congress of German sociologists<sup>27</sup>. All studies about legal history have to take account of this object the centre of which is constituted by legal rules and the nucleus of this centre by statutory laws. Around the centre and the nucleus, there is a large room for other legal phenomena inside the 'legal field' as Bourdieu called it<sup>28</sup>. With different configurations through the times and the spaces, the development of statutory law and the action of the courts, as instruments of power that have been more and more 'legalized', have triggered the creation of professionals and the blossoming of a legal education. This link between the legal field, learned lawyers and universities is particularly important in the Western world since the Bologna revolution beginning at the end of the eleventh century. The re-discovery of Justinian's compilations, their teaching besides the one of canon law, the fact that more and more judges and princes counsellors were recruited among possessors of a law degree were undoubtedly decisive facts for the construction of States and the building of the legal field in Europe, then in all parts of the world colonized by Europeans. For a long time, these phenomena were studied and they continue to stimulate new researches, discussing the numbers, the flux and the impact of legal education during the second part of Middles Ages and Modern Times. More generally, legal historians are more and more prone

<sup>&</sup>lt;sup>27</sup> Verhandlungen des esrten Deutschen Soziologentages vom 19.-22. Oktober 1910 in Frankfurt am Main, (Tübingen: Mohr, 1911) 312 and 318.

<sup>&</sup>lt;sup>28</sup> Pierre Bourdieu, 'The Force of Law: Toward a Sociology of the Legal Field', 38 Hastings L. J. (Richard Tendiman trans., 1987), 807-53.

to follow the interest of Max Weber for the different forms of legal apprenticeship, the circulation of books and of texts, the rivalries between different groups of jurists, some of them (Max Weber has called 'Rechtshonoratioren'29) trying to dominate the other. This sociological history of lawyers is, according to me, very useful to understand how the law works in action and why there were (and there are) different contextual situations, giving more or less weight to one profession or to one process of creating legal norms. Here in Ghent, I have to pay tribute to Professor Raoul Charles von Caenegem who received the Sarton Medal. As many readers, I was fascinated by his 1987 book Judges, Legislators and Professors<sup>30</sup>. However, I think that the idea that the common law is a judge made law, the French law a codified system and the German law a Professorenrecht is a ideal-type that can be discussed. All these three legal orders have known the participation of legislators, of judges and of professors in the different processes for creating legal norms. All these three countries, like the other national fields, have known different periods where the judges, the legislators or the professors were more or less powerful, more or less united, more or less divided, more or less discrete in the use of their influence. One of the tasks of legal historians is to investigate about these changing configurations, with their conflicts or their precarious equilibrium. I am personally convinced that in all systems the rulers, that are not generally chosen among the law professors, are the persons who decided to create new norms, what means that rules were always produced by legislators and judges. It does not mean that the role of academics is weak: academics have educated many legislators and judges as their students (it was the case for the advocates who wrote down the Napoleonic Code or the judges who wrote down the BGB, the German Civil Code), some academics in different periods were the counsellors of legislators, either legislating cities or princes or Parliaments. After all academics have acculturated law techniques and the feelings of respect, let alone of religious cult, towards the law. The medieval Romanists have filled all these functions: as legists for Italian cities, French, English or German princes and as propagators of a theory that maintained officially the authority of Roman laws and reinforced in fact the power of princes as well as the prestige of professors.

<sup>&</sup>lt;sup>29</sup> Max Weber, *Economy and Society* (ed. G. Roth and C. Wittich, Berkeley: University of California Press: 1978), 785-799.

<sup>&</sup>lt;sup>30</sup> Raoul Charles van Caenegem, Judges, Legislators and Professors (Oxford: Oxford University Press, 1987).

It is for these reasons that I have been always sceptical towards the power of legal writers or academics to create directly legal norms. What we call in France 'la doctrine', through an ideological expression chosen from the years 1820s to unify what was not comprised in 'legislation' and 'jurisprudence' (now understood as the force of the case law) is not a 'source' of law. It is not only clear in the representative regimes of the nineteenth and twentieth centuries in which the academic lawyers are not endowed with a power to decide for the people or the nation, but also in more remote periods. One must suspect the partiality of lawyers trying to demonstrate that in the past, as well in Rome than in the fifteenth century or during the Enlightenment, their predecessors were the true oracles of the law. With a methodology more suspicious towards the legal hagiography of professors and of a selection of great authors, the history of legal thought could be advantageously replaced by a cultural or intellectual history of lawyers. As I have advocated with many colleagues, it is time to take more account of minor legal writers, of the circulation and printing of books, of the legal reviews, of the different forms of collective movements or currents inside the legal field. Less influenced by the ideas of progress and of coherence, this intellectual or cultural history applied to legal phenomena of the past can help us to understand why some statutory laws were neglected or forgotten, whereas other documents of the legislation or rulings of the case law were celebrated and acquired a great reputation. Sometimes the legal writers are the best witness of legal phenomena, sometimes they have occulted what was more important in their time. For the remote periods, with a paucity of documents, it is difficult to say if the mirror is good or bad: are we sure that the Roman lawyers we know through the Digest have revealed all the characters of Roman law?

The links or the conflicts between lawyers and lay persons (or 'non-lawyers') are also an issue of great importance to evaluate the working of the legal field, its closure or its porosity to other social groups (and not to the Society conceived as a whole, because lawyer and legal filed are parts of the society as well as of the dominant classes of rulers). Pleading for a rehabilitation of a renewed form of legislative history has not for consequence to ignore or neglect these other perspectives, as the legal phenomena outside the State. I would not say, as a rigid positivist, that all law comes from the State, at least in Modern times and, consequently, that all the legal events outside the State depend from a 'periphery'. When I speak of returning to the primacy of statutory law, I affirm the chronological priority of statutory law in the invention of the legal technique, the keeping of a legislative frame or model even in periods of rarity for legislative acts, the development of a standardized case law in narrow relationship with legislative statements, the blossoming of cultural productions around the monuments of legislation and after their enactments (legal cultures being rather the product of rules than the source of rules). As all the law is not contained in statutes, all legal history is not limited to legislative history, there is no doubt about this question. We are speaking about law, we are studying the laws of the past. Abandoning the English language at the end of this lecture, let us remember that there is a distinction between Recht und Gesetz, Droit et Loi and, as I have to repeat all my gratitude to my Ghent colleagues, between *Wet en Recht*.

## Laudatio Katrien Vanagt

#### **Paul Simoens**

In 2014, the Department of Morphology of the Faculty of Veterinary Medicine received a request for anatomical advice by two historians, Dr. Katrien Vanagt and her cousin Sarah Vanagt, a celebrated film director, who were planning a cinematic art film depicting the historical medical research of Vopiscus Fortunatus Plempius. This 17th century physician and scientist, a contemporary of René Descartes, performed pioneering studies on the visualization process taking place within the eye. As a model for his experiments Plempius made use of bovine eyes – and in order to ascertain an accurate recording of these investigations our institute was contacted to give some veterinary anatomical background.

Most evidently we gladly contributed to this project, which resulted in a fascinating encounter of science, history, art and culture, and emanated in the award-winning short film "In Waking hours". This film is internationally applauded in numerous prestigious cinematic events including the Imagine Science Films of New York (U.S.A), the International Independent Film Festival of Lisbon (Portugal), the Filmfestival of Firenze (Italy) and at the Rencontres Internationales in Paris (France) and Madrid (Spain).

The entire project was based on the historical research by Dr. Katrien Vanagt (°1977, Bruges) who studied Romance Philology at the University of Ghent, while combining this with a Socrates program study year at the Sorbonne University of Paris. In 1999, she obtained her Master's degree with a thesis entitled: *'L'ironie d'Anatole France: Les Dieux ont soif.'* 

Subsequently, she acquired an additional MA degree in Cultural and Intellectual History of the Renaissance at The Warburg Institute of the University of London, after submitting her dissertation *'V.F. Plempius (1601-* 1671) and his Theory of Vision: between Kepler and the Aristotelian Tradition'. During these studies her interest in medical history arose, as well as her fascination with the transmission of knowledge, which have both characterized her further scientific and academic career.

From 2001 to 2006, she worked as an assistant professor in the Centre for Studies of Science, Technology and Society at the University of Twente, while combining this mandate with her PhD studies and a doctoral research training in the Huizinga Research Institute for Cultural History in Amsterdam. In 2010 she then obtained her doctorate from the University of Twente for her thesis entitled *'The Emancipation of the Eye. V.F. Plempius' Ophthalmographia and Early Modern Medical Theories of Vision'*. The study presents not only a detailed description and analysis of the innovative ideas of Plempius, but also contains a critical elaboration on the development of ancient and modern medical theories concerning the nature of the vision process.

In 2012, Dr. Vanagt was awarded a two-years Rubicon Postdoctoral Fellowship by the Netherlands Organization for Scientific Research (NWO) and the Royal Netherlands Academy of Arts and Sciences (KNAW). With the grant she could pursue further research into historical theories of vision at the Huygens Institute ING in The Hague. While investigating early modern theories of vision, she sought to understand how knowledge is transmitted between groups of people who use different disciplinary discourses, the process of appropriation which it entails, and the generation of new interpretations and meanings.

Dr. Vanagt has published her studies, findings and viewpoints in six scientific papers in different national and international journals. Additionally, she has an impressive record of lectures and presentations at art meetings and was at several occasions an invited speaker at historical and medical congresses and in various universities throughout Europe. She illustrates many of these presentations by a practical demonstration of the ancient ophthalmologic research procedures, of which she studied not only the principles, but which she learned also to perform herself by following the instructions found in early modern sources. Her audiences are enthralled when viewing the magical moment in which one can witness the birth of an image inside a freshly slaughtered cow's eye.

This reconstruction of the historical experiments performed during the

Golden Age of the Netherlands, which represent a keynote in the history of both medicine and philosophy, is a most valuable alternative method for approaching the history of science, turning historical exploration into true *experimental history of science*.

By re-enacting the hands-on experiments, which were the onset of early modern scientific culture, Dr. Katrien Vanagt has met the ultimate aim of any historian to bring the past alive, and therefore the Sarton Medal Award is most deservedly bestowed on her.

# V.F. Plempius' experiments and the 'dramatic' turn in the investigation of the eye

## K. Vanagt

## Introduction

The eye lay at the center of investigatory practice in early modern Europe. Mirror of the soul, on the one hand, mirror of the outside world, on the other, it is the place where inside and outside come together, where man and cosmos reflect upon each other. The question of how vision works was one of the fundamental philosophical questions in the early modern period. Numerous philosophers tried to unravel the mystery of seeing and of our most intriguing organ: the eye. As the French philosopher Pierre Gassendi (1592-1655) exclaims in a letter to his maecenas Louis de Valois:

'Oh! Si nous pouvions résoudre, ne fût-ce que ce seul problème: comment s'opère l'acte de vision, cette chose si familière, en quoi consiste cette faculté de voir et comment il se fait qu'elle perçoive les choses sous l'aspect où elle les perçoit?'.<sup>1</sup>

Not only philosophers, but mathematicians, artists, magicians, anatomists and physicians too shared an interest in vision and were looking for a convincing answer to the question of seeing. The question of how we see lies thus at the crossing point of different fields of knowledge, and this is what makes it so intriguing. All the more so since the relationship between these

<sup>&</sup>lt;sup>1</sup> 'Oh! si vel hoc unum intelligeremus, quomodo illiciatur Visio, res familiarissimae, qualis it haec videndi vis ; & qui fiat, ut talem rerum faciem percipiat ?', quoted and translated in Bloch O.R., *La philosophie de Gassendi. Nominalisme, matérialisme et métaphysique*, The Hague, 1971 (Archives Internationales d'Histoire des idées 38) 6.

various disciplines was called into question, in their respective attempts to achieve higher status.

If modern scholars have extensively written on the history of vision within the respective fields of optics, art history or natural philosophy, the physician's views have largely been neglected.<sup>2</sup> Their ideas on vision were often overlooked or even dispraised by historians of science for not being challenging and innovating enough.<sup>3</sup> It has often been judged that early modern medicine was conservative, and that physicians simply stacked to the Galenic framework. That framework was omnipresent, indeed, but does that mean by definition that early modern medicine was conservative?

My research on medical theories of vision has made it clear that behind the traditional framework one can find often unexpected novelties and surprising thoughts, and that early modern physicians were trying hard to introduce new ideas within the existing framework. Indeed, unlike what is commonly assumed, a close reading of early modern medical treatises has revealed that the quest for a theory of vision was at the center of the physician's preoccupation. Medical treatises include lengthy discussions on the working of the eye, and some physicians came up with striking and original ideas on vision.

It should be noted however that those original ideas do not always reveal themselves at first sight. Texts are often misleading if you only give them a quick look, and many interesting and innovating propositions lay hidden behind a traditional or 'conservative' packaging. A text-based contextual reading, therefore, constitutes an enrichment to the history of medicine and, by extension, of science, where the focus in our days is rather on social and cultural history. This approach offers interesting insights into themes that are of broader relevance in the history of science.

My research not only showed that the medical quest for vision provided new ideas on vision itself, but what is more, that it eventually changed our vision on the body itself and, not less important, on the way a physician should engage in the body. On the basis of Plempius' work, I want to show that *experiments* have played a fundamental role in the quest for a convincing

<sup>&</sup>lt;sup>2</sup> See Lindberg D. C. *Theories of Vision from al-Kindi to Kepler*, Chicago and London, 1976; Smith A.M. *From Sight to Light. The Passage from Ancient to Modern Optics*, Chicago and London, 2015; Kemp M. The Science of Art: Optical Themes in Western Art from Brunelleschi to Seurat, Yale, 1992; Park K. 'The Organic Soul', in: Schmitt Ch. B. and Skinner Q. e.a. (eds.), The Cambridge History of Renaissance Philosophy, Cambridge e.a., 1990, 464-484.

<sup>&</sup>lt;sup>3</sup> Such is the judgment of both David Lindberg and Mark Smith, for instance. See note 2 above.

answer to the question of how the eye works, and led to an almost *dramatic* novel viewpoint in the relation between the eye and the body. Plempius' investigations eventually changed the conception of medicine and of the physician's role and contributed to the transformation of medical practices.

My interest in Plempius and medical theories of vision arose when I was studying intellectual history at The Warburg Institute (University of London). I became fascinated by anatomical illustrations, and while looking at them in more detail, it stroke me that in several subsequent Dutch editions of Vesalius' anatomical treatises, the plates representing the eye were often slightly altered, whereas most of the other plates remained unchanged. It puzzled me, I went on reading about it, and soon found out that ocular anatomy was often the subject of disagreement among early modern anatomists.<sup>4</sup> From that moment on, I started a more focused search. And so, delving into libraries, one lucky day my eye fell upon Plempius' *Ophthalmographia*.<sup>5</sup> (FIG. 1)

It appeared to be a very unusual book. First of all because it focused on one



single organ, and secondly because it integrated both anatomical and pathological knowledge, a combination that was not common in early modern medical books. Upon reading the introduction, it became even more interesting: Plempius proudly claimed that his book contained a new theory of vision. It is this particular theory of vision, how it was historically shaped and what was the meaning of it that will constitute the core of this paper. I will first go back to the origins of Plempius' empirical pursuits and show that empirical investigation was present since the very beginnings of his involvement

FIG 1: Vopiscus Fortunatus Plempius, Ophthalmographia, 1632.

<sup>&</sup>lt;sup>4</sup> For a detailed account of debates on the eye in anatomical treatises, see Vanagt K. De emancipatie van het oog. V.F. Plempius' Ophthalmographia en de vroegmoderne medische denkbeelden over het zien, Ghent, 2010, 223-246.

<sup>&</sup>lt;sup>5</sup> Plempius, *Ophthalmographia, sive tractatio de oculi fabrica, actione et usu praeter vulgatas hactenas, philosophorum ac medicorum opiniones,* Amsterdam, Hendrick Laurensz., 1632. Note that my references will be to the second edition, published in Louvain by Hieronymus Nempae in 1648, which was almost unchanged with respect to the first, apart from the book on therapy.

in science. I will then give an idea of how Plempius' predecessors and contemporaries thought about vision. And finally, I will explain Plempius' new theory, with special attention to the meaning of the experiments that lay at the heart of his theory of vision, and of the 'dramatic turn' in the medical world.

## 1. Plempius, Amsterdam and empirical investigation

#### A 'polemic' spirit: look for yourself, do it yourself

Although Plempius was 'world famous' in his own time, as evidenced by the engraving on his gravestone,<sup>6</sup> it is his polemic spirit which is remembered mostly today. This characteristic of Plempius also contributed to his experimental pursuits used to convince his readers. He was never too shy to admit his wrong and to redirect his thoughts and ideas. The most known exam-



ple of this was his share in the discussion on the circulation of the blood. Plempius stood up as one of the early advocates of William Harvey's theory of circulation, in the second edition of his treatise on the institutions of medicine, the *Fundamenta medicinae*, published in Louvain in 1644. However, some years before, in the first edition of his *Fundamenta*, he had explicitly argued against that theory and vehemently opposed to it.<sup>7</sup> It was only after having carried out Harvey's vivisection experiment himself, that he was convinced of the new theory.<sup>8</sup> (FIG 2)

**FIG 2:** Vivisection inspired by William Harvey's experiment. Johannes Walaeus, 'Epistola prima de motu chyli et sanguinis', in Bartholinus, *Institutiones anatomicae*, ed. 1647.

<sup>&</sup>lt;sup>6</sup> 'viri toto orbe celeberrimi', quoted in Allard, 'Dr. Vopiscus Fortunatus Plemp', *Volks-Almanak voor Nederlandsche Katholieken* (34), Amsterdam, 1885, 276.

<sup>&</sup>lt;sup>7</sup> Plempius V.F., Fundamenta seu institutiones medicinae, Louvain, Iacob Zeger, 1638.

<sup>&</sup>lt;sup>8</sup> 'Primum mihi inventum hoc non placuit, quod et voce et scripto publice testatus sum; sed dum postea ei refutando et explodendo vehementius incumbo, refutor ipse et explodor. Adeo sunt rationes ejus non persuadentes sed cogentes', Plempius V.F., *Fundamenta medicinae*, Louvain, Iacob Zeger, 1644 (2nd ed.), preface.

This anecdote is telling for Plempius and shows the importance of experiments in his investigations into the body: the experiment had the last word and blew away his earlier thoughts.

The polemic did not stop there. Plempius also entered into discussion with René Descartes with regard to the function of the heart and the circulation of the blood in a correspondence that would be made public and that would cause a lot of commotion, not only between Plempius and Descartes themselves, but also amongst thirds who meddled in their personal quarrel.<sup>9</sup> The story of Plempius' public conversion and his troubles with Descartes are often recalled by medical historians.<sup>10</sup> And it is generally in this context and for what is called his polemic spirit that Plempius is most known today.

#### A predilection for anatomy

Vopiscus Fortunatus Plempius was born in Amsterdam in 1601 into a catholic family. He started higher education at the University of Louvain, pursued his medical studies at the recently founded and more progressive University of Leiden, and after a *peregrinatio medica* at the universities of Padua and Bologna, he went back to his native city in 1624, where he presumably started a medical practice. It is there that he painstakingly dissected eyes, as he himself confesses:

'Ick heb met lijdtsaemheyt in Honden en Ossenoogen den Natuyr ernstigh nae getracht te achter-halen'.<sup>11</sup>

The first edition of his *Ophthalmographia* was published in Amsterdam, in 1632, one year before he was called away to become a professor of medicine at the University of Louvain, where he would stay and work until his death in 1671. Although he was still very young, he had soon made himself a name as a physician and anatomist. It explains why the famous humanist Gerard Vossius, when contemplating Plempius' possible move to Louvain, declared that would mean a big loss for the science in Amsterdam.<sup>12</sup>

<sup>&</sup>lt;sup>9</sup> See Petrescu L.: 'Descartes on the heartbeat: the Louvain Affair', *Perspectives on Scienc* (21-4), 397-428.

<sup>&</sup>lt;sup>10</sup> On Plempius' role in the discussion on the circulation of the blood, see Grene M., 'The Heart and Blood: Harvey, Descartes and Plemp', in Voss S. (ed.), *Essays on the Philosphy and Science of René Descartes*, Oxford, 1993, 324-336; French R., *William Harvey's Natural Philosophy*, Cambridge e.e., 1994, chapter 8; French R., 'Harvey in Holland: circulation and the Calvinists', in: French R. and Wear A. (eds.), *The Medical Revolution of the Seventeenth Century*, Cambridge e.a., 1989, 46-86.

<sup>&</sup>lt;sup>11</sup> Plempius, Verhandelingh der spieren, Amsterdam, Jacob Aertsz., 1630, 38-39.

<sup>&</sup>lt;sup>12</sup> Letter of Vossius to Puteanus, 6 july 1633 (MS, Rawlinson Collection, Bodleian Library, Oxford, 84a fol. 71).

We know little about his medical practice in those early years in Amsterdam, but with certainty anatomy was at the heart of his preoccupation as his first three publications were dealing with anatomy. If we say 'anatomy', '1632' and 'Amsterdam', we can hardly ignore the emblematic painting of Rembrandt entitled 'The anatomy lesson of dr. Tulp' that was painted in Amsterdam in 1632. (FIG. 3)



**FIG 3:** Rembrandt, 'The Anatomy Lesson of dr. Tulp'.

Nicolaes Tulp was a well known physician of Amsterdam, and was also an important public figure involved in politics. His public anatomical demonstrations were legendary and Plempius did not want to miss one of them. Plempius himself also gave some anatomical demonstrations and was praised for his diligence. If Tulp was without doubt the most famous anatomist of the city, several sources tell us that his protégé Plempius was the second most prominent anatomist in town.<sup>13</sup> When the famous Dutch anatomical atlas of Plantijn ran out of stock, it was young Plempius who was commissioned to provide a new edition by the Amsterdam bookseller Hendrick Laurentsz. Plempius eventually preferred to make an entirely new Dutch translation of the anatomical atlas by Cabrolius, to which he added his own commentaries. He considered it to be more concise and clear than Plantijn's edition, and the format of the addenda enabled him to introduce more recent anatomical findings, often clearly the result of his own personal experiences.<sup>14</sup>

<sup>&</sup>lt;sup>13</sup> On the relationship between Tulp and Plempius, see Dudok van Heel S.A.C., 'Dr. Nicolaes Tulp alias Claes Pieterszn. Deftigheid tussen eenvoud en grandeur', in Beijer T. e.a.(ed.), *Nicolaes Tulp. Leven en werk van een Amsterdams geneesheer en magistraat*, deel I, Amsterdam, 1991, 41-91.

<sup>&</sup>lt;sup>14</sup> Cabrolius B., Ontleeding des Menschelycken Lichaems, transl. by V.F.Plempius, Amsterdam, Hendrick Laurents, 1633.

Why Plempius considered anatomy so important is stated explicitly in his treatise on the muscles, a Dutch treatise that was published in 1630, just two years before the publication of his Latin *Ophthalmographia*:

'This [anatomy] is the only Foundation on which the entire structure of our science rests: it is the Key that unveils its hidden secrets. And last, it is the guidance leading us to Praise-worthy curation'.<sup>15</sup>

According to Plempius, anatomy provided the basis on which medicine had to be built. He uses the image of a key that unlocks secret doors. Without that key, we can only speculate about what really happens behind. A body does not reveal its secrets at first sight. Only by dissecting meticulously one can get an idea of what happens inside. On the basis of what the attentive and unbiased eye encounters there, we can then start true philosophical contemplation. Anatomy ought to be the foundation of a new medical 'science' for Plempius.

