À Joël Sakarovitch,
savant européen,
et ami…

(To Joël Sakarovitch,
An european wise man,
A friend…)
Construction History:
The Building of a Discipline

(Personal reflections)

S. Huerta
The chief requisite for the making of a good chicken pie is chicken; nay, no amount of culinary legerdemain can make up for the lack of chicken.

In the same way, the chief requisite for the history of science is intimate scientific knowledge; no amount of philosophic legerdemain can make up for its absence.

(Sarton 1918)

(legerdemain: skill in doing tricks with the hands)
Never let yourself be goaded into taking seriously problems about words and their meanings.

What must be taken seriously are questions of fact, and assertions about facts: theories and hypotheses; the problems they solve; and the problems they raise.

Karl Popper, *Unended Quest* (1976)
On fait la science avec des faits, comme on fait une maison avec des pierres: mais une accumulation de faits n'est pas plus une science qu'un tas de pierres n'est une maison.

Henri Poincaré
La science et l'hypothèse (1901)

Science is built of facts, as a house if built of stones; but an accumulation of facts is no more a science than a heap of stones is a house.
No basta con mirar; hay que contemplar: impregnemos de emoción y simpatía las cosas observadas; hagámoslas nuestras, tanto con el corazón como con la inteligencia. Sólo así nos entregarán su secreto.

Do not just look; we must contemplate: impregnate of emotion and sympathy things observed; let's make them our both with heart and intelligence. Only then they will deliver us his secret.
No basta con mirar; hay que contemplar: impregnemos de emoción y simpatía las cosas observadas; hagámoslas nuestras, tanto con el corazón como con la inteligencia. Sólo así nos entregarán su secreto.

Do not just look; we must contemplate: impregnate of emotion and sympathy things observed; let's make them our both with heart and intelligence. Only then they will deliver us his secret.

S. Ramón y Cajal (1898)
*Rules and advice on scientific research*
- Origins of Construction History
- A tour through books on CH, 1920-1990
- Is it possible to teach Construction History?
- Conclusions
Origins of Construction History
18th Century. First Studies

Ziegler

Winckelmann

Piranesi

Fischer von Erlach
Das Bünders-Bild des Olympischen Jupiter von Gold

(Fischer von Erlach 1771, Entwurf einer historischen Architektur)
Construction History in the XIXth century

Rondelet *Traité théorique et pratique de l'art de bâtir* (1802)

Gothic construction:

Willis (1843) *On the construction of the vaults of the Middle Ages*
Viollet-le-Duc (1854) *Dictionnaire raisonné de l'Architecture Française du XI au XVI siècle.*
Ungewitter (1859) *Lehrbuch der gotischen Konstruktionen*
Ungewitter / Mohrmann (1890) *Lehrbuch der gotischen Konstruktionen 3. Auflage*

Ancient construction:

Choisy (1873) *L’art de bâtir chez les Romains*
Choisy (1883) *L’art de bâtir chez les Byzantins*
Choisy (1899) *Histoire de l’architecture*
Choisy (1907) *L’art de bâtir chez les Egyptiens*
Durm (1881) *Baukunst der Griechen*
Durm (1885) *Baukunst der Etrusker und Römer*
Durm (1903) *Baukunst der Renaissance*
(Viollet-le-Duc 1854)
(Durm 1885/1903)
The pervivence of Construction History, 1920’s-1990’s
The Spanish Case

The teaching of building construction in the School of Architecture of Madrid, 1920-30.