This might seem evident to a modern reader, however it is important to remind that traditionally anatomy did not form part of the fundaments or 'Institutiones medicinae', except for a description of the five big systems that make up the body (bones, muscles, nerves, veins and arteries). Anatomy was a separate undertaking. Plempius' quote is a clear plea for empiricism as the main source for medical knowledge, and shows to what point his empirical pursuits and experimental undertakings constituted the back-bone of his medicine.<sup>16</sup>

#### Empirical investigation: from body to text and back again

Plempius was not only a distinguished anatomist, he also showed a clear predilection for philology. In his attempt to find a Dutch equivalent for each Latin term, he would play an important role in the development of Dutch anatomical vocabulary. One of the terms coined by Plempius is the Dutch word for 'muscle': 'spier'.<sup>17</sup> His philological interest did not stop

<sup>&</sup>lt;sup>15</sup> 'Dit [ontleding] is de eenige Gront-vest, waer op de heele bouwingh van onse wetenschap rust: dit is de Sleutel, haer verborgentheden ontsluytende. Ten uyt-eynde dit is de Rechtsnoer ons leydende ende tot een Lof-waerdighe genesingh', Plempius V.F., Verhandeling der spieren, Amsterdam, 1630.

<sup>&</sup>lt;sup>16</sup> When Plempius later publishes his version of the *Fundamenta*, he puts his plea into practice and includes anatomy in the proper sense of the word (including all parts of the body).

<sup>&</sup>lt;sup>17</sup> For Plempius' contribution to the development of the Dutch anatomical vocabulary, see Elaut L., *Vopiscus Fortunatus Plempius en de ontwikkeling van de Nederlandse ontleedkundige vaktaal*, Brussel, 1976 (Mededelingen van de Koninklijke Academie voor Wetenschappen, Letteren en Schone Kunsten van België, Klasse der Wetenschappen 38,5) 1-35.

there. He became fascinated by Arabic, learned the language, and started to undertake a Latin translation of Avicenna's Canon, making use of some original manuscripts that he collated with great care.<sup>18</sup> This was more than a curious diversion and occupied much of his time, as becomes clear from another testimony of the earlier mentioned Gerard Vossius. He stated in a letter to his beloved colleague in Louvain, Erycius Puteanus (1574-1646), that when he met Plempius the other day he was looking quite bad, laid down by his work on the Arabic translation.<sup>19</sup> Behind his fascination for anatomy and philology lay the same spirit of a return to the original sources by empirical investigation.<sup>20</sup>

Plempius would never just blindly trust what others said, but always investigated and experienced for himself. He was diving into texts as he was diving into the body.

#### Plempius and Descartes: the encounter between hand and mind

Plempius belonged to the intellectual avant-garde of Amsterdam and was acquainted with several famous scholars. Among his friends, we find humanists such as Gerard Vossius, physicians such as Tulp and Elichmann, booksellers such as Laurensz., the poet Vondel and many more. One amongst them deserves particular attention, no one less than René Descartes. Plempius is often remembered as an anti-Cartesian because of the earlier mentioned debate on the circulation on the blood and because of his participation in the pamphlet against the introduction of Cartesianism at the University of Louvain (FIG 4.).

However, there was one particular period, in the winter of 1629-1630, in which Plempius and Descartes were very close friends. At that time, Descartes was living in Amsterdam in the so-called 'Kalverstraat' (*'Street of the calves'*), that was, as the name indicates, the butchers' street. And it was there that Plempius visited him often to discuss about 'things physical',

<sup>&</sup>lt;sup>18</sup> Avicenna, *Canon medicinae, interprete & scholiaste Vopisco Fortunato Plempio*, Louvain, Hieronymus Nempae, 1658. See Siraisi N., Avicenna in Renaissance Italy, Princeton and N.J., 1987.

<sup>&</sup>lt;sup>19</sup> Letter of Vossius to Puteanus, feb. 1633 (MS, Rawlinson Collection, Bodleian Library, Oxford, 84a fol. 68).

<sup>&</sup>lt;sup>20</sup> Paula Findlen suggests that empiricism and humanism went hand in hand, and that humanists' preoccupations with restauring the original texts stimulated empirical investigation, see Findlen P., 'Natural History', in: Park K. and Daston L. (eds.), *The Cambridge History of Science, vol.3 Early Modern Science*, Cambridge e.a., 2006, 435-468.



**FIG 4:** Anti-cartesian pamphlet in Plempius, *Fundamenta medicinae*, (ed.3), Louvain, Hieronymus Nempae, 1654.

as Plempius will recall later in his life.<sup>21</sup> Descartes too looks back at that specific period in a letter to Mersenne, in a well known quote:

'there was one winter in Amsterdam when I went almost every day to the house of a butcher to see him kill the animals and to have carried to my lodgings the parts that I wanted to anatomize more at my leisure.'<sup>22</sup> It is very likely that Plempius was the one who taught Descartes how to dissect.

Exactly in that period, in which they met each other every day to discuss about physical things and to explore anatomy, Plempius was preparing his *Ophthalmographia*, while Descartes was working on his *Dioptrique* and his treatise on light.<sup>23</sup> Many features indicate that they explored and thought out their respective ideas on vision together. It is important to stress this, because through Plempius' particular approach, we will understand to what point Descartes' theory was indebted to his predecessors, and to what point experiments and handful pursuits were decisive and crucial in Descartes' philosophy too.<sup>24</sup>

<sup>&</sup>lt;sup>21</sup> 'Saepe cum eo de rebus egi physicis', Plempius V.F., *Fundamenta medicinae*, Louvain, Hieronymus Nempae, 1654.

<sup>&</sup>lt;sup>22</sup> 'j'ay esté un hyver à Amsterdam, que j'allois quasi tous les jours en la maison d'un boucher pour luy voir tuer des bestes et faisois apporter de là en mon logis les parties que je voulois anatmoiser plus à loisir', letter to Mersenne of the 13th of November 1639, quoted in Cohen G., *Ecrivains francais en Hollande dans la première moitié du XVIIe Siècle*, Paris, 1920 (Bibliothèque de la revue de littérature comparée 1), 468.

<sup>&</sup>lt;sup>23</sup> Descartes' extensive correspondence gives a clear insight in the genesis of his works.

<sup>&</sup>lt;sup>24</sup> The view that experimental hands-on practices played a crucial role in Descartes' philosophy starts to find more and more adepts in the last years. See Bos E.-J. & Verbeek T., 'Conceiving the invisible. The role of observation and experiment in Descartes' correspondence', in: Van Miert D. (ed.), *Communicating observation in Early Modern Letters (1500-1675). Epistolography and Epistemology in the Age of the Scientific Revolution*, London, 2013, (Warburg Institute Colloquia 23) 200-221; Boulboullé B., *In touch with life. Investigating epistemic practices in the lifesciences from a hands-on perspective*, Amsterdam, 2012.

An analysis of their respective ideas on vision reveals striking similarities, despite the apparent differences: seeds of the presumably new Cartesian ideas on vision were clearly present in Plempius' *Ophthalmographia*, published some years earlier in 1632. But similar ideas in a different context get a different colour and can therefore be misleading. Descartes' theory of vision has been the object of numerous studies, historical as well as philosophical, epistemological and mathematical. None of them, however, stresses his relationship with Plempius' theory of vision in this particular context. The comparison with a *physician's* theory of vision, and the context in which their theories were conceived, shows the importance of empirical exploration for the Cartesian epistemology, and gives better insight into how empirical exploration and mathematics worked hand in hand towards a new conception of vision, both epistemological and medical.

The similarities between both theories are indeed striking. Not only the content is very similar - experiments with the camera obscura play a crucial role in both –, but even the words they use are almost identical. They also share the same concern to have an active reader who is willing to engage into the experiments they describe. There is, however, one striking difference: whereas Descartes' treatise is full of splendid and innovative illustrations, Plempius' Ophthalmographia does not contain one single image. As this treatise deals with seeing and contains a detailed anatomical description of all the parts of the eye, it is most surprising not to find any images at all. Moreover, we have seen that Plempius considers anatomical investigation as the basis of medicine and strongly believes that a thorough anatomical knowledge of the body is a condition sine qua non for being a physician. Is this a contradiction? No, I rather believe that the lack of images forms part of Plempius' entire strategy to get his readers dissect and experiment for themselves. Since there are no images to rely on, there is only one way out for Plempius' reader to know how the eye looks like: he has to dissect for himself. It is exactly this idea of 'do-it-yourself' that also forms the core of Plempius' 'true theory of vision' when it comes to experiment.

## 2. Theories of vision in the medical world

As we can see on the frontispiece of the *Ophthalmographia*, Plempius' theory of vision will argue against the opinions of all doctors and philosophers.<sup>25</sup> (see FIG 1) Doctors discussed at length about vision. But what precisely were they discussing about? First of all, it is important to note that, unlike opticians and philosophers, physicians were not so much interested in the way images travel outside the eye, but in what happened to those images inside the eye: where and how are images assimilated in the eye, how do they stimulate vision, and, not the least, what happens in case of defective vision, i.e. when the image is not seen correctly. It is precisely this last aspect that formed one of the main stumble stones for physicians: their ideas on vision had to be consistent with the theories of disease and causation. In that sense, they had a supplementary problem with respect to mathematicians and philosophers: they had to give their theories a place within the strictly medical and ultimately therapeutic thinking.

One would thus suppose that their quest for a theory of vision was an intermediary step in order to find an answer to defective vision. However, in many cases it appeared to be exactly the opposite: first there were the ideas on disease, and on the basis of these ideas doctors thought out a theory of vision. Their ideas on the diseased body determined, shaped and directed their theories of vision.

#### The embodied eye: spirits and only spirits

It is thus necessary to briefly review what these ideas were like and how physicians regarded the body. For early modern doctors it was impossible to make claims about the eye without saying something about the body as a whole. They were thinking within the framework of what is called 'holistic medicine'. The body was always seen as a whole and within this frame it was unthinkable – except within the study of anatomy – to consider organs separately. The eye, imbedded in the body, consisted of humours and visible spirits that were produced by the body, and it was the quantity and quality of those visible spirits that was responsible for seeing. Seeing was

<sup>&</sup>lt;sup>25</sup> 'praeter vulgatas hactenus Philosophorum ac Medicorum opiniones', Plempius V.F., *Ophthalmo-graphia*, Amsterdam, Hendrick Laurensz., 1632.

thus made directly dependent upon the general functioning of the body.<sup>26</sup>

This had far reaching consequences for the therapeutical advices in case of vision disorders. To tackle the cause of vision, doctors would thus in the first place give advice with respect to the so-called *regimen*. They would give dietary advice, advice regarding the daily habits, they would prescribe blood-lettings or purging, all with the same goal: to restore the natural, healthy balance and, ultimately, to regulate or restore the quality or quantity of those visible spirits. (FIG 5)

FIG 5: Georg Bartisch, Oftalmodouleia, das ist Augendienst, Dresden, 1583.



The physician's view on the use of eyeglasses illustrates well to what point that frame of thinking was dominant. It was very difficult to give them a place within the traditional, holistic medical thinking with its dominant spirits. Most physicians would therefore simply ignore eyeglasses in their

<sup>&</sup>lt;sup>26</sup> On the Galenic physiology of sight, see Boudon-Millot V., "Vision and Vision Disorders: Galen's Physiology of Sight", in Horstmanshoff M. – King H. – Zittel C. (eds.), *Blood, Sweat and Tears. The Changing Concepts of Physiology from Antiquity into Early Modern Europe*, Leiden and Boston, 2012 (Intersections 21) 551–567.



treatises. A few would even warn the reader not to use them, as can be seen in the image: 'How one can prevent himself from wearing eyeglasses'.<sup>27</sup> (FIG 6)

**FIG 6:** Georg Bartisch, *Oftalmodouleia, das ist Augendienst,* Dresden, 1583.

#### The medical debate on vision: between Aristotle and Galen

The main issue amongst physicians was whether vision happened through a so-called emission or intromission of rays. 'It is a very famous question, both because of the ambiguity of the dogma, and the fame of the authors', says the physician Ioannes Heurnius (1543-1601) in his *De morbis oc-ulorum, aurium, nasi, dentium et oris, liber* (1608).<sup>28</sup> The origin of the so-called emission or extramission theory can be found in Plato's theory of vision: our eyes emit rays that are loaded with visual power or spirits, they melt together with the air to transform it into a temporary instrument of vision, they make contact with the object, and come back to the eye carrying with them the information from the visible object. This theory was particularly popular amongst physicians, because it was this theory that Galen had chosen as a basis for his entire medical account on the eye. And Galen's medical writings, as said before, constituted the medical paradigm par excellence. The intromission theory, in contrast, goes back to Aristotle.

<sup>&</sup>lt;sup>27</sup> 'Wie man sich vor den Prillen und Augenglesern bewaren und enthalten möge', Bartisch G., Oftalmodouleia, das ist Augendienst, Dresden, M. Stöckel, 1583, fol.31r.

See Heurnius J., *De morbis oculorum, aurium, nasi, dentium et oris*, Leiden, Raphelengius, 1608, 3. Heurnius was among the first generation of professors at the newly founded University of Leiden.

According to this theory, it is not the eye but the object that emits rays. Vision happens through reception of those species or forms inside the eye.

This marked contradiction between the medical discourse and the philosophical discourse – with respectively Galen and Aristotle as the main authority – appeared to be a real problem for physicians.<sup>29</sup> To choose one option meant to oppose to one or the other authority.

The easiest way for physicians was to follow Galen's emission theory, because that theory was closely linked to a theory of the body and proposed a clear and consistent basis for ocular pathology and therapy. Galen's writings provided doctors with everything they needed to advice patients to preserve or restore sight. But one could not simply ignore Aristotle, for his world view consisted the basis of philosophical thinking. Furthermore, it was the official natural philosophy approved by the Catholic church that was taught at universities and that all physicians had studied during their preparatory years at the Artes faculty. Instead of slavishly following Galen, as is often stated, early modern physicians tried hard to solve that contradiction. And in their attempts to reconcile both theories, more than one succeeded in finding an elegant intermediary solution.

A question that was closely related to the former one, and that was heavily debated upon among doctors in the context of the theory of vision, was whether the eye was passive or active. Other favourite points of discussion that we find in medical treatises with regard to vision tackle the following questions: What is the principal organ of vision? In what part of the eye is vision accomplished and what is the function of the different parts such as the lens and the retina? Is there light inside the eye and, if so, what kind of light is it and where does it come from? What is the nature of the eye: is it rather related to fire or to water? How are images assimilated in the eye? This selection of questions illustrates well that physicians were primarily concerned with the eye itself.

Whereas physicians were endlessly debating on the role of the eye and its parts in the process of seeing, there was, however, one feature that no one dared to touch and that remained unchanged in all medical theories of vi-

<sup>&</sup>lt;sup>29</sup> On the relationship between medicine and natural philosophy, see French R., Medicine before Science. *The Rational and Learned Doctor from the Middle Ages to the Enlightenment*, Cambridge, 2003.

sion: the role of the visual spirits.<sup>30</sup> Spirits constituted the essence of medical thinking. To alter the role of the visual spirits was to alter the necessary connection between the eye and the body, and to destroy the foundations of holistic pathology and therapy.

## 3. Plempius' true modus visionis

Suffice it to say for now, that it is precisely this basic fundament of all previous medical theories of vision, that Plempius will take down and prove to be wrong. To challenge an idea that was so deeply rooted, would prove to be not an easy task. Plempius, therefore, carefully constructed his argumentative structure and took his reader step by step to a new way of thinking and acting. He introduced a new way of convincing his reader, in which experiments had a dramatic share.

#### Plempius' theory of vision: between Aristotle and Kepler

In the introduction to his *Ophthalmographia*, Plempius stated that the key for a new theory of vision lies within mathematics, and he stressed that it had far reaching consequences for the *practice* of medicine. This in itself meant an important turning point in medical thinking about sight. For Plempius resolutely inverted the sequence of medical thinking: he began with exposing a mathematically inspired theory of vision, on the basis of which he re-thought and remodeled his ideas on disease and disorder.

The idea behind the theory, however, was not new, as Plempius himself acknowledged. In fact, full of admiration he explained that the inspiration for his book came from Johannes Kepler, who was the first to prove with lengthy mathematical demonstrations that the eye worked like a camera obscura.<sup>31</sup> But Kepler's book, his *Ad Vitellionem paralipomena*, was not much read outside the circle of astronomers. The first decennia after its publication it was not widely diffused, so only a happy few were aware of

<sup>&</sup>lt;sup>30</sup> For a more detailed discussion of the medical debates on vision, see Vanagt K., *De emancipatie van het oog*; an abbreviated version in English can be found in Vanagt K., 'Early Modern Medical Thinking on Vision and the Camera Obscura: Plempius's *Ophthalmographia*', in: Manfred Horstmanshoff, Helen King and Claus Zittel (eds.), *Blood, Sweat and Tears. The Changing Concepts of Physiology from Antiquity into Early Modern Europe*, (Intersections vol.21), Leiden and Boston, 2012, 569-594.

<sup>&</sup>lt;sup>31</sup> Kepler J., Ad Vitellionem paralipomena quibus astronomiae pars opticae traditur, Frankfurt, Claudius Marnius and Haeredes Ioannis Aubrius, 1604. For an analysis of Kepler's theory of vision, see Lindberg, *Theories of Vision*, 178–208.

his new, groundbreaking theory. Moreover, his theory of vision was imbedded in a strictly astronomical work with a strong mathematical and technical character, that was not easily understood by non-specialists. Plempius therefore made sure not to scare off his readers and hastened to add that he would not bother them with the mathematical schemes and diagrams that were characteristic of such mathematical discourse. (FIG 7)



**FIG 7:** Johannes Kepler, *Ad Vitellionem paralipomena quibus astronomiae pars opticae traditur*, Frankfurt, Claudius Marnius and Haeredes Ioannis Aubrius, 1604.

While he foundation of his theory was mathematical, he employed different rhetorical strategies to convince his readers.

What did it mean for Plempius to follow Kepler's path, in view of the ongoing medical discussions on vision? Did Kepler provide the key for solving the contradiction that physicians were so much struggling with? Rather than solving the problem, Plempius in fact went from one problem to another and was now confronted with a similar problem as his fellow doctors who struggled with two contradictory authorities, this time between Aristotle and Kepler. Plempius did not want to oppose the Aristotelian theory, yet that theory was totally opposed to the Keplerian one. Or at least, that is what Kepler himself claimed. Kepler put much effort in proving that Aristotle was on the wrong track. And what about Galen? Although Plempius is often considered to be a Galenist doctor by medical historians, when one actually reads his texts it becomes clear that he was more than willing to abandon Galen's views when other more convincing theories crossed his path.<sup>32</sup>

Plempius' solution to save the authority of Aristotle, yet embracing Kepler's new ideas, was to show that although very different at the surface and in outcome, in fact Aristotle's theory carried in it the germs for the

<sup>&</sup>lt;sup>32</sup> This might have something to do with Plempius' personal admiration for Avicenna. In the case of vision, for example, Avicenna had paved the path for a medical intromission theory and had proved it possible to introduce the intromissionist alternative within medical theory. Several examples of Plempius' contempt for Galen can be found in Vanagt K., *De emancipatie van het oog.* 

Keplerian theory. Plempius' way of doing so was to include a very detailed discussion and redefinition of all elements and concepts involved in the process of seeing: he discussed at length concepts like the object of seeing, the properties of light, *species*, the medium or the meaning of transparency. This was exactly the way in which the problem of vision was treated in the Aristotelian, philosophical *De anima*-tradition.

Plempius thus employed the Aristotelian philosophical framework, that was familiar to physicians, as the structure for his work. However he gave an optical interpretation of the concepts involved that matched Kepler's theory, and he proceeded in a different way to prove his viewpoints.<sup>33</sup> And here it is that the 'experiments' come in.

#### Paving the way for a new theory of vision: experimental philosophy

Plempius' lengthy philosophical digression was not only a way to reconcile his heroes, but also a very effective way of leading his readers from the familiar to the unfamiliar, from what was known to what was new. He prepared his readers little by little for a new way of dealing with the question of vision.

A clear exposition of the *external* elements was necessary to understand a theory of vision in which light itself would become the main actor. Unlike for his fellow physicians, in Plempius' new theory an exposition about the eye itself was no longer enough, because the eye was no more than an instrument that thanks to its composition and construction altered the course of light, and that, in turn, was altered by that light. A description of how light travels through transparent and semi-transparent media was therefore of crucial importance to pave the way for Plempius' new theory.

Plempius considered the eye as a dark room, which is entirely transparent inside, and only differs from the air outside in density. The eye forms a sort of continuum with the world outside in which the object of seeing and the source of light are present. From that perspective, it almost became irrelevant to make the difference outside-inside, as they flow into each other and form a universe where the same laws apply.

It is worth noting that it was very surprising to find within a medical trea-

<sup>&</sup>lt;sup>33</sup> On the assimilation of optical concepts into anatomical discourse, see Vanagt K.," 'Hoe men zich voor brillen behoeden kan' of de moeizame verspreiding van optische kennis in vroegmoderne medische kringen", Gewina 29 (2006) 26–40.

tise no less than sixteen chapters that did not directly deal with the body, but with the external factors that influence sight. What made it so strange, is that all this was integrated into an anatomical work, in other words, into a work that *by definition* deals with the body and what is *inside* the body. By introducing a discussion about the world outside, Plempius is consciously transgressing borders. He merges different approaches and calls into question the status and relationship between different fields of knowledge. If it is clear that for Plempius anatomy is to become a new fundament of medicine, in his conception it is much broader in scope than it used to be. Anatomy is much more than cutting and mapping the body. It is a philosophically oriented practice.

In order to make his new ideas acceptable and understandable for physicians, Plempius followed the experimental way. Just as the opticians, yes, but there was a significant difference: he left out the strictly mathematical argumentation. Whereas in optical treatises the experiments were always accompanied by a thorough mathematical argumentation, in Plempius' universe *the experiments themselves became evidence* and backed up his main argument. He made sure to select very simple experiments that could easily be repeated, convinced that the empirical experience itself guaranteed its truth and did not need further proof. He repeatedly encouraged his reader to explore the properties of the different elements that are involved in the process of seeing for himself.

Plempius' particular methodology resulted in a complex mixture of different discourses, all smoothly melt into one: the ultimate goal was medical, the structure anatomical, the framework philosophical, the underlying idea mathematical, but he proceeded in an empirical-experimental way, accessible to everyone ready to participate, to explore, and to use his hands.

#### 'All this you can experience yourself': the camera obscura experiment

It took Plempius no less than sixteen chapters before coming to the core of his theory and before he could finally exclaim:

'But in order not to keep you waiting any longer, I will now explain how vision really takes place. In order to better understand this, come and enter with me into a dark room.'<sup>34</sup>

<sup>&</sup>lt;sup>34</sup> 'Sed ne te suspendam diutius, verum modum explicare aggredior, quem, ut melius concipias, ingredere mecum obscuram hanc cameram', Plempius, *Ophthalmographia*, 77.

What followed was a detailed manual explaining how to transform an ordinary room into a true camera obscura. He put much effort into suggesting how one should play with different elements to obtain a better image. So, instead of explaining his theory with a series of arguments, it is the experiment itself that constitutes his theory. It is therefore of capital importance that the reader participates in the experiment. Indeed, Plempius urges his reader to experiment for himself, with repeated exhortations such as: 'all this you can experience yourself, with only little effort and without any cost'.<sup>35</sup> What is more, he promised that the result is absolutely breathtaking:

'Once you have correctly executed those instructions, those who have been admitted to the spectacle will see that all things that are outside  $\dots$  are depicted inside on the opposite white wall, not without enchantment of the eye and delight of the mind'.<sup>36</sup>

Now, since the invitation has to be taken literally and appears to be more than just rhetoric, why was it so important for Plempius that the reader would experiment himself, and did not simply trust him on his word? What the experiment has to show, is that what happens inside a camera obscura is nothing else than a natural *play of light*. He wants to make his reader experience that light is able to paint images that are exactly like the object from which they are reflected. It is not about rays – as was often the case in contemporary images representing the camera obscura –, not about the mathematics behind, but about the simple fact that images are formed in a *totally natural way*. And this is something you can only fully grasp if you construct a camera yourself.

It is not enough to believe him or to credit him with authority.<sup>37</sup> The whole power of Plempius' argument lies precisely in re-constructing and undergoing the experience. He is convinced that whoever undergoes the experience will need no further demonstrations. Only by exploring the conditions of image formation for oneself, will the reader realize that there are no occult powers at work and that there is no magic involved in the formation of images inside a camera obscura.

<sup>&</sup>lt;sup>35</sup> 'Atque haec omnia perpauxilla opera tum nullis sumtibus potes experiri', Plempius, Ophthalmographia, 78.

<sup>&</sup>lt;sup>36</sup> 'His rite actis & observatis, omnia, quae extus vel consistunt,..., intus in opposito albo pariete omnes spectatum admissi contemplabuntur effigiari, non sine magna adspectus illecebra, atque animi oblectatione', Plempius, *Ophthalmographia*, 77.

<sup>&</sup>lt;sup>37</sup> Shapin and Schaffer argue that the detailed instructions on how to perform experiments were often a way of creating virtual witnesses and of securing credibility and authority to the author, see Shapin S.-Schaffer S., *Leviathan and the Air-pump: Hobbes, Boyle and the Experimental Live* (Princeton e.a.: 1985).

Let me remark that while the camera obscura in itself was not something new, it was often associated with magic. Giant camera obscuras were used as a form of entertainment, whereby the public was to be seated inside, and was confronted with a sophisticated play that was staged outside and projected *upside down* in the middle of the room, often on an invisible screen. In this context, it was precisely the magical effect of the camera that was stressed.<sup>38</sup>

Once Plempius has established that there is no magic involved in the way images are formed in a camera obscura, and that image formation is a natural process of light, he can now safely conclude:

"...and thus, in this instrument that was made by nature, happens the same as in the dark room that was made by art. With the only difference that providential nature made the eye even more ingenious: it is filled with as much strange liquids as are necessary for a sharper representation."<sup>39</sup>

What is important here is his insight that vision happens in a fully automatic way by a projection of images – and this, purely and simply by way of its architecture, by how it is built: a dark room with a small aperture in the front. Any 'construction' that fulfills these basic conditions will provide the same spectacle. Since the eye meets these conditions, images are formed in the same. Plempius proceeds to a detailed comparison between both instruments and shows that each part has its equivalent.

Plempius' message was a powerful one, and his carefully prepared argumentation proved to be effective. The comparison between eye and camera started to be integrated into the medical discourse within the second half of the seventeenth century. A good example can be found in the medical treatise by the Dutch physician Johan Van Beverwijck who refers to the eye as camera obscura, invites his readers to perform the experiment, refers to Plempius, and includes a nice illustration of a camera obscura into his treatise (FIG 8).<sup>40</sup>

<sup>&</sup>lt;sup>38</sup> See the description in Giambattista della Porta, Natural Magick (London, Thomas Young and Samuel Speed:1658) 336. On Della Porta and natural magic, see Eamon W., Science and the Secrets of Nature, Books of Secrets in Medieval and Early Modern Culture (Princeton-New Jersey: 1999) 194–233. Even scientists like Kepler used the camera obscura as a form of entertainment, as we can read in Dupré S., "Playing with Images in a Dark Room: Kepler's Ludi inside the Camera Obscura", in Lefèvre W.(ed.), Inside the Camera Obscura. Optics and Art under the Spell of the Projected Image, Berlin, 2007, 59–74.

<sup>&</sup>lt;sup>39</sup> 'Etenim idem hic apparatus *ex natura*, atque in clauso conclavi *ex arte*; operosiorem tamen eum prudentissima natura fecit, tot accitis humoribus ad accuratiorem repraesentationem', Plempius, *Ophthalmographia*, 78 (italics are mine).

<sup>&</sup>lt;sup>40</sup> Van Beverwyck J., Schat der Ongesontheyt, in Wercken der Genees-konste, Amsterdam, J.J. Schipper, 1672, vol.II, 87.



FIG 8: Johan Van Beverwyck, Schat der Ongesontheyt, in Wercken der Geneeskonste, Amsterdam, J.J. Schipper, 1672.

The dissection-experiment: 'take the eye...'

'May I perish, if vision in the eye does not happen in the same', Plempius boldly claims.<sup>41</sup> If this comparison is his *interpretation* of the camera obscura experiment, how does he prove to be right? How does he try to convince his reader that eye and camera are one and the same instrument? Once again, it is an experiment, and *an invitation to experiment*, that is adduced as the ultimate proof. For 'that in the eye happens the same as in a camera obscura can be shown in the eye itself', he claims.<sup>42</sup> He invites the reader to take the eye of a freshly slaughtered ox, to carefully remove the layers at the back of the eye, to cover the bare back with semi-transparent paper or the thin membrane of an egg, and to place the prepared eye into the peephole of the camera obscura. He then orders the reader to take place just behind the eye inside the camera obscura, and concludes that he will see a painting that represents in a perfect manner all objects outside.<sup>43</sup>

The dissection experiment forms a crucial moment in Plempius' demonstration and constitutes the *ultimate proof* of the process of seeing. More than simply validating the comparison between camera obscura and eye, the experiment shows that image formation in the eye takes place without interference of the body with its bodily spirits; it functions as an autonomous instrument.

<sup>&</sup>lt;sup>41</sup> 'Ad cujus instar, dispeream, nisi visio in oculo celebretur', *Ophthalmographia*, 78.

<sup>&</sup>lt;sup>42</sup> 'In oculo ipso simile atque in camera fieri ad oculum demonstrari potest', *Ophthalmographia*, 79.

<sup>&</sup>lt;sup>43</sup> Plempius, Ophthalmographia, 79 'Cape oculum bovis recens mactati, et in fundo ad nervum opticum dextre tunicas aufer, ut magnam portionem humoris vitrei detegas, sic tamen, ut nihil ejus efffundatur: dein vitreum rursus papyro aut pellicula ovi tegito, atque oculum si fenestrae foramini imponito e regione objectorum illuminatorum. Tu igitur stans in cubiculo illo obscurato retro oculum, videbis picturam perfectissime omnia objecta repraesentantem'.

The need for *tangible proof* can be linked to the tendency of early modern physicians to unravel the body by dissection and the ever-growing popularity of anatomy. During the Renaissance of anatomy in the mid sixteenth century – with Andreas Vesalius as its most known exponent – it was about mapping the body, and discovering structures.<sup>44</sup> But soon, towards the end of the century, philosophers and physicians became more interested in trying to discover the *functions* of the different bodily parts through dissection.<sup>45</sup> A well known example is Fabricius de Acquapendente's anatomical treatise of the eye with the telling title: *De visione*.<sup>46</sup> Fabricius deplaced the focus from the structure of the organ to its function vision and included a clear plea for more attention to function, thus stressing the philosophical dimension of anatomy.<sup>47</sup>

In order to see the body at work and to make bodily *processes* visible physicians also started to perform vivisections on animals. The most famous example is Harvey's demonstration of the working of the heart and the circulation of the blood in a living dog. (see FIG 2). Plempius' experiment with the dissected eye stems from the same wish to make the act of seeing itself visible, with the difference that it now comes to include the use of instruments. Since the body works like an instrument, an artful construction of instruments can teach us fundamental features about the physiology, i.e. the mechanism, of the body. The body had to be manipulated artificially for its secrets to be unveiled.

<sup>&</sup>lt;sup>44</sup> See Wear A. e.a., The Medical Renaissance of the Sixteenth Century, Cambridge e.a., 1985; see also Cunningham A., The Anatomical Renaissance. The Resurrection of the Anatomical Projects of the Ancients, Brookfield, 1997.

<sup>&</sup>lt;sup>45</sup> On the link between anatomy and physiology, see especially Cunningham A., "The Pen and the Sword: Recovering the Disciplinary Identity of Physiology and Anatomy before 1800. I: Old Physiology – The Pen, Studies in History and Philosophy of Science Part C. Studies in History and Philosophy of Biological and Biomedical Sciences 33 (2002) 631–665 and idem, "The Pen and the Sword: Recovering the Disciplinary Identity of Physiology and Anatomy before 1800 II: Old Anatomy – The Sword", Studies in History and Philosophy of Science Part C. Studies in History and Philosophy of Biological and Biomedical Sciences 34 (2003) 51–76.

<sup>&</sup>lt;sup>46</sup> Fabricius de Acquapendente H., *De visione sive de oculo visus organo*, Venice, Franciscus Bolzetta, 1600.

<sup>&</sup>lt;sup>47</sup> On the shift from structure to function, see Cunningham A., 'Fabricius and the 'Aristotle project' in Anatomical Teaching and Research at Padua', in: Wear A. e.a., *The Medical Renaissance of the Sixteenth Century*, Cambridge e.a., 1985, 195-222.
#### Towards a dramatic turn in the history of medicine: from mindful to handful

As a physician raised within the holistic tradition, Plempius realizes the significance of his disembodied eye. By disconnecting the eye from the body, he touches upon the essence of medical thinking. The experiment can therefore be considered as a key moment in the history of medicine: it is an early instance of the Cartesian idea of *l'homme automate* that will shake the foundations of Western philosophical thinking, a few years after the publication of the *Ophthalmographia*. Plempius' experiments have dramatic consequences for his way of conceiving medicine and for what ought to be the role of the physician.

The basic and central idea for doctors to retain was that there is no intervention of spirits whatsoever – a process which I called elsewhere the 'despiritualization' of the eye.<sup>48</sup> Since the process of seeing was no longer dependent on the general well-being of the body, the traditional advices to restore the balance lost their reason of existence. He replaced the therapeutic 'advices' by remedies that were to be applied to the eye itself (eye drops, eye unguents, eye baths, etc.), and did not concern the rest of the body, and barely advised medicines to be taken in orally.<sup>49</sup>

Plempius' new theory of vision also drastically changed the way of proceeding as a doctor: he did not have to give advices on the body, but had to tackle the problem in the eye itself. In the first place he had to try to find out where the problem was, what was wrong with the instrument. The problem was local, and had to be discovered *empirically*. And secondly, he had to determine how to solve the problem. One of the solutions Plempius came with was the use of eyeglasses. Within his theory, eyeglasses now fully made sense: they can improve the construction of the human instrument by artificially remedying outside what was wrong inside. In Plempius' vision, it is thus possible to improve nature by artificial means.

Plempius is pushing his readers from passive readers into active explorers, a new role for the physician that begins with the way in which he deals with texts: he can no longer passively consume and accept what he reads,

<sup>&</sup>lt;sup>48</sup> See Vanagt K., 'Early Modern Medical Thinking'.

<sup>&</sup>lt;sup>49</sup> For a detailed analysis of Plempius' ideas on ocular diseases and therapy, and the relation with the practice of medicine, see Vanagt, *De emancipatie van het oog*, 297-381. For a clear general account on the transformation of therapy in the seventeeth century, see Porter R. 'Les stratégies thérapeutiques', in: Grmek M. D. (ed.), *Histoire de la pensée médicale en Occident. 2. De la Renaissance aux Lumières*, Paris, 1997 (translated from Italian), 199-223.

but has to participate and to reenact. The next step is that the physician has to adopt a similar active attitude in his consult with patients. Not only in the process of assimilating knowledge, but also in his daily practice, when confronted with a patient, inspection and manipulation is needed.

I have been talking about the dead eye, but Plempius does not stop there. He also expresses the need to look inside the living eye, the eye of a living human being. How is that possible, without cutting it open? Once again, he is eager to push ideas and practices a step further. Plempius suggests the use of an *instrument* that would make it possible to look into the eye. It is again a wonderful example of experiment and empirical investigation. He recommends to have a glass sphere made for the purpose and to attach a thread to its upper part so that one can hold it suspended in the air. He then orders to take place in a darkened room and to place a candle in front of the globe in such manner that the light of the candle will go through the globe into the affected eye. And than, he adds, 'all parts of the eye will be observed clearly'.<sup>50</sup> It might be a little too anachronistic to call it an oph-thalmoscope, but it is nonetheless a clear predecessor of this instrument that will revolutionize ophthalmic consult much later in history.

It is known that the distinction between hand and mind, between the mind-reflecting physicians and the hand-intervening surgeons, became blurred during the seventeenth century.<sup>51</sup> The introduction of instruments - traditionally the hallmark of practitioners - in medical practice provides a telling example thereof. Plempius' 'ophthalmoscope' provides a fascinating example of how experiments and instruments worked together towards a new way of conceiving medical practice. Unlike practitioners-oculists who used instruments to *intervene* into the body. Plempius now suggests an instrument to *investigate* the body, in the same way as the camera obscura was used to investigate the working of the eye. In doing so, he shifted the attention from purely speculative thinking on the connection between body and the world (the non-naturals), to an *instrumental* and thus *mediated* way of investigating the body itself. An investigative practice that is no longer limited to add to the field of theory (anatomical inspection), but also to that of practice, the medical consult (introspection of the diseased eye in order to locate the disturbing factor).

<sup>&</sup>lt;sup>50</sup> '& videbuntur clare omnes oculi partes', Plempius, *Ophthalmographia*, 239.

<sup>&</sup>lt;sup>51</sup> On the shifting role from mind to hand in the Scientific Revolution, see Smith P., *The Body of the Artisan. Art and Experience in the Scientific Revolution*, Chicago and London, 2004.

#### Conclusion

Plempius' experiments in investigating the eye provide a clear and early instance of how the conception of medical practice was dramatically transformed in the seventeenth century, from mind to hand, from holistic to local, from dietetic to curative.<sup>52</sup> Within Plempius' new conception of medical practice, doing and conceiving, thinking and acting, dissecting and exploring, or curing and intervening were respectively two sides of the same coin, and clearly pointed to a new conception of medicine.



This dramatic innovation, however, would only be completed a few years later with the publication of Descartes' *Discours de la méthode* that would shake the foundations of Western philosophy.<sup>53</sup> Descartes' image on seeing (FIG 9) illustrates exactly the dissection-experiment with the fresh eye that Plempius invited his readers to perform, and that Descartes describes too.

**FIG 9:** René Descartes, *Discours de la méthode*, Leiden, J. Maire, 1637.

<sup>&</sup>lt;sup>52</sup> On the transformation in medicine in the seventeenth century, see French R. and Wear A. (eds.), *The Medical Revolution of the Seventeenth Century*, Cambridge e.a., 1989

<sup>&</sup>lt;sup>53</sup> Descartes R.. *Discours de la méthode*, Leyden, J. Maire, 1637.

It is one of those images that have often been reproduced outside its proper context, and that, to use the words of Claus Zittel, belong 'to the permanent stock icons of the mythography of the so-called 'Scientific Revolution'. 'In more recent cultural history', he adds, those images 'generally served as a visual symbol of the seventeenth century's new way of thinking'.<sup>54</sup> It shows to what extent physiological experiments such as the experiment with the disembodied eye not only played a crucial role in the transformation of medicine, but ultimately had a dramatic share in the transformation of our vision of the world.<sup>55</sup>

<sup>&</sup>lt;sup>54</sup> Zittel C., 'Conflicting Pictures: Illustrating Descartes' *Traité de l'homme*', in: Dupré S. and Lüthy Ch.(eds.), *Silent Messengers. The Circulation of Material Objects of Knowledge in the Early Modern Low Countries*, Berlin, 2011, (Low Countries Studies on the Circulation of Natural Knowledge 1) 217-260, esp.232.

<sup>&</sup>lt;sup>55</sup> Together with filmmaker Sarah Vanagt, we reenacted the experiment with the dissected eye that Plempius and Descartes describe, and we filmed the entire process. A wonderful experience that resulted in the short film 'In Waking Hours' (2015), see www.balthasar.be. I would like to express my deepest gratitude to Professor P. Simoens for his invaluable help and support in this special project.

# Laudatio William De Groote

#### Jan Victor

It is my pleasure to express the laudation for Dr William De Groote to you. As you all know, a laudation describes the professional career of the laureate, but in the case of Dr De Groote it would be too time consuming, consequently I will focus on the essentials.

I have known Dr De Groote since a long time, he was one of the godfathers who inspired me as a young doctor to choose for an orthopedic training program. At the time I fulfilled an internship as medical student, he was a junior staff member in the department of Orthopedics and Traumatology in St-Jan's hospital in Bruges. Many years later, the casual acquaintance was renewed and I learned he was a very dedicated, talented and ambitious orthopedic surgeon. He incorporated the steep ambitions of St-Jans Hospital and played a crucial role in the development and organisation of his institution. He gave the impetus for a flourishing orthopedic and traumatologic drive in Bruges. I was in a good position to see this happening as I was working next door.

During these years William was known as a very loyal colleague, looking beyond the local boundaries. He understood the growing importance of collaboration between institutions and subspecialisation in orthopedics. At a national level, he was a founding father of BOTA, the 'Belgian Orthopedic Trauma Association', and OTC Belgium, an organisation aimed at improving the trauma care. He organised numerous symposia, offering significant added value to the orthopedic community.

But this all too limited description of his professional activities would fall short of describing who William really was. He wanted to understand how

and why things happened in society and science, explaining his love for historic research. As secretary, he co-founded Montanus, the Collegium Medico-Historicum Brugense in 1992. In 2005 he became president of this well respected society studying the history of medicine, hospital organisation, and pharmacy. Montanus organises three symposia per year and publishes the journal 'Tijdingen Montanus'. Highlights were the expositions "van chirurgijns tot pestheiligen" and the maxi symposia "Geneeskunde in de 16de en 17de eeuw", "Geneeskunde en WOI" and "Napoleon en de krijgsgeneeskunde". Last year this culminated in the unveiling of a bust of Thomas Montanus at the St-Jan Hospital site.

As most of you know, Dr De Groote is at home in Bruges, and as can be expected, his enthusiasm and organisational talent does neither go unnoticed in his home town. He is the leading force behind the 'Heilige Bloedprocessie' and Unesco World Heritage in Bruges. Besides he played a leading role in the development of the VIVES school and numerous educational projects for his Bruges.

In summary it is clear that Dr William De Groote is an exceptionally talented and energetic individual, who uses his talents in the best possible way. Despite the variety of his projects, he succeeds in delivering quality in all of them. Above all, he is a warm personality and an exceptional colleague who fully deserves the Sarton Medal today.

# The history of skeletal fracture care 5000 years of traumatology

#### William De Groote

#### Introduction

Knowledge of trauma is as old as mankind and therefore traumatology can be seen as the earliest form of surgery. During millennia, only surgeons, especially army surgeons, exercised fracture treatment, because war was the only event with massive casualties. Until the 20th century, war has always been the main catalyst in the evolution of trauma treatment.

On the one hand surgeons have always been searching for better immobilization and fixation of fractures, and on the other hand for optimization of wound care. Up to now the latter remains the most crucial treatment in skeletal surgery.

This article discusses diagonally, over the major step stones, the evolution of skeletal fracture care over a period of 5000 years, from external splint to internal fixation.

In the 21st century, skeletal trauma is still the leading cause of physical disability. Due to the growth of the world population, the increasing industrialization and the densification of traffic in the developing countries, there will be exponentially increasing demand for solid and minimally invasive trauma care.

#### Traumatology in the antiquity

Our current Western knowledge of trauma care has a history, which like the whole Western science, has made a trip around the Mediterranean sea, which starts about 2700 BC.

In the Egyptian Nile delta, basic fracture treatment was splinting of the limbs supporting the fractures. On the mummies in the sarcophagi splints made of linen, gum, palm, papyrus and acacia bark were found.



Open perimortem ulna – and radius – fracture of a mummy (2500 BC) splinted with acacia bark, with traces of blood on the dressing and without any sign of callus formation.

Noteworthy here is that the problem of open fracture treatment can be recognized. On some mummy splints traces of blood at the fracture side and underlying fractures without any callus formation were found, suggesting an early death after the accident [27].

Until the 20th century an open fracture was mostly fatal, and even today sometimes no solution to the wound- and infection-problems are found in open fractures, making amputation unavoidable. Up to this day, the open fracture remains an enigma! (During a long time amputation was the only possible treatment for an open fracture).

In ancient Greek medicine, fracture treatment was enshrined in the Hippocratic Corpus [6]. Splints and bandages were used as basic fracture stabilization techniques. Lesser bleedings were cauterized and open fractures amputated transarticularly (disarticulation).

During the following centuries Greek physicians recognized the infectious syndrome of wounds and open fractures, but made a first fundamental error in wound care, based on the "four humors" theory, arguing that pus had a cleaning function of the wound and was thus beneficial. Evacuation of pus was considered restoring the humoral balance, or the homeostasis.

The humoral theory was defined as a dogma in the 2nd century AD by the Greek – Roman physician Galen (Pergamom 129-216, Rome). Galen suggested that – in order to maintain the balance between the four humors – by excess of one humor (blood, phlegm, black and yellow bile), this humor had to be removed from the body by purging, vomiting, bloodletting, as well as evacuation of toxic substances from the infected wounds. This theory has discredited appropriate wound care durinng 1500 years.

Also in the Roman time, Cornelius Celsus (25BC-50AD, Rome) introduced the vascular ligature for bleedings and proposed a daily wound cleaning with wine and vinegar. In order to facilitate the transosseous amputation, he also developed the amputation saw.

After the Roman time, medical science continued its journey around the Mediterranean sea via Constantinople, where in the 7th Century Paul of Aegina (625-690, Constantinople) transferred the surgical knowledge to the Arab surgeons. Initially in Baghdad and at a later stage in Cordoba, where the Arabic surgical school reached its peak under Al-Zahrawi or Albucasis (936-1013 Cordoba), who made a compilation of surgical knowledge in his "Al - Tasrif". This book would remain the standard in surgery for more than 700 years [38].

Al - Zahrawi recommended fracture splinting with soft splints of clay and egg white, which may be windowed to allow wound care and bone debridement. He performed only distal amputations below the elbow or knee in open fractures. However, the technique of the vascular ligature according to Celsus got lost and the Arab surgeons therefore treated any bleeding, even those in amputations, with cauterization. Cauterization continued to be the standard haemostasis for many centuries during the middle ages.

When in the 11th century the Almohads took the power in the Caliphate of Cordoba, there came an end to the peaceful coexistence between Muslims and Jews, who were expelled.