The album of the lectures on building construction of Prof. Carlos Gato taken by the young student Luis Moya
El Panteón de París, construido en 1900 por Soufflot.
The lectures on building construction of Rafael Fernández Huidobro
School of Architecture of Madrid, 1947
Lecciones de construcción del Prof. Rafael Fernández Huidobro
Escuela de Arquitectura de 1970’s
Some books 1920’s-1980’s
Die Technik des Altertums

Von

Dr. Albert Neuburger

Vierte Auflage

Mit 676 Abbildungen

R. Voigtländer's Verlag in Leipzig

(1917/1929)
THE MEDIAEVAL BUILDER AND HIS METHODS

BY

FRANCIS B. ANDREWS
BUILDING
IN ENGLAND
DOWN TO 1540
A DOCUMENTARY HISTORY

L. F. SALZMAN

(1934/1955)
KONSTRUKTION UND FORM IM BAUEN

(Construction and Form in Building)

(1943)
(Arcos, bóvedas y cúpulas)
(1947)
FRIEDRICH HESS

STEINVERBÄNDE UND GEWÖLKBEBAU

VERLAG HERMANN RINN MÜNCHEN

(1948)
Gevelven
(Vaulting)
(Thunnissen 1950)
HISTORY OF STRENGTH OF MATERIALS

With a brief account of the history of theory of elasticity and theory of structures

STEPHEN P. TIMOSHENKO
Professor of Engineering Mechanics
Stanford University

New York Toronto London
McGRAW-HILL BOOK COMPANY, INC.
1953
ÉCOLE FRANÇAISE D’ATHÈNES
TRAVAUX ET MÉMOIRES
DES ANCIENS MEMBRES ÉTRANGERS DE L’ÉCOLE ET DE DIVERSES SAVANTS
FASCICULE XVI

LES MATÉRIAUX DE CONSTRUCTION
ET LA TECHNIQUE ARCHITECTURALE
DES ANCIENS GRECS

PREMIÈRE PARTIE

PAR

A. ORLANDOS
DE L’ACADÉMIE D’ATHÈNES — MEMBRE CORRESPONDANT DE L’INSTITUT

TRADUIT DU GREC PAR

VANNA HADJIMICHALI

PARIS
ÉDITIONS E. DE BOCCARD
1, RUE DE MÉDICIS, 1
1966

(1955/1966)
Aus dem Nebel der Vergangenheit steigt der Turm zu Babel
LA TECNICA EDILIZIA ROMANA
CON PARTICOLARE RIGUARDO A
ROMA E LAZIO

VOLUME I
TESTO

GIUSEPPE LUGLI

ROMA MCMLVII
PRESSO GIOVANNI BARDI
EDITORE

(1957)
A HISTORY OF BUILDING MATERIALS

NORMAN DAVEY
O.B.E., D.Sc., Ph.D., F.S.A.

With frontispiece, 48 pages of plates,
and 154 illustrations in text

PHOENIX HOUSE
LONDON

(1961)
THE CONSTRUCTION OF GOTHIC CATHEDRALS
A Study of Medieval Vault Erection

JOHN FITCHEN

(1961)
Kraft mal Weg = Arbeit

(Force by Distance = Work)

(Rupp 1963)
(1964) (From Roman to Pre-stressed concrete. Contributions to a History of Concrete)
Kunst und Technik der Wölbung

(Hart 1965)
De vakverslagen aanbieden geen duidelijkheid te bieden. Een voorbeeld van een dergelijke groot schaal wordt gegeven in een cartoon (afb. 141 t.t. XIV). Deze schaal schijnt op een oogst van voorste kant worden gesneden in. Je ziet de grootte en vorm van een platteboord, terwijl er stijf in het midden blijft staan en een oude beeld. De schaal toont de wisselingen van en voor een gewaad en voor een muisje. Je kunt een verklaring van hoe de oude schaal in de lange periode van de schaal is geplaatst. Wanneer de grootte van een platteboord is geplaatst, dan verschijnt de maat van een oud praatje dat er in zit. Onderaan boven een waagstuk van een oud praatje dat er in zit. Onderaan boven een waagstuk van een oud praatje dat er in zit.
An Historical Outline of Architectural Science
SECOND EDITION
HENRY J. COWAN
APPLIED SCIENCE PUBLISHERS

Fig. 1.11. Centrifugal machine for dispensing holy water, described by Hiero of Alexandria. It contained a lever mechanism not unlike that of a modern vending machine. This enabled a plug to release a measured quantity of holy water.

of the inclined plane, credited to Isidore of Miletus in the 1st century BC, and the inclined plane in terms of “dilated gravity”, the steeper the plane, the greater the dilation of gravity [36].