Jewish scientists, called Arabists, emigrated to southern Italy, up in Salerno, and to Lunel in the French Languedoc. There they transferred the Arab knowledge to Western Europe through translations of Arabic scientific books into Hebrew, Greek and Latin. Abu al-Qasim al-Zahrawi (Albucasis, Cordoba), "the father of surgery", published in ± the year 1000 an Arabic encyclopedia of medicine and surgery, his "Kitab al Tasrif".

Traumatology in the Western Middle Ages

This immigration created the first Western medical schools in Salerno and Montpellier, which were the germ for the later development of Western universities (Bologna 1050, the first medical faculty in 1185). Clerics with greater or lesser degree of ordination were formed as physicians.

However, because of decisions taken by the Catholic Church, the clergy medics had to leave surgery to artisan barbers, who were not formed at university. Indeed, the Council of Clermont (1095) proposed a ban on the monks clergy medicine and the Council of Tours (1163) banned clerics from all contact with blood, hence traumatology disappeared from the academic con-



text and the activity was left to locally trained surgeons. These surgeons, especially army surgeons and in cities more specialized bonesetters, took care of all injuries, wound care, fractures and fracture dislocations in the Western Middle Ages.

Surgeon bonesetters during reduction of a shoulder dislocation in the St. John's Hospital in Bruges 1778 (Jan Beerblock 1739-1806, Bruges). During the Middle Ages there was little high-impact trauma. Interesting is the study of Carla L. Burrell on "the fracture patterns in the medieval period". This study compared the fracture prevalence of two medieval populations after excavations of bodies in two churches, namely rural Poulton and urban Gloucester. In Poulton 10% of the population showed signs of fractures, but this raised up to 20% in urban Gloucester, probably resulting from more violence in the cities [26].

The study also showed that, on average, 65% of fractures occurred in the male population, whereas 25% in women and 10% in children. It mainly concerned thoracic fractures. Fractures on the extremities occurred more at the left side (defence side), compared to the right and were in majority distal fractures of the long bones.

It is also remarkable that in the urban Gloucester more skull and lower limb fractures occurred. Malunions were observed, but there was usually a consolidation of the fractures. In Poulton there were no perimortem fractures found (fractures without any callus reaction), probably because heavy trauma patients were taken to the hospice and then buried there after death.

Of course there were war injuries in the high Middle Ages, but at that time these were mostly stab and crush wounds, so relatively low-energy trauma. According to the teachings of Albucasis, the surgeons attempted to treat these fractures by splinting and the bleedings by cauterization, and possibly amputation in case of open fractures.

Medieval low energy stab and crush wounds were treated with cauterization or amputation in case of open fractures.



#### Traumatology in the early modern period

From the early modern period a significant turn in traumatology was seen with the introduction of gunpowder during warfare. Gunpowder was introduced in the west by the Mongols of China in the 14th century. Because of this new technology army surgeons were faced with a new form of warfare, with shot wounds from guns and artillery, which produced high-energy injuries. Based on the still accepted humoral theory, a second major error was introduced in wound care. It was believed that the bullet wounds were highly inflamed by the gunpowder, which acted as a poison.

According to Giovanni da Vigo (1450-1525) and the humoral theory, poison should be treated with fire, so with the hot iron cauter or boiling Sambuc oil (a mixture from elderberry oil and theriaca). The treatment caused more inflammation, necrosis and pain, so amputation was even more unavoidable on the rare survivors [24-43].

For closed fractures surgeons developed reduction techniques, as was found in the "Feldtbuch of Wundtartzney" von Gersdorff in 1517. Unfortunately



particularly wooden rigid splints were recommended, which regularly gave rise to pressure ulcers.

Fracture stabilisation with wooden splints. From "Feldtbuch der Wundtartzney" von Gersdorff 1517.



Reduction of a shoulder dislocation on the "Scammon of ambi device". From "Feldtbuch der Wundtartzney" von Gersdorff 1517. The most groundbreaking surgeon of the 16th century certainly was

Ambroise Paré (1510-1590 – surgeon of three French Kings), who described a number of key changes in trauma care exercise in his "Dix livres de la chirurgie - 1564" [15-22].



Ambroise Paré (1510 1590), "The father of modern surgery" published his " Dix livres de chirurgie" in 1564.

First by promoting regular splint change, he pleaded against the pressure ulcer lesions in the splint therapy.

Secondly based on his experience in the battle of Susa – in 1537 during the French Piedmont campaign – where he lacked sambuc oil by the abundance of gunshots, he observed that rose water treatment for the gunshot wounds caused less inflammation than boiling oil. So he became the first ardent opponent of the use of boiling oil in the treatment of gunshot wounds. He stated: "Je me délibéray de ne plus jamais aussi brusler aussi cruellement les pauvres blessés de arquebusade" [25].

He also developed "the crow beak", a tool that allowed him to perform a vascular ligature during amputations in a simple manner. This way bleed-



ing could be treated more adequately, which significantly increased the survival rate of the patients.

A windowed upper arm splint, according to Ambroise Paré, which allowed wound care in open fractures.

Ambroise Paré developed "the crow beak" to perform a vascular ligature in a more simple manner during amputations. Remarkably however is that he kept supporting the humoral theory and still saw pus production in wounds as beneficial (pus bonum et laudabile).

Surgeons as Ambroise Paré did have a clear progressive vision of trauma care but were limited in the realization of their ideas. On the one hand by a total lack of asepsis, resulting in a high rate of postoperative surinfections, and on the other hand by the total absence of pain control and anaesthesia with the consequence only superficial surgery being possible.

Despite the improved knowledge of human anatomy in the 16th century (with Vesalius, Da Vinci...) surgeons had no understanding of articular fracture pathology, due to a total lack of imaging. It took until 1814 before Abraham Colles (1773-1843, Dublin) finally defined a wrist dislocation as a wrist fracture [3].

Until the end of the Ancien Régime, also the dogma of total prolonged immobilization for patients with a fracture was still promoted. This was caused by the insufficient stabilization of the splints. This prolonged immobilization caused the fracture disease, with a significant muscle atrophy, osteoporosis and ankylosing of the surrounding joints. A displaced fracture in the Ancien Régime became synonymous to a significant disability, provided that the patient, such as in open fractures, survived his trauma.



At the end of the 18th century a new trend for more softer and comfortable bandages and splints was seen as described by some surgeons, like Pierre Joseph Desault (1738-1795) in his "Les oeuvres chirurgicales" from 1798. But the new devices permitted only little or no fracture reduction and offered no possibility of joint mobilization [44].

From "Les oeuvres chirurgicales – 1798 " of Pierre Joseph Desault, his "Desault's bandage" for immobilization of the upper limb and his "Appareil à extension continue" for fractures of the lower limb.

#### Traumatology in the "Nouveau Régime"

In the Nouveau Régime a sharp increase in the number of traumas was noted, due to the expansion of cities and the industrialization. Also the Napoleonic wars, carried out far from home, caused a need for ambulant fracture treatment.

During the Napoleonic campaigns new trends in fracture treatment were observed. First, the high number of amputations carried out in open fractures. However there was a very low chance of survival for the patient after an amputation, caused by the usually developed cascade of infection, gangrene to sepsis, and death.

As amputation technique, Dominique Larrey (1766-1842), chief surgeon of the Imperial Guard, advocated a fast disarticulation [38]. Others such as the Ghent surgeon major Joseph Kluyskens (1771-1843, Ghent) suggested a transosseous, more distal amputation [42]. His son Hippolyte Kluyskens published later the results of the amputations carried out by his father after the Battle of Waterloo in 1815. He observed that after closing of the amputation wounds, the majority of patients died. If stumps were left open, a lot of those recuperated. With the development of the tourniquet (Jean Louis Petit 1744), the amputation technique became more efficient but this was offset by the total lack of asepsis in the field hospitals. In summary, it must be said that in these war conditions, the patient was helpless and the surgeon hopeless.



Dominique Larrey (1766-1842) and his disarticulation technique of the shoulder.

#### The search for an ambulatory fracture treatment

Dominique Larrey provided two other innovations. With the development of the "ambulance volante" a quicker evacuation from the battlefield was possible. He was also the first surgeon to develop an "inamovible" cast for ambulant fracture care, consisting of bandages soaked in camphorated alcohol, lead acetate and egg white. This was the first switch from splint to a well-moulded cast. But this cast still did not provide sufficient rigidity [38].



"L' appareil inamovible " of Dominique Larrey, a first attempt for an ambulatory fracture treatment.

The Brussels surgeon Jean Louis Seutin (1793-1862, Brussels) further developed the idea with his "bandage amidonné" or "starch bandage", consisting of cardboard splints and laundry starch. It was the first "inamovible" cast, that showed a sufficient stability [42].



He also promoted the early mobilization of patients. He was the first surgeon to argue for a controlled adjacent articular mobilization in order to avoid oedema, atrophy and stiffness. He was the father of the "déambulation régime" to prevent the "fracture disease". Seutin can be regarded as the first modern traumatologist.

The definitive solution for a solid ambulant fracture immobilization was applied by Antonius Mathijsen (1802-1878, Budel) with the plaster cast or "Plâtre de Paris". Already in 1798, the British diplomat Eaton reported that he observed fracture treatment by the Ottoman surgeons with a "plâtre Coulé", immobilizing the limb in a coagulated plaster bed [27]. However, this technique was met with skepticism in the West. For example Joseph F. Malgaigne (1806-1866 Paris) was very critical about the swelling problem in such rigid casts. But in 1852 Antonius Mathijsen optimized this technique by applying the plaster, analogous to the technique of Larrey, on a cotton bandage, that must be wrapped around the limb [13]. This "plâtre de Paris" would become the standard technique for immobilization for 150 years ("The plâtre de Paris" got its name from the analogous gypsum mixture used by plasterers of the city of Paris).



The "plätre coulé": Ottoman surgeons used liquid plaster for fracture immobilisation.

Antonius Mathijsen (1802-1878, Budel) developed, out of the "plâtre coulé" technique, his plastercast or the "Plâtre de Paris" by applying the plaster on cotton bandages that must be wrapped around the limb.







#### The spring of Medicine, care becomes cure

With the knowledge of bacteriology and the development of antisepsis (Joseph Lister 1810-1894 [11].) and anaesthesia, soft tissue surgery was made possible, starting in the middle of the 19th century. From 1895 onwards, also the introduction of radiology offered a better understanding of fracture pathology. However, implant surgery, necessary for bone fixation, remained problematic due to the high number of surinfections. As a consequence in 1895 the "Congrès Français de chirurgie" condemned operative fracture treatment. However, individuals like William Arbuthnor Lane (1856-1943, London) [10], with his no-touch technique, and Albin Lambotte (1866-1955, Antwerp) were the rare advocates of surgical fracture stabilization at that time [9].

#### **Traction therapy**

After the plaster cast, a second conservative standard treatment was introduced in the 19th century: the osseous traction, focusing on the reduction of limb shortening in displaced fractures. A traction system was already proposed in the early 14th century Guy De Chauliac (1300-1386), but the technique was insufficient due to its problematic skin fixation with consequent pressure ulcer problems.

The first performant traction system was developed by Hugh Owen Thomas (1834-1891, Liverpool). His traction splint or "the Thomas splint" was the first device making an ambulant immobilization possible of displaced fractures of the lower limb [27-38]. The system became the standard treatment in the Allied camp during World War I. Along with the Carrel-Dakin intermittent irrigation (an antiseptic solution of sodium hypochlorite and boric acid), developed in 1916 during World War I in Compiègne by Alexis Carrel and Henry Dakin [38], this traction system reduced mortality in open femoral fractures from 80 to 20%. However, amputation remained routine surgery in open fractures during World War I.

In the same period, in the azmies of the Central powers (German-Austrian), transosseous traction was developed. This was introduced in 1907 by Fritz Steinman (1872-1932) [38] and later optimised by Martin Kirschner (1879-1942) [19], and allowed a more optimal length traction.



#### Fracture treatment during the interbellum

In the interbellum period between World Wars I and II, fracture treatment was based on two basic conservative treatments.

On the one hand, the reduction of fractures under general anaesthesia (or under the developing rachi anaesthesia), followed by a plaster cast. On the other hand prolonged length traction [12] treatments, followed by a subsequent immobilization in plaster, sometimes with massive "thoraco pelvipedieux" plaster immobilizations, from the thorax to the foot, applied on the traction table [2]. The transosseous traction therapy for an proximal femoral fracture, followed by the casting on the traction table, with an "thoraco pelvipedieux", a cast immobilization from the thorax to the foot.



In the interwar period, the post immobilization gymnastics was introduced, the birth of physiotherapy. Even during World War II, plaster cast and traction remained the primary fracture treatments. However, in World War II the spectacular introduction of the sulfonamides and the first antibiotics was noted.

#### The operative fracture stabilization

In the fifties of the 20th century, as a result of the optimization of asepsis, anaesthesia and popularization of antibiotic therapy, implant surgery became possible with the development of osteosynthesis.

## The prehistory of osteosynthesis

The Arabian surgeons already used the nuchal ligament of camels to per-

form a contention – cerclage in open patellar fractures. In the 17th century, Severin of Naples used a tin wire for the same indication. But it was the French navy surgeon J.B. Beranger-Feraud (1832-1900) who was the first to generalize the bone suture, "la suture osseuse". From 1854 onwards, he used lead wires to fix surgically fractures, a technique which he called "la synthésisation", the precursor of the osteosynthesis [38].



The French navy surgeon J.B. Beranger-Feraud (1832-1900), promoter of the "suture osseuse". He used lead wires to fix surgically fractures, a technique which he called "la synthésisation".



#### Plate osteosynthesis

The first to propose an efficient plate fixation was Hansmann (1886 Hamburg). The disadvantage of his system was the fact that the screws needed to be placed transcutaneously [38].



The plate fixation according to Hansmann (1886) with the transcutaneous screws.

Under the trim of William Arbuthnor Lane (1856-1943, London) [10] and Albin Lambotte (1866- 1955, Antwerp) osteosynthesis was developed. Albin Lambotte defined osteosynthesis as follows: "On entent par osteosynthèse la contention artificielle des fragments osseux des fractures par des appareils spéciaux agissant directement sur les os et destinés à les fixer définitivement dans leur position quo ante" [9].

Relying on the, at that moment, performant Belgian metallurgy, he developed plates in aluminium, steel, silver, copper and even resorbable magnesium fixation plates. He called his plate system the "prothèse interne" and he also immediately advocated a logical screw placement system, consisting of drilling, screwing and taping. The weakness in his technique was the fact that he used screws with a timber profile, which gave an inferior stability.

Albin Lambotte (1866- 1955), the "father of osteosynthesis", with his planning for a "prothèse interne".



In 1907, he published in his book "L'intervention opératoire dans les fractures récentes et anciennes" his basic techniques for the, at that time, revolutionary osteosynthesis [33].

Albin Lambotte was a multitasker, who also optimized surgical instruments, for example the still being used "Coapteur of Lambotte" for fracture reduction. He also developed the first stable external fixator and started intramedullary nailing in clavicular and trochanteric fractures. This particularly handy surgeon and also excellent violinist, produced 182 violins.



Albin Lambotte, this particularly handy surgeon and also excellent violinist, produced himself 182 violins and also multiple new instruments for fracture reduction.

In 1926 William Sherman (1880-1979) optimized the osteosynthesis system to a more stable fixation, supported by the Carnegie steel company in Pittsburg, with his vanadium steel plates and the self-tapping screws.



William Sherman (1880-1979), optimized the osteosynthesis system with his vanadium steel plates and his self-tapping screws.

#### The compression principle

The major optimization of the internal immobilization was applied by Robert Danis (1880-1962, Brussels) with his "compression principle".



In his basic work "Théorie et pratique de l'osteosynthèse", he explained his basic principles for the optimal osteosynthesis [4].

These were:

- Restoration of the bone in its original form;
- "Soudure per primam" or "soudure autogène", the principle of primary bone healing without external callus formation;
- Immediate mobilization of the surrounding joints. He agreed with the "early mobilizers" such as Seutin, Paget, Lucas-Championnière...

To achieve its interfragmental compression, he developed his "Coapteur", a plate fixation with a lateral compression screw.

The young Swiss surgeon Maurice E Müller visited Robert Danis in Brussels in 1950, and was impressed by Danis' principles. He continued to develop this technique within the Swiss A.O. group (Arbeitsgemeinschaft für Osteosynthese Fragen), among others with Hans Willenegger, Martin Allgöwer...

The Swiss AO group adapted and modified the basic principles of Albin Lambotte and Robert Danis region specifically. They also optimized and systematized the plate arsenal and the specific instruments. By their teaching (The Davos courses), the plate osteosynthesis was globally propagated [36].





The Swiss AO-group, with Hans Willenegger, Maurice E. Müller en Martin Allgöwer, optimized the compression system of Robert Danis.

At a later stage, they also optimized the oval slot compression plate, a system that was previously developed in 1958 by George W. Bagby [1].



George W. Bagby developed the "oval slot system" in 1958 and introduced the compression plate technique.



Another important contributor to internal fixation is Emile Letournel (1927-1994, Paris). From 1981 he became the great advocate of the acetabular and the pelvic stabilization, developing new surgical approaches (extended iliofemoral approach) and reduction techniques [34].



Emile Letournel was, from 1981 onwards, the major stimulator of acetabular reconstruction (L). An acetabular stabilization carried out via the by Letournel developed extended iliofemoral approach (R).

In the last decades of the 20th century, the development of the minimally invasive approach, a more biological approach for the plate osteosynthesis (MIS – minimally invasive surgery) was observed.

However, the development of the angle stable screw on the locking compression plate was the "egg of Columbus" for the plate osteosynthesis. Mipo was a fact, the "minimally invasive plate osteosynthesis", which maximally respected the soft tissues and provided a much greater stability.

At the same time, also new techniques for bone substitution were developed.

The angle stable screw was the "egg of Colombus", which finally gave the plate osteosynthesis its necessary stability.



#### The intramedullary fixation

Bernardino de Sahagun (1499-1590), a Spanish monk who travelled in 1529 with Hernán Cortes to Mexico, reported in his "Historia general de las cosas de la Nueva España" (the history of the things of New Spain) that Aztec physicians stabilized open fractures of long bones by putting wooden sticks intramedullary.

But it was not until the end of the 19th century that the promoters of the intramedullary technique started with intramedullary fixation of fractures, axially in the bone, this is in contrast with the inferior biomechanical lateral plate osteosynthesis. The first promoters were Gluck with an ivory intramedullary peg in 1890, N. Bircher [38] with a short metal rod in 1893 and Nicolas Senn with an animal bone allograft, also in 1893 [18]; they introduced it centrally, via a direct open access in the medullary canal.

In 1890, Gluck reduced – as the first surgeon – a diaphyseal fracture with an intramedullary peg (L). In 1893, Bircher stabilized the same fracture with a short metal rod (R).





In 1893, Nicolas Senn reduced an diaphyseal humeral fracture with a turkey bone allograft.

In the first decade of the 20th century, Albin Lambotte used simple metal carpenter nails to reduce clavicular – and trochanteric fractures [9].

During World War I, Ernest Hey-Groves (1872-1944, Bristol) used – as the first surgeon – long metal intramedullary nails, introduced through a retrograde "va-et-vient" system at the fracture level [5]. The great advantage of his system was the greater rigidity. The disadvantage was the significant surinfection risk, earning Hey-Groves the nickname of "Septic Ernie" [27].



From 1916 onwards, Hey-Groves introduced open and retrograde long intramedullary rods at the fracture site, like in this shot wound, with femoral fracture.

In 1936, the brothers Leslie and Lowry Rush started with the indirect fracture reduction with their flexible intramedullary Rush pins, using a three point fixation [17]. But the real breakthrough of the intramedullary technique was introduced by Gerhard Küntscher (1900-1972, Hamburg) with his "elastic nailing". A minimally invasive fixation system, using an open elastic cloverleaf nail, introduced axial in the medullar canal of the bone, with respect to the periosteal vascularization [8].

Gerhard Küntscher (1900-1972, Hamburg) developed the "elastic nailing", an open cloverleaf nail (L), axial introduced intramedullary, with respect of the periosteal vascularization, this in contrast with the cortical plate osteosynthesis (R).



He also developed the medullary reaming, which not only facilitated the nail introduction but also realized bone grafting at the fracture side.

The "Küntschernail" became the optimal fixation technique for mid-diaphyseal and relatively transverse fractures of the femur and the tibia, and even the humerus. The fixation principle of Küntscher based on a three point fixation, was however deficient in multifragmental diaphyseal fractures and fractures in the metaphyseal region. Just before his death in 1970, Gerhard Küntscher described the solution for this instability (telescoping) problem with his "detensions nagel", a stabilization of the fracture by locking the nail proximally and distally by transverse transosseous screws [32].



In 1970, Gerhard Küntscher described the solution for the telescoping problem in multifragmental fractures (L), with his "detensions nagel", a stabilization of the fracture by locking the nail proximally and distally by transverse transosseous screws (R).

Up to his death there was a twenty years' conflict between Gerhard Küntscher and the AO-group, because of an idiological trauma dispute between the believers of the indirect – and direct fracture stabilization.

After Küntschers death, the locking nail stabilization system was further optimized. First by Klaus Klemm (1932-2001) and W. D. Schellmann and later by Ivan Kempf and Arsène Grosse (AIOD – Association Internationale pour l'Osteosynthèse Dynamique, Strasbourg), who developed their "enclouage verrouillé". With the use of the traction table and the image intensifier, the nail could be more easily and in a minimally invasive way locked bipolarly [31].

Arsène Grosse (Strasbourg), the great promoter of the "enclouage verrouillé", the locking nail with the bipolar screw fixation, anti-telescoping and anti-rotating.







From the "enclouage verrouillé", originally indicated for diaphyseal fractures, also meta – and epiphyseal applications were developed such as the Gamma nail (Gilbert Taglang) for trochanteric fractures, the Supracondylar femoral nail (David Seligson) and the Humeral nail (H. Seidel). The locking nail evolved to the most optimal and reliable fracture stabilization, called the "wonderbra of traumatology".



Out of the Enclouage verroullé (1), the Gamma nail (2), the Supracondylar nail (3) and the Humeral nail (4) were developed.

#### The external fixation (Exfix)

The external fixation created the possibility for bone fixation outside the wound area in open fractures. A first attempt was undertaken in 1847 by Joseph F. Malgaigne (1806-1866, Paris) with his "Claw of Malgaigne", the "griffe métallique" to stabilize open patellar fractures [27-38]

Joseph F. Malgaigne (1806-1866, Paris) developed in 1847 his "Claw of Malgaigne" (griffe métallique) for stabilization of open patellar fractures.



Next in 1897, Clayton Parkhill (1860-1902, Denver) was the first surgeon to develop an external fixator which was usable on diaphyseal bones [16].

The first diaphyseal external fixator of Clayton Parkhill (1897).



But it was again Albin Lambotte who introduced the first high-performance external fixator system, to which he later added a compression system. However, the Lambotte exfix was a quite rigid and hard to applicate device.

Already in 1902, Albin Lambotte developed a prototype (1) of his external fixator (2) and later on an external fixator with compression option.