Before any progress could be made towards an analysis of the forces acting on a structure, it was necessary to define the notion of force as a vectorial unit, i.e. as a quantity having both magnitude and direction. This was a task which called for a considerable effort of abstraction. Leonardo da Vinci was the first to solve this problem. Born in Florence in 1452, he was one of the most versatile men of the Renaissance. He published nothing during his lifetime, but he left his extensive notes to his friend and pupil Francesco Melzi, after whose death the notebooks were dispersed; some have been lost. Leonardo, who was left-handed, wrote in a writing which ordinary people can only read in a mirror and he used many abbreviations. Most of his writing has been transcribed only during the 20th century.

Leonardo considered the condition of equilibrium of two inclined strings carrying a weight (Fig. 1.12). He noted that the pull in a string could be ascertained by hanging it over a pulley, and balancing it with a weight. If one hung a weight from two inclined strings, and set out the pull in the strings and the weight carried by them to scale,

In the early 18th century, glasshouses became fashionable in northern Europe. These were garden houses with large windows facing south, for growing orange trees and other plants which required protection from the cold in winter. In the 18th century, complete glasshouses were built for the same reason (Fig. 6.5).

such windows [191]. Christopher Wren used similar windows for the new palace at Hampton Court. The slightly curved, brilliantly clear crown glass fitted into sliding window sashes remained a popular material in Britain until the 18th century.

In the early 19th century, the cylinder process was greatly improved in France and in 1832, Lucas Changeau began to use the French process in his Birmingham works. The cylinder was blown larger and allowed so cool. Instead of being cut hot with iron shears, it was cut cold with a diamond cutter, rebattled and flattened out on a bed of smooth glass, instead of an iron plate covered with sand. With the new process, a better surface finish and larger sheets could be produced.

In 1895 Emile Fourcrau in Belgium and in 1905 the Libby-Owens Glass Company in the USA developed processes for drawing sheet glass directly from a pool of molten glass.

These innovations were essential for the new uses of glass. The Crystal Palace (Section 6.4) could not have been built without the improved cylinder process, nor could the glass-walled buildings of the 1970s have been erected without the Fourcrau process.
Éléments d'une histoire de l'art de bâtir

Jean-Baptiste ACHE

Préface de Guillaume Gillet
Membre de l'Institut.
Architecte en Chef des Bâtiments civils
et Palais nationaux.

Éditions du Moniteur des Travaux Publics
51 rue du Faubourg Saint-Honoré Paris 8

(1970)
The Masterbuilders
A History of Structural and Environmental Design from Ancient Egypt to the Nineteenth Century

Henry J. Cowan

Science & Building
Structural and Environmental Design in the Nineteenth and Twentieth Centuries

Henry J. Cowan

(1977)  (1978)
Peters, Tom (1977)
Bauen und Technologie 1820-1914. Die Entstehung des modernen Bauprozesses
Diss. ETH, Zürich

(1987) Transitions in Engineering

(1996) Building the Nineteenth Century
Arches and barrel vaults in Islamic Architecture.
Vaulting technique and form
(Cejka (1978))
(Structural design
and his historical development)
### Session 1
- **Mr. David Adler**
  - A structural chronology
- **Mr. G.B. Godfrey**
  - 100 years of tall buildings
- **Dr. Tom F. Peters**
  - The building of the Crystal Palace
- **Mr. R.J.M. Sutherland**
  - The bending strength of cast iron
- **Dr. Denis Smith**
  - The wind-pressure question

### Session 2
- **Mr. W. Addis**
  - History in terms of theory and practice
- **Lord Howie**
  - The engineer's attitude
- **Dr. R.J. Mainstone**
  - Understanding the past
- **Professor A.C. Walker**
  - History as a predictor

### Session 3
- **Dr. Norman A. Smith**
  - Roman structures
- **Professor G.R. Collins**
  - Cohesive thin masonry vaulting
- **Professor Sir Alan Harris**
  - Construction of Gothic vaulting
- **Mr. E.C. Ruddock**
  - Cornices and pediments

### Session 4
- **Professor T.M. Charlton**
  - Least work principle
- **Professor J. Heyman**
  - Abutments for masonry bridges
- **Mr. K.H. Reineck**
  - The design of reinforced concrete
- **Dipl.-Ing. Jörg Schlaich**
  - Concrete shells
- **Mr. Andrew C. Smith**
  - Concrete shells
Jacques Heyman made Doctor Honoris Causa

The Polytechnic University of Madrid has honoured Professor Jacques Heyman (on the right in the photo above) by conferring a Doctor Honoris Causa Degree on him, following the proposal of the School of Architecture.