In 1938 (Geneva), the Swiss surgeon Raoul Hoffmann developed the functional solution with his "fixateur simple élastique". He developed a ball joint system with an extreme suppleness that allowed an easy fracture reduction. (Interestingly is that Raoul Hoffmann is another typical example of the traumatologist – multitasker: as a surgeon, theologian – minister and cabinetmaker) [38].



Raoul Hoffmann (1) modified the rigid external fixator of Lambotte to the "fixateur simple elastique" (2), by the development of the universal ball joint in 1938 (3).

During the last quarter of the 20th century, new types of external fixators were presented such as the compression fixator of De Bastiani (1978) and the cylindrical Ilizarov fixator. The device was already introduced around 1950 by Gavriil Ilizarov (1921-1992, Kurgan) for leg lengthening, but found an indication in traumatology around 1980 in the treatment of septic non-unions [7].



Out of the combination of the Ilizarov fixator (L) and the fixateur simple élastique, the Hoffmann II hybride fixator was developed (R).

Despite the perfection of wound cleaning, wound care and stable external fixator, along with the possibilities of the vascular – and especially the reconstructive surgery, the "enigma of the open fracture" still remains. Non-unions, septic non-unions and major trophic lesions are still observed. Currently there are still – although extremely minimal – indications for immediate or delayed amputation.

"The enigma of the open fracture". For some extreme open fractures – Gustilo IIIC – there are still indications for immediate amputation.



#### The polytrauma care

The Poulton – Gloucester study showed that out of wartime multiple trauma rarely occurred in the Ancien Régime. The patient also rarely reached the hospital, where neither surgeon could provide adequate relief.

In the 19th century, Joseph Malgaigne reported that he included 2368 patients with a fracture at the Hôtel Dieu in Paris in a period of 11 years, of whom only 30 with multiple fractures [38].

During the great wars of the 19th and 20th century obviously a major increase in the number of casualties with multiple injuries was observed, progressively more performing evacuation – and stabilization systems were developed. But in civil society polytrauma remained a rarity.

With the densification of traffic in the 60s of the 20th century, together with the expansion of the heavy industry and the bikers phenomenon, an exponential increase of high-energy trauma is noted.

At the same time also the development of medical emergency teams is seen, going from the hospital to the accident scene to perform the first aid. The aim is bringing the polytraumatized patient as quickly as possible to the hospital, where after proper resuscitation and control of the haemorrhage, final skeletal reconstruction could be started.

Where in the last quarter of the 20th century a fairly aggressive "all-in-one" procedure was chosen, currently a rational "damage control" approach is performed.

## Fracture treatment by arthroplasty

Due to the aging of the population since the second half of the 20th century, there is an exponential increase of the number of osteoporotic fractures. For some of these fractures, particularly the Garden III and IV hip fractures and four-part subcapital shoulder fractures, an immediate partial joint replacement can provide better results.

Arthroplasty as treatment in hip fractures was initiated by Ernest Hey-Groves (1927, Bristol) with his ivory femoral head prosthesis [5] and later by the Judet acrylic prosthesis (Robert and Jean Judet, 1946, Paris) [38].



The ivory Hey-Groves femoral head prosthesis from 1927 (L) and the acryl Judet prosthesis from 1946 (R) for the treatment of femoral neck fractures.

From the fifties onwards, especially the Thompson-Moore hemi-arthroplasty [20 - 14], with its stem fixation in the medullary canal, provided the first adequate solution for osteoporotic femoral neck fractures. However, the problem with the first generation arthroplasties was the insufficient metaphyseal anchoring on the one hand and the acetabular protrusion phenomenon on the other hand.



De Austin Moore hemi-arthroplasty (L) for cementless diaphyseal stemfixation and the Thompson hemiarthroplasty (R) for cemented stem fixation.

The first problem found its solution in the development of the total hip arthroplasty (especially the Charnley-Müller stemmed total hip prosthesis), with its better stem design and a more optimal cement fixation. The second problem was managed with the use of a double cup. This bipolar hip
arthroplasty is currently commonly used in the osteoporotic femoral neck fractures of the 4th age group.



The problem of the protrusio acetabuli by the femoral head hemiarthroplasty, was solved by the bipolar head prosthesis.

## What brings the 21st century?

In the 21st century, an evolution towards the replacement of the metallic implants by bio absorbable fixations, together with a more intensive biological fracture treatment, based on stem cell therapy can be expected. Navigation can also provide a solution to the X-ray radiation exposure for the trauma surgeons.

However, the sword of Damocles over the implant surgery in the 21st century is the increase in the number of nosocomial infections. The question will be whether certain population groups who are potentially contaminated (such as those in the biopharming industry, nursing homes and diabetic patients with foot ulcers) will not need an alternative treatment (Exfix), or will be treated on an alternative location outside the traditional hospital.

#### Conclusion

Globally we can state that fracture fixation has evolved over the centuries from the external splint to the internal stabilization.

The various osteosynthesis systems have gone through a similar evolution, from unstable implant to a rigid – and later an elastic fixation and finally to the biological osteosynthesis (MIS – Mipo). So today the most complex fractures can be stabilized and reconstructed.

The final question is which country introduced the most essential ideas

in the evolution of osteosynthesis? Is this "Little Belgium", created in 1830??? Probably!!! Indeed, With Louis Jean Seutin, with the first "inamovible" cast and the stimulator of early mobilization, Robert Danis, the initiator of the interfragmental compression, and especially Albin Lambotte, the "genius of osteosynthesis", father of the plate osteosynthesis, the external fixation and the intramedullary nailing, this country offered a very important contribution to the evolution of traumatology. So we can clearly state "osteosynthesis is a Belgian product".



Louis-Jean Seutin, Albin Lambotte en Robert Danis, the Belgian pioneers of modern traumatology!

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## Laudatio Manfred Curbach

#### Luc Taerwe

Manfred Curbach was born and grew up in Dortmund where he obtained his Civil Engineering degree at the University of Dortmund in 1982. His doctoral research on "Strength increase of concrete under high lading rates" was performed at the University of Karlsruhe with Prof. Eibl as supervisor and he obtained his PhD degree in 1987 magna cum laude. In 1988 he started as project manager at the engineering company Köhler + Seitz where he became a partner in 1994. Since 2005 he is a partner in Curbach Bösche Ingenieurpartner in Dresden. In August 1994 he was appointed as professor at the TU Dresden and director of the Institute for Concrete Structures. He is involved in many national and international associations. In 1982 he spent a few months at Princeton University with Prof. David Billington, who was awarded the Interfaculty Sarton memorial Chair in 2000. Manfred received several awards and honours among which an honorary doctorate of the TU Kaiserslautern (2011), the German Bridge Design Award (2012) and the Wolfgang-Zerna-Honory Medal of the VDI Society for Construction and Building Technology (2014).

The history of science and, above all, that of building and construction research in the broadest sense, looking at it also from a biographic perspective is a subject that has interested him for a very long time. He states about that:

"As engineers, we do not want to reinvent the wheel. Rather, we need to continue and improve the work of our predecessors. Analysis of past abnormalities, understanding of historical developments, are worthwhile for us to be taken as the cornerstones of the solutions of the future. For me, being a civil engineer in today's world means above all dealing with building materials, computational techniques and construction methods used in the past to identify starting points from where we can look to the future, saving not only material and energy, but also working time."

Manfred Curbach is actually involved in a research project on the history of some of his famous predecessors at the TU Dresden. At the center point is Willy Gehler, being well known for his method to solve frame statics by making use of rotation angles as basic variables, which he published in 1916 as "Rahmenberechnung mittels der Drehwinkel". Also Otto Mohr, who is well known from his famous circle and his analogy, was also a professor at the TU Dresden and a laboratory is still named after him.

At a national level Manfred is involved in the German Society of Construction History. At an international level he initiated the fib Task Group 1.6 "History of concrete structures" of which I am also a member. Every year, the famous "Brückenbau Symposium" is organized at the TU Dresden and last year I was invited to give a lecture on the pioneering work of the late Prof. Gustave Magnel.

Nowadays, one of the major challenges in construction is the preservation of old and historic structures, both buildings and bridges. From this perspective Dresden offers a lot of unique opportunities. After the dramatic bombing of Dresden during Valentine's night in 1945, the historical buildings in the city centre have been gradually reconstructed, and these works still continue until today. Prof. Curbach published on the structural aspects of the dome of the famous Frauenkirche, ship impact on the piers of the historical bridges over the Elbe river and strengthening of reinforced concrete shell structures with textile concrete to name but a few topics.

Historical bridges is the topic of his lecture and one of the bridges he will mention is the Pont de Normandie near Le Havre, designed by Michel Virlogeux, who received the Golden Magnel medal for this project in 1999.

We know each other already for quite a long time but we had more intensive contacts since the comprehensive research project on Textile Concrete started at TU Dresden. I served several times as an external evaluator for the "Sonderforschungsbereich" project, sponsored by DFG, the Deutsche Forschungsgemeinschaft. Manfred coordinated this innovative project in a very dynamic way and thus contributed to unique developments and applications in the field of textile concrete which are recognized at the international level. Since 2013 he is the coordinator of the C<sup>3</sup> Carbon Concrete Composite project, which deals with the substitution of steel, which is a heavy, corrosion-sensitive material with average strength, by a lightweight, enduring and high strength material such as carbon. This change of material leads to a new way to construct, to build and to live. This concept allows to reduce energy consumption and CO<sub>2</sub> emissions during production of our buildings, to protect our valuable resources and to revolutionize concrete construction.

As a recognition of his unique and pioneering research work on the historic aspects of concrete structures and the link with modern strengthening and renovation techniques, the Sarton medal has been bestowed to Prof. Dr. Ing. Manfred Curbach.

# What European history, legendary bridges and the design of the Euro have in common

#### M. Curbach

#### Introduction

Since January 1st of 2002, the euro is the common currency in many countries of the European Union. For the newly introduced euro currency, in addition to coins, having on one side a country specific motif, new notes were created with the same front and back design for all countries. In February 1996, several designers were invited by the European Central Bank, which was then called the European Monetary Institute, to design the new euro notes. The colours to be used and the theme "ages and styles of Europe" were given. Since only seven notes were going to be circulated, images that could be clearly associated with a particular country were prohibited, because it would have made it impossible to take each country into consideration otherwise. It was clear that individuals had little chance to be portrayed on the new euro notes. The competition was won by the Austrian graphic designer Robert Kalina, who worked at the Austrian Central Bank and had previously designed the Austrian currency.

On one side of the euro notes are windows, doors and gates, which symbolize the openness of the new Europe. On the other side – to the delight of bridge builders – are images of bridges that are meant to interconnect the people of Europe. The design of the notes had to ensure that the pictures chosen were not renderings of famous landmarks in any given country. Instead, the architectural styles of seven periods of European history were successfully represented. Classical Antiquity, Romanesque, Gothic, Renaissance, and Baroque periods, along with the Industrial Revolution and

the 20th Century Modernism eras were chosen by the designer.

The design began by scanning bridge pictures, which the designer implemented in graphics that were further modified. The designer had to agree not to disclose the source of his newly created "art" bridges, so no one but Robert Kalina knew the models used on the euro notes. In this way, the templates could be attributed to any bridge.

To identify the sources of the designs one must rely solely on conjecture. If one searches in the Internet, the sources of the designs have been already suggested by some and disputed by others.

Among them is an article by Georg Küffner, published in the Frankfurter Allgemeine Zeitung (FAZ) [1].

Nevertheless, all published articles are only conjectures, which may or may not be wrong.

Within this framework, the bridges presented below are the personal conjectures of the author.

Indeed, they could be wrong as well. They also differ, at least partially, from those presumptions published in the FAZ and in the Internet. The selection is highly subjective. If several bridges were in question, the one that was perhaps the first of its type, or which boasted an exceptional feature, in any way, was chosen. In some instances, it was described along with another alternative that could also fit the rendering.

## Classical Period | 5 € note

Let's start with the 5  $\in$  note and the rendering of a bridge from the Classical Period, Fig. 1.

The bridge structures built by the Greeks were rather low; they were designed to match the shape of the shores or banks and to follow the path of the existing landscape inland. The Greeks really did not master the use of a true arch construction. Rather, they used post and lintel construction to create cantilever structures that resemble the shape opening of an arch, but in reality carry the forces in a distinct manner. An example of this is the Greek voussior arch construction at the Tomb of Mycenea in Greece. The Romans were the first to build big and long bridges. Some of them were



used as paths and roads, or for the special purpose of carrying water. The Romans put an incredible effort into ensuring the supply of their cities with water. If there was a challenge to span valleys and canyons, colossal bridge structures were built. Some of these aqueducts have remained into current times; perhaps the most famous one is the Pont du Gard.

This presumption puts the Pont du Gard as a very close rendering of the bridge that is portrayed on the  $5 \in$  note.

As the only preserved aqueduct with 3 floors and 64 arches, the Pont du Gard is one of the masterpieces of ancient architecture. The canal across this bridge aqueduct supplied water to the city of Nemausus, known today as Nimes. The water came from a spring located 20 km away from Nimes. This spring was located at an altitude that was 17 m higher than that of Nimes. In order to bring the water through the rough terrain down to Nimes, the Romans constructed a 50 km long aqueduct, which had an average gradient of 34 cm per kilometre over its entire length. Incidentally, the spring belonged to a small river called Eure. That reason alone makes it clear that this bridge must be portrayed on the 5 € note. It took 24 to 30 hours to carry the water to Nimes, where every inhabitant was provided with 400 liters of water per day, more than twice the amount of what is consumed today in industrialized countries. The entire bridge was built of limestone, a very soft and brittle stone. Despite the softness of this material, a bridge could be built that lasted for 2000 years – by the way, without any mortar. With the help of about 1,000 workers, it took only 2 to 3 years to be finished [2], Fig. 2.



An unknown Roman architect had built-in some interesting irregularities within the dimensions of the structure comprised of a total of 64 arches. Towards the ends, at the lower tiers. the diameters of the arches are always smaller, varving from 24 m at the largest opening to 15 m at the outside arches. However, in the top row, all openings are equidistant – probably because always the same scaffolding was used - yet all pillars have different widths, Fig. 3.

Robert Kalina was criticized for setting every second pillar of the second tier of arches above the vertices of arches that lay at the tier underneath. But hadn't the

Romans done the same in the third row? We can easily forgive Kalina for the experiment of slightly changing Pont du Gard.

If you look at this bridge, admire the three tiers of arches and consider its age and history, this bridge really deserves to be a model for the  $5 \in$  note.

#### Romanesque Period | 10 € Note

Many assume the Rhône Bridge in Avignon to be the model for the bridge portrayed on the  $10 \in$  note, Fig. 4.

In the 12th century, numerous bridges in France were built by monks under the guidance of the monk Brother Bénoît, later known as the "Order



of the Bridge Builder". It is assumed that this bridge in Avignon was also built by these monks [3]. However, the local legend says otherwise [4]: The shepherd boy Bénézet, skinny and poor, had declared that he could build a bridge, where neither God, the Saints Peter and Paul, nor Charles the Great or anyone else could build one. The bishop of Avignon said: "I will only believe that he can build a stone bridge when I see him moving a rock of limestone in my palace." According to the legend, the shepherd Bénézet could fulfill the challenge of the bishop of Avignon: He dragged a ton-boulder from the episcopal palace to the banks where he had planned to build a bridge across the Rhône. This story of the supernatural powers of the frail shepherd had served its purpose: Everyone was ready to give donations and thus to support the construction of the bridge as an act of charity. No one knows whether Bénézet or the monk Bénoît actually built this bridge.

With an overall length of 920 meters and 22 arches, joined without mortar, with spans from 20 m to 35 m, the masterpieces of ancient bridge construction were surpassed in Avignon. Furthermore, the architect created the longest bridge in the medieval world. In a straight line, it linked the eastern shore with the island of Barthelasse. There, it bent to better withstand extreme spring tides.

Although it had only two more bays than the London Bridge, which was built around the same time, the bridge with its elliptical arches was more elegant and three times longer. Bénézet did not live long enough to see the completion of the works. He was buried in the newly inaugurated bridge



chapel that stood up at the second pillar, Fig. 5.

As of 1233, the bridge became a pilgrimage site for the now declared Saint Bénézet. With the transfer of the papal residence to Avignon in the year 1305 by Pope Clement V, the bridge became a meeting

point for negotiators and diplomats, clergies and princes. Only after the departure of the Popes from Avignon (from 1378), the loosing of its importance and its holiness, and the floods of 1665, when most of the bridge but three of arches were washed away, the Bridge of St. Bénézet became world-famous – by the French folk song "Sur le pont d'Avignon". Today there are four arches with spans between 30.8 m and 33.5 m [5], Fig. 6.

But the Romanesque buildings are usually connected to terms such as massive, defiant, and earthy. However, these descriptions do not precisely fit this bridge, which seems rather slim and light. Thus, it is far ahead for its time, the Romanesque period.

It could also be the stone bridge in Regensburg across the Danube River, which is even older than the bridge in Avignon [6]. This bridge was originally 336 meters long Of the 16 semi-circular arches, 15 still remain. The individual arches have spans from 10 m to about 17 m, while the pillars have widths in between of almost 6 m and 8 m, The relationship between the opening and pillar was about 2 : 1.



#### Gothic Period | 20 € note

The bridge shown on the 20  $\in$  note symbolizes a structure from the Gothic period, Fig. 8.



The pointed arches are clearly recognizable style elements. The model could be the bridge Valentré across the River Lot in Cahors, which was built in the years of 1308-1355. On pictures, towers are visible. They must had to be omitted by the designer, because one could otherwise recognize the bridge immediately, Fig. 9.

At that time, the towers were crucial. Cahors was a rich city, because the southern France moneylenders, known as Cahorsini, were headquartered in Cahors. They had to protect themselves against intruders. Thus, defense



towers with large portcullis were added in 1378.

The arches of the Valentré Bridge, with its Gothic pointed arches, have spans of 16.5 m. In the protruding pillar projection, added to the upstream side of the bridge, there are man-size holes which, together with the smaller opening below, were probably meant to be used for the installation of wooden trusses and therefore as a temporary bridge, Fig 10.



The later one was possibly used as a temporary structure during the very long construction period. The large openings are, in any case, a characteristic of this bridge, and can also be found on the note – although, modified and thus in a poorly – usable manner. There is also a story about this bridge [3]:

Because the work proceeded so slowly, the bridge builder of Cahors had completed a pact with the devil. Shortly before completion of the bridge, the bridge builders had the idea to ask the devil to fetch the water for the last mortar with a large sieve in order to save their souls. When the devil failed, and therefore lost the bet, he took revenge by breaking out a corner of the middle tower every night, so that the stones had to be replaced again during the day. When the architect Paul Gout restored the Valentré bridge in 1879, he heard this legend through the inhabitants of Cahors.

That is how the locals explained the missing piece on the middle tower of the bridge. In order to preserve the old story, Gout commissioned the sculptor Calmon to carve a Satan, who is just about to crack a stone from the masonry, Fig 11. The figure was put where the bridge damage, due to the missing part, was located; over time, people referred to it as the "Devil's Bridge" or the "Satan's Tower".



In France, the story is so famous that a well-made comic about it was made [7], Fig 12.

#### Renaissance Period | 50 € note

We come to the Renaissance and to a bridge which, while following the classical motifs instead of using a circular arc, as it was common in ancient times, has an elliptical arc shape in most openings, Fig. 13.



It is the Pont Neuf in Toulouse, the "New Bridge" from the year 1632, indeed a time within the Renaissance period. The bridge has a total length of 229.76 m and has eight arches with spans from 18.36 m to 32.07 m, Fig 14.



The two smallest arches have a pure circular crosssection; each one of the remaining six arches follow compound curves. The large openings, which carry the floodwater discharge, heavily define the look, and therefore it is worth checking out whether this bridge could still be the role model.

Let's look at the fact that a lot of bricks were used in the bridge. The city of Toulouse had the problem that the closest stone quarries were far away. So, they burned the bricks in Toulouse.

At the time there was not much trust in the use of bricks for bridge construction after all. On the underside of an arc, it can be seen that individual layers made of natural stone had been inserted, which had to be transported from far away, Fig. 15. When taking a closer look at the brick surfaces, one finds that the distrust in the use of bricks is evident. As it can be seen, the mortar was obviously more durable, Fig. 16.



By comparing a front view of the bridge and a magnified image of the  $50 \in$  note, it is clear that the inclined surfaces of the deck at the pillar projections were pulled up along with the underlying pillar projection, which is by no means a problem using a computer. This becomes even clearer when one

takes a drawing [8] of the Pont Neuf Bridge and puts it next to the note. The arch of sandstone, the keystone, the filling of masonry, it all fits perfectly, Fig. 17 a-c.





But a road bridge called Pont Louis-Philippe in Cahors could also be the model for the bridge on the  $50 \in$  note, fig 18. The arch shape is exactly reproduced; only the round pillar projections were turned into triangular ones. The latter could be a quite conceivable disguise introduced by the designer.

#### Baroque Period | 100 € note

On the 100  $\notin$  note, there is a bridge with exceptionally slim, not to say, thin, pillars, when compared to the large span, Fig. 19. What seems to us perhaps normal today was a bold idea during the Baroque period.



Is this model the Black Mountain Bridge in Vienna, as it has been suggested by many? One speaks about it, while it is in Vienna. After all, one might suspect that the note designer had selected a bridge from Vienna, his hometown. However, it was built in 1865 and subsequently demolished in 1905. At the time of the bridge's construction, in 1865, such slender pillars taken in relation to the span length were nothing new. One can also strongly classify a bridge which was built in 1865, as belonging to the Baroque period. To understand its relevance, we have to go back in history a bit.

Almost all Roman bridges had a ratio of 3 : 1 between span and pillar widths.



This was necessary in order to accommodate the arch lateral pressure, thrust from the vault, when adjacent arches had to be built side by side.

The only exception to this rule is the Pont du Gard, in

which the unknown builder of the structure was very brave to choose a ratio of 5 : 1, unusual at this time.

After that, in 1687, the French architect Mansart used, for the first time again, a 5 : 1 ratio to design the bridge Pont Royale. The chief engineer of a similar bridge was Jean-Rodolphe Perronet, who observed that during construction of this bridge a pillar had moved due to the arch outward thrust.

Since then, a span after another had been built. His construction plan of the Pont Neuilly-sur-Seine involved constructing all the spans at the same time, so that the arch thrust of the individual spans would cancel-out each other at the piers, and only at the ends, massive abutments would be required; in this manner, a ratio of 9 : 1 was possible, Fig. 21.



Perronet constructed the long-span compound curve arch out of eleven intermediate segments.

Outward bevels gave the impression of thinner segmental arches, which had their starting points 5 meters above the high point of the compound curves further inside. This deliberate and elegant visual effect was increased by the revolutionary thin pillars, achieving an unusual ratio of 9.3 : 1.

The logical consequence of this approach was, of course, the erection of

scaffoldings over the entire length of the bridge, since all the spans had to be built at the same time, Fig. 22.



The construction of the bridge took two years, and on September 22, 1772, Perronet mounted a large special effect event, as all the bridge timber scaffoldings sank in the river within just a few minutes, Fig. 23.



Despite all the planning and caution that Perronet took, the foundations of the bridge sank slightly after the removal of the scaffolfding. Nevertheless, the bridge was in service for almost two centuries before it was demolished in 1939, despite its historic significance, because it could no longer accommodate the increasing flow of traffic.

An excellent illustration of the individual stages of construction of the Pont Neuilly-sur-Seine, shown as models in 1 : 40 scale, can be seen at the Deutsches Museum in Munich [9].

#### Industrial Revolution Era | 200 € note

The epoch of the 200th € note is the era of industrialization, Fig. 24.



At the time, cast iron was readily available as a new building material for bridges. One of the most beautiful bridges, built in 1814 during the early days



when cast iron was used in bridges, is the Craigellachie Bridge across the small river Spey in Scotland; it is considered the model of the bridge portrayed on the  $200 \in$  note, Fig. 25.

A single supported arch comprised of four ribs between two abutments span-

ning 150 feet, about 50 m, where both the bow and the deck supporting the road are extremely delicate. The deck is comprised of two thin, parallel layers interconnected by latticed girders and radial rods. The thin slab is slightly curved and connected to the steel layer by filigree rods that extend primarily in a radial direction. The overall shape has an intrinsic lightness; the structure's silhouette is made up of steel parts; there are no ornaments or mounted parts. *This extraordinarily intricate design was widely admired and it prompted the poet Robert Southey* to the words, as he was recalling

a remarkable anecdote told to him at the site by a local resident: "As I went along the road by the side of the water," said he, "I could see no bridge: at last I came in sight of something like a spider's web in the air – if this be it, thought I, it will never do! But presently I came upon it, and oh, it is the finest thing that ever was made by God or man!" [10], [11].

At the bridge, there is a sign placed in memory of Thomas Telford, Fig. 26: He belonged to a generation in which one identified oneself, for the first time in history, as a civil engineer.

In 1792, he wrote about an earlier decision: "Feeling in myself a stronger disposition for executing works of importance and magnitude than for details of house architecture I did not hesitate to accept their offer, and from that time directed my attention solely to Civil Engineering." [10], [12]. Thomas Telford had the courage to build an incredibly intricate structure of cast iron. In the road map of Scotland, the bridge is actually labeled



as the Telford Bridge, even though only a pedestrian bridge is in operation. But was it really the Craigellachie Bridge that served as a model?

The filigree rods of the Craigellachie Bridge are nowhere to be seen on the

 $200 \in$  note. Rather, it looks as if the unnamed railway bridge at the south of the city of Cahors could have been the model used.

In 1869, the construction of the railroad reached the town of Cahors. At this time, the bridge at the end of the station of Cahors was built. A total of five layers of steel made up this 213.45 m long bridge. It is clearly evident



from the profile of the steel arches, the vertical bars in between the roadway and bow and cross-frames about halfway between the road surface and arc [13], Fig. 27. This is now the third time that a bridge of Cahors is shown, so the issue is becoming more pressing: where is actually Cahors? Cahors is located in the southwest of France, and it is a small town with some 21,000 inhabitants; the River Lot flows around Cahors like a big U. In this city, we find three bridges, which could all be role models for euro-bridges, Fig. 28:

- The Pont Valentré in the West,
- The Pont Louis-Philippe in the southeast and
- The nameless railway bridge in the south of the city.



## 20th century modernism era | 500 € note

500 € note, one can easily regognize a cable-stayed bridge, Fig. 29.



Since the history of cable-stayed bridges can be traced back to 1784, the bridge shown here is certainly not the first bridge of its kind. More likely, the largest span cable-stayed bridge at its time was used as a model.

The Pont de Normandie in Le Havre has a span length in between the pylons of 856 m, at that time – in 1995 - a world record, and until this day, still a European record. 184 cables with lengths from 95 to 450 m carry the road. The approach slabs, and the first 116 meters of the main span of this roadway are made out of concrete. In the central region, with a length of 624 m, a steel structure image was used to save weight [14], Fig. 30.



The pylons have a height of 214 meters each and a weight of 35,000 tons. That sounds rather safe, when one realizes that the piles, under the pylons,

extend about 60 m far into the subsoil. The entire bridge has a length of about 2 km, or to be exact, 2141 m, and crosses the mouth of the Seine at a height of 60 m. To get to this level, the two approach ramps have a slope of about 10 %, Fig. 31 and 32.

In this note, it is the author's opinion, without a doubt, that this beautiful bridge, the Pont de Normandie, is a model for the bridge portrayed on the 500th  $\notin$  note.



According to Georg Küffner, the author of the FAZ article, it is a pity that the creativity shown in recent years in bridge design is shown only on the 500 € note and not on a more commonly used note, "but so modern bridge aesthetics will probably only rarely admired by ordinary citizens because of widespread pecuniary bottlenecks." [1]

## Closing

Many of the bridges shown are located in France: Pont du Gard near Nimes, Pont Bénézet in Avignon, three different bridges in Cahors, including the famous Pont Valentré, Pont Neuf in Toulouse, Pont Neuilly-sur-Seine in Paris and Pont de Normandie near Le Havre. Is France perhaps the Euroland?

Bridges from other countries were also shown: the Stone Bridge in Regensburg in Germany, the Black Mountain Bridge in Vienna in Austria, and the Craigellachie Bridge in Scotland.

It is a highly subjective selection of possible models, in which the bridges

and their builders are much more important than the country in which they are located.

In any case, it is the bridges in which their builders – some unknown, some famous – have proved great courage by conveying their ideas, each at their period in time.

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# Laudatio Pierre De Clercq

#### José Martins

Tonight I have the honour to introduce professor Pierre De Clercq and will at the same time disclose why the Faculty of Sciences unanimously decided to award the Sarton medal 2015-2016 to him, as originally proposed by the three departments of chemistry.

Let me first highlight a few milestones in his professional career.

He studied chemistry at our university and obtained his PhD in 1973 with professor Maurits Vandewalle as promotor. Following postdoctoral stays at the University of California in Santa Cruz and at the University of Cambridge (UK), he starts his independent career at the State University of Ghent as a researcher at the National Fund for Scientific Research, where he eventually became research director. He joined the regular staff in 1989 and became full professor in 1994.

In his career he has been involved intensely in research, teaching and community service. He is the promotor of 38 doctorates and author and co-author of more than 300 peer reviewed scientific publications. In 2009 he received an award "in recognition of career contributions to vitamin D research". He has been responsible for teaching organic chemistry to numerous students for many years and was, as the chairman of the Education Committee for Chemistry, the main architect of the chemistry programme in the Bachelor's/Master's degree program. His commitment to service within the university was intense, and in particular I want to stress the fact that he was the head of the Department of Organic and Macromolecular Chemistry during a period of ten years, a function I took over in 2012. But eventually, in 2013 he had to retire.

The Sarton medal is awarded to him today in recognition of his efforts to

highlight the historically important and in chemistry very well known figure of Kekulé. Even today, Kekulé is a name that resounds not only in our domain but also far beyond. It is fair to state that Kekulé realised his most important scientific contributions while he was professor at our university, from 1858 to 1867.

You may wonder what the origin is of our laureate's interest in Kekulé. I am pretty certain that he was quite surprised when he was asked to promote the figure of Kekulé at the occasion of the election of the greatest professor in the history of our university. The event was part of a campaign organised by Ghent University and Radio 2 with the aim of promoting the history of our university. Eventually, Kekulé was not elected as the greatest professor (professor Guislain of the Faculty of Medicine was the winner), but the germ had been introduced.

Pierre realised at the time that he was very much ignorant about the professional and human aspects of Kekulé. He was in a way forced to dig into the past and he soon became infected by the Kekulé virus. The incubation period of the infection lasted until 2011, the International Year of Chemistry. At that occasion the university was awarded a Chemical Landmark by the Royal Society of Chemistry (RSC) in recognition of the pioneering work of professor Kekulé in Ghent. The Chemical Landmark Scheme is an initiative recognising sites where the chemical sciences have made a significant contribution to health, wealth or quality of life. The Landmark was delivered to our university during an academic session in the Aula on October 28th of that year. With our laureate functioning as Master of Ceremonies and lecturer, the "Kekulé virus" was definitely activated.

Last year Pierre De Clercq contributed a scientific article in the proceedings of a one-day symposium at the occasion of the 25th anniversary of the History Section of the Royal Flemish Chemical Society, an event that coincided with the anniversary of the discovery of the structure of benzene by Kekulé 150 years ago.

So, with the laureate's increasing interest in the person of Kekulé, his work and his life while staying in Ghent, the Kekulé virus could gratefully benefit from the time that became available since his retirement on October 1, 2013. Eventually, the infection evolved into a real chronical time devouring condition which his wife defined as "chronic Kekulitis".

# Tracing August Kekulé in Ghent (1858-1867)<sup>1</sup>

#### **Pierre De Clercq**

One may wonder whether there exist any connections between George Sarton and August Kekulé, whose stay in Ghent in the second half of the nineteenth century only lasted nine years. Sarton (1884-1956) and Kekulé (1829-1896) were not really contemporaries, Sarton was twelve years old when Kekulé died. There is however a link between both, be it an indirect one, in the person of Jan Gillis (1893-1978).

Professor Gillis was an analytical chemist and co-founder of the Flemish Chemical Society. He had also been dean of the Faculty of Sciences and rector of the institution for a period of four years. When he became pro-rector in 1957, his interests shifted towards the history of science. It is the merit of Gillis that the memory of Kekulé at our university has been kept alive.<sup>2</sup> The August Kekuléstraat in Ghent and a commemorative national stamp edited in 1966 were initiatives of pro-rector Gillis.

The pivotal role of Gillis in the present story is due in the first place to the three essays he wrote for the Royal Flemish Academy in which the figures of August Kekulé (1959)<sup>3</sup>, Leo Baekeland (1965)<sup>4</sup> and George Sarton (1973)<sup>5</sup> are central. The title of Kekulé's essay<sup>3</sup> discloses what Gillis found most striking about his short stay in Ghent as a professor: the history of his appointment and the creation of the first chemical tutorial laboratory in Belgium. The interest of Gillis in Kekulé's stay in Ghent went far beyond the mere interest of a colleague for a person who had been active one hundred years earlier. In one of the numerous letters<sup>6</sup> that Gillis wrote in the context of his research work on Kekulé we note the following sentence: 'C'est là que j'ai appris à le mieux connaître et à l'aimer comme un grand aïeul.'

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Kekulé was born in 1829 in Darmstadt as a descendant of a noble Bohemian family.<sup>7</sup> He studied chemistry in Giessen with the famous Liebig (1803-1873) as mentor and obtained his PhD in 1851. Previously he had spent several months in Paris in the laboratory of Charles Gerhardt (1816-1856). His postdoctoral period includes stays in Chur, Switzerland, and in London, where he worked as an assistant at St. Bartholomew's hospital. One year after leaving London in the autumn of 1855, he obtained his Habilitation in Giessen with the support of Liebig and Bunsen (1811-1899). He became Privatdozent in Heidelberg in March of 1856. In 1858 Kekulé eventually moved to Ghent where he was appointed as full professor.<sup>8</sup>

Kekulé will only stay for nine years in Ghent. In 1867 he accepted a professorship in Bonn and joined the newly erected Chemisches Institut, of which he soon became the director. He had also been rector of the university in Bonn and president of the Gesellschaft Deutscher Chemiker. He was enobled in 1895; his name changed to Kekule von Stadonitz with loss of the French accent.<sup>9</sup> He died shortly after.

The nine years that professor Kekulé spent in Ghent were without any doubt the most fruitful in his career.<sup>10</sup> In the context of the jubilee celebration<sup>11</sup> organised on September 15-16, 1965 by the Division History of Chemistry of the American Chemical Society in Atlantic City (N.J.) the following text appeared: '*The theory of structural organic chemistry as developed in the 19th century may be the most fruitful conceptual scheme in all the history of science. Central to this scheme is the hexagon structure for benzene, proposed by August Kekulé in 1865.*'

Kekulé owes his fame in the first place to benzene, a colorless flammable liquid with carcinogenic properties. Benzene was discovered in 1825 by the Englishman Faraday (1791-1867) who succeeded in its isolation from the remnants in gas cylinders used in London to illuminate the streets. City gas was produced in gas plants, of which Ghent possessed one in that period.<sup>12</sup> As it has a rather pleasant smell, the term aromatic has been introduced for compounds that are chemically related to benzene.

In principle, benzene ought to possess a simple structure. It contains only twelve atoms, six carbon and six hydrogen atoms. Before his arrival in Ghent Kekulé had already formulated two important postulates. The first postulate<sup>13</sup> states that the element carbon is tetravalent, and as such can establish four bonds to monovalent hydrogen to form natural gas or meth-
ane. In the second postulate<sup>14</sup> it is stated that carbon can engage in bond formation not only with hydrogen but also with other elements, including carbon, so as to generate carbon chains in that particular case. The hydrocarbon propane consists of a chain of three carbon atoms, of which the remaining empty valences are connected to hydrogen atoms, eight in total. In the same way, in a linear chain of six carbon atoms no less then fourteen hydrogen atoms are required to saturate the chain. But what to do in the case of benzene, with only six hydrogen atoms available? Kekulé's solution was a cyclic structure, namely a hexagonal disposition of the carbon atoms joined together by alternating single and double bonds.

Whereas we now associate bonds with electron pairs, one should realise that electrons were not known at that time. When Kekulé left Ghent in 1867, Bohr (1885-1962), the founder of the theory on the electron configuration of the elements, was not yet born and Mendelejev (1834-1907) would only present his periodic system in Russia two years later. It is difficult to imagine that in that period even concepts as atom and molecule were not clearly defined.

In this context a first international chemical congress took place in Karlsruhe in September 1860 on the initiative of Kekulé and a few young colleagues with the aim of clarifying basic concepts involved in structural theory. More than 126 participants from twelve different countries attended the symposium. Famous scientists such as Cannizzaro, Dumas, Beilstein, Hoffmann, Bunsen, Erlenmeyer and Mendeljev were present. The proceedings of the conference, including the list of all the participants, are included in the work of Carl Anschütz (1852-1937), the successor of Kekulé in Bonn. He is the author of Kekulé's biography, published in 1929.<sup>15</sup>

The discovery of the structure of benzene was the result of a rather long maturation process, which probably started around 1862, shortly after the publication of the first volume of his reference text book on organic chemistry.<sup>16</sup> One can distinguish several stages in the disclosure of the classical structural formula for benzene. A first time in 1865 in Paris on January 27 during a meeting of the French Academy chaired by Louis Pasteur (1822-1895); Kekulé's contribution was then presented by a colleague, Charles Wurtz (1817-1884).<sup>17</sup> A few months later on May 11 at the meeting of the Royal Belgian Academy in Brussels, Kekulé personally presented his proposal.<sup>18</sup> One year later, the contents of these two communications were included in a full paper of 68 pages in the top journal Annalen der Chemie und Pharmacie.<sup>19</sup>

In the same year 1866 the second volume of his text book of which the third part was devoted to aromatic chemistry, was published.<sup>20</sup> Quite remarkably, in this second volume the classical hexagon structural formulation for benzene with alternating single and double bonds only appears once.<sup>21</sup> Moreover, the formulation is not even the one that chemists are used to, but is rather the image of a mechanical molecular model in which the carbon atoms possess the tetrahedral geometry.<sup>22</sup> Instead of the regular hexagonal representation Kekulé himself used in that period so-called 'sausage formulas'. This mode of structural representation originates from the way he used to draw the structural formulas of chain molecules. The first sausage formula of benzene appeared in 1865.<sup>17</sup>

Kekulé was struggling with the structural problem probably not only from a theoretical-conceptual point of view, but also from a mechanical one. Indeed, the mechanical models that he used in the period 1857-1865 do not allow benzene to be represented in a regular hexagon. One can realise instead two cyclic structures in which the configuration of the six hydrogen atoms is different.<sup>22</sup> These two alternative configurations were first proposed in the 1865 communication in the Belgian Bulletin.<sup>18,23</sup> And whereas Kekulé restrained in using the hexagonal representation of the closed carbon chain for several years, most of his colleagues readily adopted it.

In spite of Kekulé's own doubts, 1865 will be immortalised as the discovery year of the hexagon structure of benzene by Kekulé. And hundred years later this event was extensively celebrated in the scientific community. In the autumn of 1964 the Flemish Chemical Society organised an exhibition at the opening of which pro-rector Gillis gave a lecture.<sup>24</sup> One year later the Gesellschaft Deutscher Chemiker organised in Bonn a symposium on the theme "Kekulé und seine Benzolformel", where Gillis not only gave a lecture, but was also honored in recognition of his contribution to the history of chemistry, in particular his historical research on Kekulé's stay in Ghent.<sup>25</sup> In the same period a 16mm animation short movie was financed by Bayer.<sup>26</sup> The title of the movie, "Herr Kekulé, ich kenne Sie nicht!", was directly related to the fuss that accompanied Kekulé's appointment in Ghent in 1858.

Kekulé's nomination represents a crucial episode in the chemical education at Ghent University. The history of our institution started in 1817 with the creation of four faculties.<sup>27</sup> In those early years the German professor Jean-Charles Hauff (1766-1846) was in charge of teaching chemistry.<sup>28</sup> He

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was however one of the foreign professors who were dismissed in 1830. At the same time the Faculty of Sciences was abolished in Ghent, only to be restored five years later in the state university. At that time, Daniel Mareska (1803-1858), a physician who played a pioneering role in the field of social medicine in the city, was in charge of the chemical instruction. After a long illness Mareska died in March 1858, and Kekulé came on the scene.

The successor of Kekulé is Théodore Swarts (1839-1911), the father of Frédéric Swarts (1866-1940), who became famous as a pioneer in the development of fluorinated organic compounds. Up to 1936 the courses in chemistry included both general inorganic and organic chemistry. From that year on, organic chemistry was taught separately, with professor Firmin Govaert (1902-1993) as the first in a long line of organic chemistry professors. In a way Frédéric Swarts may be considered as a key figure in our story since he had direct ties with four major characters: his father Théodore is the successor of August Kekulé, his sister Céline married Leo Baekeland, and Frédéric Swarts was the promotor of both Jan Gillis and George Sarton.

On October 8, 1858 Kekulé was appointed full professor with a teaching assignment involving both inorganic and organic chemistry. Initially the position was offered to Jean-Servais Stas (1813-1891), a world authority in analytical chemistry. Stas, who was appointed at the Royal Military School in Brussels, did not want to accept the offer, because he had a private laboratory that he did not want to abandon. However, the Minister of Internal Affairs who at the time was responsible for educational matters in the state universities ordered Stas to find a successor, preferably young and famous, with the charge of promoting the experimental side of chemistry.<sup>29</sup> This was necessary because at that time chemistry in Belgium remained more a theoretical discipline, in which the educational process consisted mainly of preparing students for the state exams. The government was aware that the succession of Mareska was offering a unique opportunity to promote chemistry, which importance for the industrial development had become obvious with the dye industry in Germany as a triggering example.

But Stas encountered a lot of resistance in his mission, not least because there was also an internal candidate, François Donny (1791-1872). This person, known in Ghent as an amateur photographer, was previously responsible for the preparations in Mareska's laboratory and had taken over several courses when he became ill. But Stas was well aware that the right person had to be found abroad. He therefore contacted several colleagues who were recognised internationally. Donny was recommended without reserve by the French colleagues of Stas. Very characteristic is the following passage from a letter<sup>30</sup> which Dumas (1800-1884) addressed to Stas: '... *je vous dirais que lorsqu'on a sous la main M. Donny il est singulier qu'on ait besoin de chercher mieux. Vous êtes difficile.*' The German colleagues on the other hand suggested Kekulé who had already a solid reputation in Germany.<sup>31</sup> After having been contacted by Stas, Kekulé soon accepted the offer and moved to Ghent.

The appointment of a full professor at the state university at that time was a political event that was covered by the press.<sup>32</sup> Whereas Kekulé's nomination was supported by liberal newspapers such as le Journal de Gand, the catholic press was very critical. In an editorial of Le Bien Public one may read: '... *Reste à savoir pourquoi M. le ministre de l'intérieur a cru devoir demander un chimiste à l'Allemagne plutôt qu'à la Belgique.*' When the same newspaper expressed doubts about Kekulé's expertise, Le Bien Public answered: '... *n'est il pas ridicule, disons nous, de voir les chimistes et alchimistes du Bien Public lui dire: je ne vous connais pas. Vous ne le connaissez pas; en vérité c'est dommage.*'

The pressure against Kekulé's nomination was intense. Stas was even told that '… *vous pouvez être certain qu'il y aura du bruit lorsque M. Kekulé se présentera*'. The first lecture of Kekulé took place on Tuesday, November 16, ten days after his arrival in Ghent. A month later Kekulé wrote to a German friend that whereas at the start of this lecture some student animation was noticeable, he could close the lecture under general satisfaction of his audience.<sup>33</sup> Kekulé could captivate his students by using experiments to illustrate the theory. He had certainly inherited this faculty from Liebig, but also Hauff, the first professor in chemistry in Ghent, used lecture experimentation as early as in 1826.<sup>34</sup>

In those days a professorship also involved a threefold mission: teaching, research and community service. During his short stay in Ghent Kekulé was elected dean of the Faculty of Sciences for the academic year 1862-1863 and acted twice as secretary.<sup>35</sup> But Kekulé was in the first place a passionate researcher, who regarded a rather heavy teaching load as a burden. In the academic year 1858-1859 the university counted about 300 students of whom 39 were enrolled in the Faculty of Sciences and 71 in the different engineering schools. Students in pharmacy were enrolled in the Faculty of sciences are researched.

ulty of Medicine. All together there were seven different groups attending Kekulé's lectures at the same time.<sup>36</sup> In addition he was also involved in their practical education. In particular he was responsible for the creation of a chemical tuition laboratory.

The teaching laboratory became functional at the start of the academic year 1862-1863.<sup>37</sup> Such a laboratory, in which two kind of activities were organised, was unique in Belgium. The first activity was related to the practical exercises of the regular students. It consisted of a series of thirty, two hours lessons during which the professor carried out a number of experiments to be repeated by the students afterwards. The second activity was intended for PhD students and furthermore for anyone who wished to enhance their chemical knowledge. These persons would be involved in research work, again under the guidance of the professor. They could use the teaching lab every day of the week, from nine to five, provided the room was not occupied by the regular first and second year students.

As a result, Kekulé had to spend more time than he wished in teaching activities, although he could definitely use some more free time during that period. Indeed, in June 1862 August Kekulé married Stéphanie Drory (1842-1863), the 19 years old daughter of George Drory (1802-1879) and Stephania Van Aken (1813-1897).<sup>38</sup> However, Kekulé will not enjoy marriage for a long time. His wife passed away one year later when giving birth to a son, Stefan, on May 3, 1863.<sup>39</sup>

The second part of this essay is devoted to the search of the locations in our institution where professor Kekulé had been active. At that time the central university campus was located in the centre of the city in the immediate vicinity of the Aula. The site was originally designed by the Jesuits in the early part of the seventeenth century.<sup>40</sup> The construction of a church was followed by the collegium where the fathers lived, and eventually by the gymnasium, the school of the Jesuits. The latter two buildings are relevant to our search. Afterwards the site was taken over by the state. In 1817 started a series of renovation works which were carried out by the city architect Louis Roelandt (1786-1864), with a drastic impact on the site. The church was demolished and replaced by the Aula and three wings were added to the original collegium wing so as to form the typical neoclassical square. Nowadays the site is housing the Faculty of Law: the gymnasium wing is part of the Emil Braunschool with entrance in the Universiteitstraat.

Kekulé's laboratories and lecture hall were located on the second floor of the former collegium wing, the western C wing of the Oude School.<sup>41</sup> Nowadays none of these premises are preserved. Indeed, since its conception the second floor has known a turbulent history over a period of 200 years. Whereas in the beginning all university students would follow lectures on the same site, this situation soon became untenable with the steadily increasing number of students. In the second half of the nineteenth century major relocations took place. While the students in medicine were moved to the Bijloke site, a new location was sought to house the Faculty of Sciences and the engineering schools. This issue became a hot topic of debate within the Academic Council of the university, often with lively discussions about chemistry.<sup>42</sup> One of the arguments used to keep the site in the downtown location was: 'Monsieur B... a prétendu que si les émanations des laboratoires de chimie ne sont pas fatales aux professeurs et aux élèves, elles le seront encore moins aux voisins, 'And in this context Kekulé had a bad reputation as one can further read in the proceedings of the same meeting that 'Mr. Kékulé a gaté tous les fruits aux environs de l'université.'

Eventually, both the engineering schools and the different departments within the Faculty of Sciences, except the department of biology, moved to the Institut des Sciences, a novel imposing building which was erected on the Blandijnberg with entrances in the Plateaustraat and the Rozier.

Soon after the move a number of premises with a lingering chemical smell were occupied by pharmacy. Later on, the second floor became largely the domain of the Laboratorium voor Warenkunde of professor Beyaert (1914-2003). This laboratory was part of the High School for Economics and Business Administration, then part of the Faculty of Law. Ground plans of the whole site anno 1963, the period during which pro-rector Gillis was active, can be consulted in the university's archives.<sup>43</sup> Two locations on the second floor deserve further attention.

The first one, located on the second floor of the C wing at the northern end of the main corridor, has been identified by Gillis as the lecture hall of Kekulé.<sup>44</sup> This room does not exist anymore. Indeed, in the course of the renovation of the Braunschool, terminated in 2010, the room was split in order to provide a junction between the original collegium and gymnasium wings. The second relevant location on the ground plan is situated at the other end of the corridor beyond the staircase. This room, which was still in use during Gillis' pe-

riod,<sup>45</sup> used to be the original tuition laboratory built for Kekulé in the early 1860s. As part of the renovation of the Oude School at the Universiteitstraat in the 1970s the part of the building beyond the staircase was completely destroyed. As a result, this historical location has disappeared.

The original lecture hall where professor Kekulé was active was however not located at the northern end of the corridor as suggested by Gillis, but rather at the other end of the corridor next to the staircase. This was a logical setting at the time since the students could directly access either the lecture hall or the tuition laboratory when they had reached the second floor using the staircase.

On the basis of a series of ground plans of the second floor it becomes possible to identify and locate the original lecture hall. One set of four drawings, dated 1861, are related to the transformation works, effected in the context of the installation of the tuition laboratory.<sup>46</sup> One of the drawings shows in great detail the position of the different premises, including the amphitheatre, the chemical laboratories, the professor's office and the different stock rooms. The other three documents contain figures of the equipment, benches, etc. of the tuition laboratory in particular. Another floor plan, dated April 26, 1826 and signed by L. Roelandt,<sup>47</sup> shows the lay-out of the different premises on the second floor. At that time professor Hauff was in charge of chemistry. Comparison of the two floor plans shows that the 1826 one served as the basis for the one drawn in 1861. It is interesting to note that Gillis must have been aware of the existence of at least the early 1826 version since he used an extract of it in his 1959 essay.<sup>48</sup>

As a matter of fact, Kekulé's lecture hall was an amphitheatre. In both documents the drawing of the lecture hall leaves no doubt: the hall is an amphitheatre with circular benches. It is not clear why the original lecture hall has been incorrectly identified by Gillis, since he must have known that the room was in fact an amphitheatre. Indeed, the essay that Gillis wrote on Leo Baekeland<sup>4</sup> which consists of a short biography and a compilation of the abundant correspondence of Baekeland, contains a letter, dated June 27, 1938, addressed to one of his close friends living in Ghent, with the following passage: *'What disgusts me is that somebodys in the Belgian Government have been stupid enough to have destroyed that memorable laboratory of Kekulé, and the amphitheatre were he used to lecture, and attract the finest students from the whole world, who became his disciples. It pains me to know that these destroyers have torn up those old circular*  wooden benches on which you and I learned our chemistry when we were students. I call it disgusting vandalism.'

Later on, when the chemistry department moved to the Institut des Sciences and the amphitheatre was dismantled, the amphitheatre space received a different function. It must be a matter of coincidence that nowadays a lecture hall, de Rode Zaal, again occupies the same space on the second floor next to the staircase.

The passage mentioning Baekeland's disappointment about the fate of Kekulé's floor was included in a letter<sup>6</sup> that Gillis addressed to the rector a few years before his death with the aim of convincing him to save the original bench at which Kekulé had worked while doing research in Ghent.<sup>49</sup> In Kekulé's biography Anschütz mentions an interview<sup>50</sup> with Carl Glaser (1841-1935), at the time Kekulé's private assistant and later director of BASF: 'Das Genter Universitätslaboratorium befand sich in der dritten Etage des Universitätsgebäudes. Das Privatlaboratorium lag neben dem Auditorium und hatte, meiner Erinnerung nach, fünf Arbeitstiche. Ich hatte meinen Platz neben dem des Chefs, der während der Arbeit immer laut dachte und mit den in Privatlaboratorium Arbeitenden die Problemen erörterte, die ihn beschäftigten.'

Kekulé's workbench has also known a tumultuous history. Its impressive dimensions correspond well with those of the bench drawn on the 1861 floor plan.<sup>46</sup> Kekulé's successors were well aware of the historical value of the piece of furniture. Despite its dimensions it was moved to the Institut des Sciences at the end of the nineteenth century. Later on the bench was part of several exhibitions and was even exposed in the science pavilion at the 1958 World Fair in Brussels. Yet, as Gillis describes in his letter, afterwards the bench was dismantled and stored, first in a cellar under the Aula, and eventually in a garage next to the Museum of the History of Sciences. This museum, founded in 1946, moved to the Korte Meer in the centre of the city in 1965, and Gillis' emotional plea to restore the historical piece of furniture so that it could find at last a dignified location was responded to, for eventually the bench was moved into the museum. Unfortunately, due to its dimensions it had to be cut into two pieces in order to reach its location in the museum. Nowadays, the restored bench rests in the Museum for the History of Sciences located at the campus Sterre.

At the occasion of the International Year of Chemistry 2011 a Chemical

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Landmark was awarded by the Royal Society of Chemistry to August Kekulé in recognition of his pioneering work at Ghent University. With the former collegium wing in the Oude School as appropriate hosting location, there will at last be one item reminding us of Kekulé's stay in Ghent.

### **References and Notes**

- 1. This essay is a shortened version of the lecture 'In het spoor van Kekulé te Gent (1858-1867)' delivered at the occasion of the receipt of the Sarton medal on March 24, 2016. I wish to express my appreciation to my chemistry colleagues who took the Sarton initiative, and in particular to professor José Martins, my proximus, to the members of the Council of the Faculty of Sciences, who recommended me for the medal, and in particular to professor Herwig Dejonghe, the dean of the faculty, and to the members of the Sarton committee and professor Robert Rubens.
- For references related to Kekulé's stay in Ghent, see: (a) Gillis J. Un grand savant étranger en Belgique: August Kekulé. Industrie Chimique Belge 1960; 919-936. (b) Gillis J, translated by Oesper R. Kekulé's life at Ghent (1858-1867). J Chem Educ 1961; 38: 118-122. (c) Gillis J. August Kekulé in België (1858-1867). Mededelingen van de Vlaamse Chemische Vereniging 1966; 28: 53-65. (d) Gillis J. Auguste Kekulé et son oeuvre réalisée à Gand de 1858 à 1867. Mémoires de l'Académie Royale de Belgique, Classe des Sciences 1966 ; XXX-VIII, fasc. 1: 1-38. (e) Collumbien H. Kekulé te Gent (1858-1867). Ghendtsche Tydinghen 1983; 12: 317-331. (f) Lox F. August Kekulé, nieuwkomer te Gent. Tijdschrift voor Industriële Cultuur 1992; 10: 9-12.
- 3. Gillis J. Kekulé te Gent (1858-1867): de geschiedenis van de benoeming van August Kekulé te Gent en de oprichting van het eerste onderrichtslaboratorium voor scheikunde in België. Brussel: Koninklijke Vlaamse Academie voor Wetenschappen, Letteren en Schone Kunsten van België; 1959. 101 p. In the series Verhandelingen van de Koninklijke Vlaamse Academie voor Wetenschappen, Letteren en Schone Kunsten van België. Klasse der Wetenschappen; 62.

- Gillis J. Leo Hendrik Baekeland: verzamelde oorspronkelijke documenten. Brussel: Koninklijke Vlaamse Academie voor Wetenschappen, Letteren en Schone Kunsten van België; 1965. 139 p.
- Gillis J. Paul Mansion en George Sarton. Brussel: Paleis der Academiën; 1973. 21 p. In the series Mededelingen van de Koninklijke Vlaamse Academie voor Wetenschappen, Letteren en Schone Kunsten van België. Klasse der Wetenschappen; 35,2.
- 6. In the library of the Museum for the History of Sciences of Ghent University (Sterre campus, Krijgslaan 281, 9000 Gent) are kept various documents, such as reprints of local publications, the correspondence of Gillis in relation to his research work on Kekulé's stay, photos, etc.
- Bill MS. Kekulé's Czech Ancestry. Chemistry and Industry 1965; 1455-1456. See also: Jennen J. De Stamboom van Friedrich August Kekule von Stradonitz. Mededelingen van de Vlaamse Chemische Vereniging 1966; 28: 92-93.
- (a) Gillis J. Honderd jaar geleden werd August Kekulé Professor te Gent (1858-1867). De Brug 1958; II: 65-73. (b) Gillis J. August Kekulé honderd jaar geleden benoemd tot hoogleraar te Gent. Chemisch Weekblad 1958; 54: 365-367. (c) Gillis J. De August Kekulé-tentoonstelling. De Brug 1959; III: 34-37.
- 9. Wotiz J, Rudofsky S. Kekulé or Kekule? Ambix 1983; 133-136.
- 10. Swarts F. Auguste Kekulé von Stradonitz. Liber Memorialis Université de Gand 1913; II: 151-161.
- 11. Benfey OT. Kekulé centennial. Washington (D.C.): American Chemical Society; 1966. 198 p. In the series Advances in Chemistry; 61.
- 12. The first gas plant was erected in the late 1920s by Louis Roelandt, who at the same time was the city architect. The plant was located in the Kleine Huidevettershoek at the Waalse Krook.
- Kekulé A. Ueber die s. g. gepaarten Verbindungen und die Theorie der mehratomigen Radicale. Annalen der Chemie und Pharmacie 1857; 104: 129-150.

- 14. Kekulé A. Ueber die Constitution und die Metamorphosen der chemischen Verbindungen und über die chemische Natur des Kohlenstoffs. Annalen der Chemie und Pharmacie 1858; 106: 129-159.
- Anschütz R. August Kekulé: Leben und Wirken (Band I), Abhandlungen, Berichte, Kritiken, Artikel, Reden (Band II). Berlin: Verlag Chemie; 1929.
- 16. Kekulé A, Professor der Chemie an der Statsuniversität zu Gent. Lehrbuch der Organische Chemie oder der Chemie der Kohlenstoffverbindungen (Erster Band). Erlangen: Ferdinand Emke; 1861.
- 17. Kekulé A. Sur la constitution des substances aromatiques. Bulletin de la Société Chimique de Paris 1865; 3: 98-110.
- Kekulé A. Note sur quelques produits de substitution de la benzine, Bulletin de l'Académie Royale des Sciences 1865; 34: 551-563.
- 19. Kekulé A. Untersuchungen über Aromatische Verbindungen. Annalen der Chemie und Pharmacie 1866; 137: 129-196.
- Kekulé A, Professor der Chemie an der Statsuniversität zu Gent. Lehrbuch der Organische Chemie oder der Chemie der Kohlenstoffverbindungen (Zweiter Band). Erlangen: Ferdinand Emke; 1866. The third part, including p. 493-744, is devoted to aromatic chemistry.
- 21. See page 496 in reference 20.
- 22. This item of historical interest is exhibited in the Museum for the History of Sciences, Ghent University.
- 23. This paper is however rarely referred to, even not by Kekulé himself, see e.g. reference 13.
- 24. The scientific-historical Kekulé-exhibition took place in the exhibition hall of the Kunsthistorisch Instituut. Two lectures were given at the opening on November 22, 1964 by J. Gillis and H. Viehe (Union Carbide – European Research Associates, Brussels).
- 25. The Kekulé-Ferier were held on September 13-18, 1965. Gillis was awarded a Gmelin-Beilstein penning (6.000 DM) and the university received a painting representing Kekulé in 1890.

- 26. The 16mm movie of 215 meters length was directed by Robert Menegoz and Wolfgang Urchs and financed by Bayer upon request of the Gesellschaft Deutscher Chemiker. On December 5, 1966 a copy (nr. 7) of the movie was given to the university and kept in custody by professor J. Quintyn, the director of the Museum for the History of Sciences.
- 27. Langendries E, Simon-Van der Meersch AM. 175 jaar Universiteit Gent Ghent University. Stichting Mens en Kultuur; 1992. 336 p.
- Deelstra H. Het scheikundig onderwijs en onderzoek te Gent voor de komst van A. Kekulé in 1858. Tsch Gesch GnK Natuurw Wisk Techn 1979; 2: 110-117.
- 29. When Kekulé arrived in Ghent the Belgian Minister of Internal Affairs was the liberal Charles Rogier and the administrator-inspector of the university Philippe de Rote.
- 30. See p. 14 in the Kekulé-essay of reference 3.
- 31. Limpricht, professor at the university of Göttingen, was recommended by Wöhler and was offered the position first but he refused for financial reasons.
- 32. University archives, see: fonds van de beheerder-inspecteur, 4A2/4, box 17 (200b). See also p. 26-28 in the Kekulé-essay of reference 3.
- 33. The letter addressed to his friend Weltzien, dated December 4, 1858 also describes the lamentable situation of the laboratories at the time Kekulé arrived in Ghent.
- 34. See correspondence between Hauff and Roelandt.
- 35. In the academic years 1860-1861 and 1865-1866. See the Wegwyzer der Stad Gent en der Provincie Oost-Vlaanderen in the archives of the city, De Zwarte Doos, Gentbrugge.
- 36. Kekulé was lecturing every week of the academic year on Tuesday, Thursday and Saturday from 10:00 to 11:30 a.m.
- 37. The reglementation of the laboratory was worked out by Kekulé and approved by the council of the faculty in November 1861 and finalised as official document in January 1862.

- 38. At the time Kekulé arrived in Ghent George Drory was the general inspector-administrator of the Imperial Continental Gas Association responsible for the street illumination in the city.
- 39. Stefan Kekule von Stradonitz became famous in Germany in the field of genealogy; he introduced the so-called numbers of Kekulé used to develop family trees.
- Brocken H, Langendries E, Vleesschouwers-Van Melkebeek M. Van Jezuïetenklooster tot Rechtsfaculteit. Rijksuniversiteit Gent: Bibliotheek Privaatrecht; 1988. 30 p.
- 41. See figure 52 in the Kekulé-essay of reference 3.
- 42. Archives of the university. ARUG 281, Notulen van de academieraad, 21 mei 1880.
- 43. Archives of the university. Plan 06.00. ARUG 31 11 1963.
- 44. See figures 54 and 55 in the Kekulé-essay of reference 3.
- 45. See figure 56 in the Kekulé-essay of reference 3.
- Cosemans A, De Bock-Doehaard R. Laboratoire de chimie, Tableau et plans 1861. Enseignement supérieur 1988, nr. 649. State Archives of Belgium, National Archives Brussels.
- 47. University Library, BIB. ARCH. 007343.
- 48. See figure 50 in the Kekulé-essay of reference 3.
- 49. See figure 57 in the Kekulé-essay of reference 3.
- 50. See reference 15 (Band I), p. 272.

## Laudatio Zeynep Çelik

#### Johan Lagae

Tonight, just as we celebrate Zeynep Celik, Distinguished Professor of Architecture in the College of Architecture and Design at the New Jersey Institute of Technology, as a recipient of the Sarton Medal 2014-2015, Brussels and Paris are cities "under siege", due to the horrific attacks that shook up the capital of France on November 13<sup>th</sup>, 2015. This rather unsettling context gives a particular depth to tonight's event, as the work of Professor Celik in the field of architectural history holds important lessons that can help us gain a better understanding of the complexities resulting from a globalizing world. Indeed, from the very beginning of her academic career, professor Celik has been discussing how architecture and urbanism offer powerful tools to rethink political, economic, cultural and social relationships between the so-called "West" and "non-West", or, to put it differently, between the so-called "First World" and "Third World", demonstrating all along how complex cultural intersections throughout the nineteenth and twentieth centuries render these categories obsolete as tools for critical analysis. "Regardless of where and how it originated", she already wrote in a key text of 1998, "it is essential to understand modernism as a universal phenomenon in the 20<sup>th</sup> century and not as something that belongs solely to the 'West'".<sup>1</sup> The work of professor Celik invites architectural historians to shift the geographic gaze of their discipline as well as dismantle the Eurocentric perspective that still pervades large part of the historiography. In doing so, professor Celik continued and extended the approach of architectural historian Spiro Kostof, her PhD supervisor, from whom she also

<sup>&</sup>lt;sup>1</sup> Zeynep Çelik, 'Cultural Intersections: Re-visioning Architecture and the City in the Twentieth Century', in Russell Ferguson (ed.), *At the End of the Century. One hundred Years of Architecture*, Los Angeles/New York: The Museum of Contemporary Art/Harry N. Abrams Inc. Publishers, 1998, 190-227.

borrowed a fascination for what can be termed the "urban process", which Kostof defined as "that intriguing conflation of social, political, technical and artistic forces that generates a city's form".<sup>2</sup>

After being trained as an architect at Istanbul Technical University, Zevnep Celik earned her PhD degree at the University of California, Berkeley with an innovative study of the nineteenth century urban development of Istanbul. Published in 1986 under the title The Remaking of Istanbul: Portrait of an Ottoman City in the Nineteenth Century, it focused on the perspective and agency of local actors, thus introducing a line of inquiry that also underscores her following publications, Displaying the Orient: Architecture of Islam at Nineteenth Century World's Fairs (1992) and Urban Forms and Colonial Confrontations: Algiers under French Rule (1997). The latter book immediately became a reference text for anyone interested in colonial architecture and urban form, and how these are intertwined with political, cultural and gender issues. Bringing postcolonial theory into architectural historiography already in the early 1990s, professor Celik played a pioneering role in re-assessing some of the canonical projects and figures of nineteenth and twentieth architectural history. In this respect, her groundbreaking 1992 article entitled "Le Corbusier, Orientalism, Colonialism", in which she critically unpacks the ideological underpinnings behind the Plan Obus, Le Corbusier's famous urban project for the city of Algiers of the 1930s, remains a key text and a stimulating read even twenty years after publication.<sup>3</sup>

Yet, professor Çelik succeeded in steering clear from what Rasheed Araeen already in 2000 tellingly called the "tyranny of postcolonial theory".<sup>4</sup> Firmly embedded in reflections on (cultural) theory, her writing of architectural history is exemplary in the way it engages in creative and in-depth investigations of the wide variety of sources that scholars have at their disposal: other than just paying close attention to the material remains of buildings and urban landscapes, which might have changed considerably over time, her work draws on archival documents, building manuals, bureaucratic reports, scientific publications as well as on popular media and all kinds of visual material: urban maps, architectural drawings, and, in particular,

<sup>&</sup>lt;sup>2</sup> The importance of the work of Spiro Kostof and his notion of the 'urban process' in particular, is articulated in Zeynep Çelik, Diane Favro & Richard Ingersoll (eds.), *Streets. Critical Perspectives on Public Space*, Berkeley: University of California Press, 1994.

<sup>&</sup>lt;sup>3</sup> Zeynep Çelik, 'Le Corbusier, Orientalism, Colonialism', Assemblage, 17/1992, 58-77.

<sup>&</sup>lt;sup>4</sup> Rasheed Araeen, 'A New Beginning: Beyond Postcolonial Cultural Theory and Identity Politics', *Third Text*, 50/2000, 3-20.

photographs. Her book *Empire, Architecture, and the City: French-Ottoman Encounters, 1830-1914* offers the reader a glimpse of the adventurous trajectory of a scholar working her way through an enormous bulk of material in both French and Ottoman archives, and confronting the information collected with fieldwork experiences in many of the cities discussed. Published in 2008 and winner of the Society of Architectural Historians Spiro Kostof Book Award in 2010, this book also set new grounds by drawing attention to the margins of imperial territories, a long-overlooked theme that is now being picked up by a growing number of (young) researchers.

Apart from being an outstanding scholar in the field of architectural history, Zeynep Çelik has also demonstrated a keen interest in the teaching of this discipline. Having taught it for many decades, she launched an important reflection on the theme in 2002-2003 as the editor-in-chief of the prestigious *Journal of the Society of Architectural Historians*, by commissioning a global inquiry of how architectural history was being taught in various contexts, from Europe to Japan, from Russia to Asia, from Latin America to Africa.<sup>5</sup> This remarkable editorial project addressed two fundamental challenges that remain relevant for the teaching of architectural history today: How to overcome the division between "Western" and "non-Western topics"? And how to deal with the often uncomfortable in-between space that architectural history as an academic discipline occupies in the practice-based curriculum of architecture schools?

Over the last years, Zeynep Çelik has also made an effort to reach out to audiences outside of academe by (co-)curating a number of groundbreaking exhibitions: *Walls of Algiers* (Los Angeles, 2009); *Scramble for the Past: A Story of Archaeology in Ottoman Empire, 1753-1914* (Istanbul, 2011); and, most recently, *Camera Ottomana. Photography and Moderni-ty in the Ottoman Empire 1840-1914* (Istanbul, 2015). Exemplary in their interdisciplinary scope, these exhibitions also testify to her remarkable capacity to engage with the multilayered nature of photographs and develop novel insights on the often neglected "mundane" nature of colonial and imperial modernity.

In short, professor Zeynep Çelik has made a major contribution to dismantle the Eurocentric perspective of the architectural historiography of the

<sup>&</sup>lt;sup>5</sup> Zeynep Çelik (ed.), 'Teaching the History of Architecture. A Global Inquiry', *Journal of the Society of Architectural Historians*, vol. 61, 3/2002, 333-396 (part I); vol. 61, 4/2002, 509-558 (part II); vol. 62, 1/2003, 75-124 (part III).

nineteenth and twentieth centuries, thereby deconstructing biased notions such as those of the "West" and the "non-West" via narratives of complex multidirectional patterns of influence, communication and transfers of expertise. Dear Zeynep, by granting you the Sarton medal, we want to pay tribute to a prominent and engaged scholar whose efforts to write a more inclusive history of architecture and urban form offer a continuous source of inspiration for many of us, but not only: your work also gives us ample food for thought as we try to understand and come to terms with the turbulent times that we, as citizens of a globalizing world, are currently living.

# Archaeology and Ethnography

### Zeynep Çelik

This lecture will examine several topics in the history of archaeology, which have been overlooked by scholars until recently. My focus is the Middle East in the late nineteenth-early twentieth century, namely the lands included within the borders of the late Ottoman Empire. The issues I will raise are not isolated and innocent details within the archaeological discourse. They are packed with political meanings, they reflect imperial power struggles and the ideological mindsets of the time, and they bear tremendous consequences that extend to the present day.

The history of archaeology has commonly been told through heroes: learned and scientific-minded Western men who undertook difficult travels to primitive places, where they "discovered" antique treasures, not understood and appreciated by local peoples. Nonetheless, the "science" of archaeology was not particularly scientific, especially in the mid-nineteenth century, and produced fanciful scenes such as the "Palaces of Nimrud" reconstructed (or shall I say imagined?) by Austen Henry Layard and drawn by James Fergusson (from the immensely popular book, *The Monuments of Nineveh*, 1853). I could cite many such examples, which are still accepted as truthful representations.

Meanwhile, a careful look at the ignorant "natives" deemed so unappreciative of the past may allow for more complicated arguments. One case study, Palmyra, will hopefully open a perspective on what Yannis Hamilakis coined as "indigenous archaeologies."<sup>1</sup>

Describing the ruins of Palmyra (in Syria) in the 1780s, Constantin-François Volnay noted in the courtyard of the Temple of Baal (Temple of the Sun) a "spectacle" which he considered "even more interesting [than the temple] for a philosopher": "in these sacred ruins [showing] the magnificence of a powerful and refined people, there are about thirty mud huts, where as many peasant families live in misery ... All the industry of these Arabs depends on cultivating a few olive trees, and a little wheat that they need for living; all their richness has been reduced to a few goats and a few sheep which they graze in the desert."<sup>2</sup>

The glory of the past civilization, associated with the foundations of European civilization, and the misery of the current village, inhabited by backward people, presented a powerful dichotomy. In the following decades, other European visitors repeated Volnay's observations and photographers documented the site, exposing a rather picturesque general view. The overall layout adhered to an order, with some straight streets (the main streets of the village). The awareness and appreciation of the unique setting in which the peasants placed their village can be glimpsed in the axial relationship of one street (qualified as "a mean street" by a traveler in 1906) to the entrance of the temple, but also in the decision to remain on the lower level, likely stemming from the desire not to intrude with the monumentality of the ruins. Many of the houses ("more like wasps' nests than any other thing" according to the same traveler) have walled gardens and decorative details.<sup>3</sup> Examining these images against the background of travelers' observations unravels a village which is proud of its location, its connection to history, and which is able to reach a harmony between the forms of the past and its own aesthetic traditions.

In an argument that is very much alive today, European scholars insisted that the historic treasures had nothing to do with the cultures and the societies where they stood, but belonged to the Western civilization. The scramble of antiquities that accompanied this line of thought gave way to the transportation of many important pieces to European museums, with its most spectacular moment in the Elgin marbles, whose on-going saga you know well. There are, of course, innumerable other instances, ranging from the Venus de Milo (in the Louvre) to the Temple of Zeus (in the Pergamon Museum in Berlin), each instance pointing to the urge to link modern nations with historic keystones.

It is in reaction to the European interest that the Ottoman state began to own up the antiquities in its extended territories and set forth the principles for an all-encompassing policy. A document from 1868 expressed the shifting Ottoman vision: "It is known to all that there are more antiquities held in the Ottoman Domains than in other lands; and the fact that the museums of Europe are filled and decorated with antiquities generally taken from here is evident proof of this argument. In order to benefit from the useful and valuable knowledge that antiquities have given as a gift to human history, for a long time the civilized states have been gradually correcting their shortcomings by opening museums, [and] it is clear that it should not be acceptable that we should still not have a museum, and that if this [state of affairs] is allowed to continue any longer, it is evident that those places where it is hoped that antiquities will be found and that have not yet been searched will also be excavated and all the valuable, important, and rare objects that they contain will gradually be extracted and transported away."<sup>4</sup>

With this declaration the Ottoman Empire took a decisive step toward the drafting of laws that regulated the excavation and collection of antiquities and became a major actor in the field of archaeology. A series of laws, passed in 1874, 1884, and 1906 increasingly exerted control over the work of foreign archaeologists and put them under the strict scrutiny of the Ottoman authorities. The laws first restricted, then entirely banned the exportation of antiquities – a situation that understandably caused great unhappiness in the European and American archaeological community.

The main protagonist in all this activity was Osman Hamdi Bey, an intellectual and an artist with a twist on Orientalist painting. Osman Hamdi is a vast topic in himself and a great deal of work has been done on him, especially during the past two decades. His art is debated with passion and his paintings are worth fortunes. I feel I should open a parenthesis here to say a few words on Osman Hamdi's art, in reference to two of his paintings. The first, a harem scene, conveys his utilization of the genre, as well as his "corrections" to it in order to convey a different message on Ottoman society [in this case he makes a commentary on women of the harem by portraying them as respectable human beings, fully clothed and engaged in household chores, as opposed to the typical sex slaves of artists such as Jean-Léon Gérôme]. He thus "speaks back" to the Oriental school by using its own language. In the second work, he does the opposite, by Orientalizing an archaeological site. The site is Nippur (in Mesopotamia – I will come back to Nippur); the painting was done from a photograph, literally duplicating it. Osman Hamdi dotted the image with color, emphasizing its picturesque quality by highlighting the human figures, who are the workers in the photograph. Yet, the workers are hardly working in the Ottoman artist's canvas. In the background, a file of men seem to suggest labor, but those in the foreground are sitting, squatting, watching – and reiterating the popular concept of the "lazy Arab" so prevalent in the discourse of the time.

Under the leadership of Osman Hamdi, who served as the Director of the Imperial Museum, Ottomans also started to carry out their own excavations, most notably in Sidon (Lebanon) and Nemrud Dağı (southeastern Anatolia). Their work methods were not any different than their Western colleagues. Furthermore, Ottoman archaeologists shared the overall visions of their foreign colleagues in their perceptions of local people as ignorant, irrational, and child-like "others," thereby doing away with the Eastern-Western dichotomy. A widely reproduced photograph of Osman Hamdi in Nemrud Dağı epitomizes this position, with the archaeologist carefully clearing the antiquities, the worker behind him reduced to a static, primitive sculpture of sorts. Other photographs taken by Hamdi Bey underline the "otherness" paradigm in a semi-ethnographic documentary mood.

The famous sarcophagi found in Sidon (Lebanon) created the impetus to build a new and modern museum building in 1891 in Istanbul across from the fifteenth-century kiosk (Çinili Köşk, ot the Tiled Kiosk) used to house the antiquities until then. The sarcophagi, especially the one wrongly attributed to Alexander the Great, attracted a great of international attention, facilitated by a scholarly publication, titled *Une nécropole royale à Sidon: Fouilles de Hamdy Bey* in 1892. The well-preserved colors of the sarcophagus shifted the on-going debates on polychromy in ancient Greek art. If the statues of kings in Nemrud Dağı were too huge to bring to the Ottoman capital, the museum was filled with pieces from the extensive imperial territories, and had to be enlarged twice, turning from a linear structure, into a U-shaped one with two wings by 1908.

The appropriation of antiquities did not remain on the official level and penetrated late Ottoman culture in many ways. We observe it in literature, for example, in a romantic novella by Ali Kemal, titled *Çölde bir Sergüzeşt (An Adventure in the Desert)*, published in 1894. Ali Kemal uses the ruins in Palmyra metaphorically as an emotional and psychological backdrop for the exploration of the inner world of its protagonist, a young woman from Istanbul. A painting by an army officer Ahmed Emin, titled *Ruins of* 

*Baalbek*, conveys the fascination of the Ottoman artist with the ruins. In one striking case, antiquity was revived visually to exorcise perhaps the most tragic episode in late Ottoman history: the persecution of Armenians. Zabelle Boyajian presents Armenia during idealized and peaceful times in paintings made to illustrate *Armenian Legends and Poems* (1916). For this purpose, she uses details borrowed from newly excavated Assyrian and Babylonian sites, including Assyrian artworks depicting ancient Urartu, which was then beginning to be identified with an Armenian past. Here, an Armenian artist, born in the Ottoman city of Diyarbekir in southeastern Anatolia is citing antiquity as a mythic golden age.

Up until this point, I talked about some new questions in the historiography of archaeology we addressed in a recent book I edited with Zainab Bahrani and Edhem Eldem. The book is titled *Scramble for the Past: A Story of Archaeology in the Ottoman Empire, 1753-1914*, the first date marking the foundation of the British Museum, the second the foundation of the Museum of Islamic Art in Istanbul. While we believe that we opened up the field radically, we also realize how incomplete the picture still is, and how much more serious research needs to be done to understand the intricacies of the topic. The remaining part of my presentation is drawn from my forthcoming book, *About Antiquities: Politics of Archaeology in the Ottoman Empire* (Austin: University of Texas Press, 2016), which that attempts to expand the field further.

A chapter that has been conspicuously absent from histories of archaeology is the landscape of labor. Archaeological work always depended on a large labor force, drawn from local populations and that could reach seasonally hundreds of workers every day. The relationship between the archaeologists and fieldworkers was indispensable and intimate, even though history only talks about archaeologists. Yet, archaeologists themselves conveyed much information on their relationships with the "natives" and mundane quotidian events on excavation sites. From Austen Henry Layard to Hormutz Rassam to John Purnett Peters and Osman Hamdi Bey, they mixed the accounts of their work with ethnographic and anthropological data, mostly in anecdotal, but sometimes in a semi-scholarly manner. Read "against the grain" of their imperial and Orientalist mindsets, these accounts help envision a social history of excavations, hopefully restoring some overdue recognition to the multitude of people ever-present in the documents – textually and visually. In photograph after photograph, laborers appear carrying out their tasks as individuals and in groups. Often the scenes give us the dynamics of the relationships on the sites. A turn-of-the-century frame from Babylon displays the plurality of the characters involved in the operation: three Europeans ("a committee of German scientists" – as the caption says), an Ottoman officer, and workers. (Figure 1)



Figure 1. Babylon View of the excavation site showing the committee of German scientists in charge of the operation. (Istanbul University Central Library, Abdülhamid Albums 90473)

I should perhaps give some background to the increasing Ottoman supervision. Commonly, from the 1880s on, if permanent inspectors could not be sent to a site, the directors of education (maarif müdürleri), the highest officers of the Ministry of Education in the provinces, were held responsible for keeping an eye on the activities of foreigners and reporting to the Ministry. However, as these officers' headquarters were away from the excavation sites, they could not always successfully carry out their duty. Consequently, the net was cast much wider and by 1900, civil service personnel (memurin-i mülkiye), such as governors (mutasarrif) and district head officials (kaymakam), as well as high school principals (mekatib-i iddivve müdürleri) in larger settlements, middle school teachers (rüsdivve *mualimleri*) in smaller towns, directors of sub-districts (*nahive müdirleri*), and police and gendarmerie officers, were all held responsible for controlling foreign archaeological activity.<sup>5</sup> Hence, by the end of the century, the social dynamics of archaeology had become intricate in its grouping: foreign archaeologists, Ottoman administrators, and local laborers, each keeping a close eye on the others for different reasons. The photograph testifies well to this multipartite structure. Meanwhile, it also features technology in the form of rail lines. The workers push the carts under the eyes of overseers, the distance between the carts showing the serial and efficient organization and evoking a factory-like production. Much more is happening in the background.

A scientific and neutral-looking section drawing from Osman Hamdi Bey's Sidon excavation metamorphoses into a story about labor upon some reflection. The drawing shows one sarcophagus being pulled on rails out of a low and narrow cave. The delicate nature of the work called for slow and careful work. We can thus easily image how the workers, photographed at the mouth of the cave in a moment of triumph, had spent long hours in the heat and the dark in uncomfortable postures.

The first director of the Metropolitan Museum of Art, Luigi Palma Di Cesnola's account of digs in wells 40 to 50 ft underground in Golgoi (Cyprus) from 1878 is accompanied by a chilling image, which triggers the viewer to empathize with the horror of working in this pit for fifteen hours (as stated by the archaeologist), as well as the fatigue, pains, thoughts, and feelings of the men in the hole. (Figure 2) Di Cesnola seems to provoke a deliberate frisson in his readers; the sectional drawing is complemented by a cluster of instruments used in the operation. The caption underlines the message: "… How tombs are excavated, and with what tools."<sup>6</sup>



Figure 2. Golgoi, excavation of tombs (Cesnola, *Cyprus*, 255)

Attempting to bring the barefoot man pushing the cart in Babylon, the ones in the pits in Sidon and Golgoi, and many others to the foreground of archaeological expeditions, I will take some methodological risks in interpreting the textual and the visual documentation as I try to decipher archaeologists' gaze on natives and natives' gaze on archaeologists, based on bits and pieces of data gleaned from the records.

I will focus on one case study, Nippur, Mesopotamia, which was excavated between 1889 and 1900 in four seasons by scholars associated with the University of Pennsylvania, namely John Purnett Peters, Herman Vollrat Hilprecht, and John Henry Hanes. Nippur is to the West of Divaniye, 160 kilometers to the southeast of Baghdad on the Euphrates. The other sizeable settlement in the region is Hille, about 70 kilometers to the north of Divaniye and 95 kilometers to the south of Baghdad. Hille and Divaniye provided the Americans with basic services, ranging from food supplies to security forces, and connected them to the rest of the world through mail and telegraph, benefits of the fragmented Ottoman modernity in Iraq. In contrast, Nippur (Nifer) was in the midst of a barren countryside, with nothing around it, but the ruins. "We [are] cut off from civilization," Joseph Meyer, the architect of the excavation project, wrote in his diary, "by the long stretch of the desert and marsh."<sup>7</sup>

Upon their arrival at Nippur on their first expedition (1888-1889), the archaeologists pitched their tents on the highest point, to the southwest of the ruins. According to Haynes, the site had great advantages: unobstructed views of the swamps and the desert, protection from malaria, and from "possible attacks from the Arabs."<sup>8</sup> A number of facilities were built around them in a square plan; they included the stables, store-rooms, workshops, a kitchen, and a hut for guards. They adhered to regional construction traditions. Outside this compound, an "indigenous" village which housed the workers grew spontaneously.

The second expedition (1889-90) came with a much more disciplined pattern, correcting the "mistakes" of the previous year. The first was open to hot winds and sand storms; this one was better protected. The first could not stop the curious Arabs from wandering into the tents of the Americans; this one took measures against such intrusions by design. "Huts" with various facilities serving the team surrounded the tents, where the archaeologist lodged. This inner compound in a square plan was protected by open spaces on four sides, then separated from the outside world by three-feet tall wall. At a "considerable distance" (Hilprecht), but still part of the settlement, was the workers' village in reed and palm-leaf architecture, around a large open court and neatly lined at right angles in an unprecedented layout for the region. The archaeologists' compound had only one entrance on the east side, turning away from the native compound and enabling them "to guard themselves better against treachery."<sup>9</sup>

The third expedition (1893-96) engraved the American presence permanently in the landscape by means of a prominent structure. As this expedition would last two to three years, a proper building was needed. It would ensure better protection from the harsh climate, as well as from the "thievish inclination of the Arabs" (Hilprecht). Just as significantly, it was meant to broadcast an "appearance of strength," conveying a message about the power and status of the archaeological team.<sup>10</sup> (Figure 3)



Figure 3. Nippur, view of the "Castle" with the "native village" in the foreground (UPMAAA,Nippur 6025)

Dominating everything else around it, the expedition house attracted much attention and was named "the Castle" (or, the Kala) by the Arabs – a name Americans adopted. Constructed with local materials and in harmony with the architectural forms of the region, it was inspired by the residences of local families of wealth and status in nearby settlements, for example by "Abdel Hamid's Castle."

The proximity and the separation of the archaeologists' castle from the "native" village, which ran through the different phases of the Nippur expedition, gave way to complex and shifting relationships between the Americans and the natives. The journals kept by Peters in 1889 and 1890 reflect a telling development from neutral and impersonal records to more engaged ones. Early on, for every entry, he jotted down the number of the workers on the site, the increase from 32 men on February 7 to 144 on March 16, 1889 and reaching to 250 in late January 1890, for example, expressing the growth in the scale of the work. Along the way, he described the organization of labor and the division of the workforce into gangs, with each gang structured according to a strict hierarchy – reflected in the payments.<sup>11</sup>

Peters's journal from late 1890 displays a more intimate relationship with the workers, especially the foremen. He gave their names and described their responsibilities and the work achieved by them. He wrote, for example, that "Mousa el-Jerwani had been working for two days in the third room of the Hebrew house," "Hassan has found that the second of his rooms rests against the step like wall which seems to be a part of the terrace," and "Hisbat has found an immense fine looking wall of mud brick in step like work." Peters drew a plan of the site, showing the different locations of excavation, numbering each location and linking the number with the names of the workers: in area 1, he noted, Hussein Davud "is digging out rooms on the outer face, west of breach," whereas "Dhaki is digging out rooms on the east of the breach on the inside"; in area 2, "Hussein el Khalif is digging out old brick wall on slope of plateau," and "Abdullah el Ouadah is descending to foundation of long wall by its first buttress east of center," and so forth.<sup>12</sup> "Arabs" thus become individualized, and gained agency.

During the third and the fourth expeditions, Haynes, the new director, undertook a more systematic ethnographic research and documentation, most likely stemming from the longer excavation seasons, the view of a complete village from the Castle (especially from its roof terrace), and the University of Pennsylvania's financial support of photographic documentation. Indeed, the University of Pennsylvania and the Smithsonian endorsed the ethnographic project, as evidenced by a letter from George Brown Goode, the assistant secretary of the Smithsonian, to William Pepper, the provost of the University. In this letter, written in 1889, Mr. Goode urged Peters, then director of the expedition, to send to the Museum "a costume of a Mesopotamian chief or of his wife or both." He added a wish list:

"Any illustration of the methods employed in spinning, weaving, dyeing, working with metal or wood, would be exceedingly valuable to us, especially if accompanied by illustrative photographs. Any musical instruments, especially the cruder and simpler forms, and simple lamps, or appliances for making fire, or heating, would also be immediately available." Goode thus outlined a rough research guideline for the archaeologists. Haynes' field notes are speckled with casual observations on the life and customs of the workers. To cite one example, he wrote that the first day of the "Moslem feast called 'Bairam' ... [was] a day of rejoicing and feasting." It was an occasion for acquiring new costumes or at least "one garment." The "supremely happy" crowd celebrated by chanting "most lustily their hosas" in an improvised manner.<sup>14</sup>

Joseph Meyer, complemented Haynes' accounts with his more informed observations on the music played in the village. In spontaneous notes on the margins of his log book he described the songs he heard from the rooftop of the Castle in some detail. Likening them to "serenades or noc-turnes," he stated "songs are evening diversions," and continued "towards the evening, our arabs begin to be lively." He believed that music must have served as a relief and relaxation from fatigue at the end of the day and added that on the excavation site, workers would start a "lively chant" when making a physical effort, such as pulling a rope and lifting a weight.<sup>15</sup>

Nevertheless, the ethnographic record in Nippur is most striking in the photographs of the "native village" taken during the last two expeditions.

The indigenous houses, their construction techniques, and their materials constitute a major category in Haynes' photographs. Labeled as "Building Workman's Hut," "House Building in Nippur," "Houses under Construction," and so forth, they covered the construction from the earliest phases depicting the building of the frame, to the filling in of the walls and covering of the roof, and finally to the finished product. "Natives," shown putting their own houses together, helped explain the process, while giving a sense of scale. One caption outlined a construction technique: "the architect and



chief builder are twisting several moistened flags, or in other words, is making ropes to be used (in place of nails) to build the parts of the structure together." (Figure 4)

**Figure 4.** Nippur, construction of a hut, assembling the frame. (UPMAAA, Nippur 7003) Another category is about daily life and depicts the villagers carrying out their "authentic" activities against the backdrop of their new settlement. Photographs show a group of three men weaving baskets, while a third cleans "a brace of pistols," a potter working from his hut, and "two brothers in sham fight" – according to the captions. Women's work centered on food production: they pounded rice to remove the husk from the kernel and in many views, they prepared meals squatting on the ground in small groups and using the ovens in the courtyards. An uncharacteristically long and detailed caption focused on one woman "patiently building up a storage jar of clay which only requires drying in the sun to complete it for use." Several household implements lay about "in usual confusion," including "another jar in process of formation and to be made in three sections or set three different times, it being necessary to partially dry each section before another section can be built upon it."

Haynes documented festive occasions. In a private celebration, a foreman, Hassan Sahab, exhibited his youngest son, only ten days old, to the community. The women of Haji Tarfa's household in a neighboring village were also identified, not only as members of his harem, but also with their proper names. Fatima was the first wife and the "mistress of the harem," and Lira was "the youngest of Haji Tarfa's three wives" The middle one was Khadija.

With its "crude and simple" architecture and lifestyles, the "native village" in Nippur was the unlikely cousin of the indigenous villages common to the universal expositions held in European and North American cities during the very same years. Assembled in part as exotic curiosities, in part as ethnographic tableaux vivants, and loaded with notions of civilizational superiority, colonial power, and race-thinking, these villages served as platforms to introduce "others" to European and American crowds. The archaeologists in Nippur, undoubtedly familiar with these extremely popular displays, deemed authentic, must have been intrigued and amused to realize that they had something much better in their front yard.

Taking a detour, I will now try to view camp from the villagers' perspective. The first question that comes to mind is what it must have meant to take on the job. Regular and relatively good pay was undoubtedly the main attraction, despite the seasonal nature of the work. The site was isolated, making lodging and meals difficult and necessitating support from families. The likely anxiety about leaving women and children behind must have also played part in moving entire households to Nippur. Once settled, everyday activities seem to have followed familiar patterns of the original villages. The difference for men was in the nature of the work and the long hours on the site; during daytime the village was occupied only by women and children.

The big novelty for the "natives" must have been the presence of a group of foreigners with unfamiliar customs living in the midst of them, but protected from them by their fortress and by the security forces provided by the Ottoman governor in Divaniye (zabtive). The curiosity of the workers was evident in their frequent and sneaky visits to the tents during the first two expeditions. As to the Arab-proof Castle of the third expedition, at least some workers knew some things about the architectural organization and the spaces because they had built it and served as house-help in it. And, it is most likely that they passed the information on to the village residents. Still, life in the forbidden Castle must have been an infinite source of gossip and speculation, from the simple everyday routines to the manner in which the foreigners entertained their guests. The "natives" had a good idea of the food provisions and the quantities involved (as they watched them being delivered), but could they peek into a dining party with male and female guests and many courses served (including wines from Syria)? What did they think of the archaeologists' cumbersome clothes – and their hats, and their bicycles? What did they make of Mrs. Haynes, who may have fit into her own gender-based role at home, but who diligently went to the dig, took field notes as her husband, and mingled in her curious ways with the workers? How did the workers react to being photographed by Haynes? Did Haynes show them any photographs or give them copies for keeps? What would an ethnographic record kept by the "natives" on Americans reveal?

Such questions will never be answered, but at least wondering what the "silent" men, women, and children of Mesopotamia experienced on the archaeological site may begin to acknowledge their presence in the history of archaeology.

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