Heyman graduated in engineering from Cambridge in 1944, gained his doctorate under Baker in 1949 and moved to Brown University in 1952. Except for a short period of time spent at Oxford, he developed his academic career, which reached its peak as head of the Engineering Department, back at Cambridge.

While working in Baker's team he collaborated in the development of the mathematical basis of plastic theory. It is not in his nature to claim credit, but he cannot conceal that he was able to understand and publish in 1966, in his seminal work "The Stone Skeleton", that an approach to the analysis developed for metal structures was perfectly applicable to fabric structures.

[Editor's note: I cannot help but observe that the UK universities clearly do not have a monopoly on extraordinary academic人才培养.]

Obituary

Sir Howard Montagu Colvin
Architectural historian, 15 October 1919 - 27 December 2007

Contents
1. Honorary doctorate: Jacques Heyman
2. News from the USA: CHSA
3. Around the CHS Committee Table:
4. The archeology of Castelli e Prati di Mauro Niccolo Zacchia and its Troubled Publishing History
5. The Wheel and the Horse - Marking our Transport Heritage
6. Diet's Cross with Clachan Thistles
7. Lending hands - liquid and gas lighting
8. A Revolution At The Round Foundry, Language of the Building Site
9. Climbing and the Historic Building
10. Beals' Nottingham CHS site visit
11. Major Acquisitions to UK Repositories in 2006 Relating to Building and Construction
13. L. Grondin & Son Plumbers' Mouldings Collection
14. The Lancashire and the Porthcawl clock, Cardiff - part of the heritage

Obituary

Sir Howard Montagu Colvin
Architectural historian, 15 October 1919 - 27 December 2007
Bilddokumente römischer Technik

(Kretschmerz 1983)
(Graefe ed. 1985-1995, 7 vols.)

(Construction History)
De gothische bouwtraditie

R. Meischke

Bekking Amersfoort

(1988)
Geschichte der Baukonstruktion und Bautechnik

Von der Antike bis zur Neuzeit
Eine Einführung

Werner-Verlag

(1988)
Is it possible to teach Construction History?
HISTORY OF CONSTRUCTION

PART I. FROM ANTIQUITY TO THE MIDDLE AGES

Mesopotamia. Ancient Near East
2. Brick constructions. Walls, temples. Transport of colossi
3. The invention of the arch. Vault construction. Tombs.

Ancient Egypt
5. Temple construction
6. Vaults in Egyptian architecture
7. Obelisks: extraction, transport and erection. The transport of colossi

Ancient Greece
10. Temple structure: foundations, walls, columns, lintels, roofs
11. Vaults in Greek architecture. Greek cranes.

Ancient Rome
12. General. The invention of the Roman concrete. Walls and foundations
13. Vaulting. Theories about Roman vaults
14. The Pantheon and the Therms
15. The treatise of Vitruvius

Byzantium
17. Vault construction without centering. Barrel and groined vaults

Islamic architecture

Middle Ages
22. Vault erection. The gothic structure
23. Medieval structural design. Late-gothic manuals.
Index for each lecture:

1) Generalities;

2) Materials (brick, stone, etc.) and tools;

3) Elements (walls, columns, vaults,...);

4) Auxiliary means and building activities (cranes, scaffolding, transport,...);

5) Building types (temples, churches, towers,...);

6) Design procedures. Drawings.

7) The organization of work
PART II. FROM THE RENAISSANCE TO THE 20th CENTURY

Renaissance
24. The construction of the dome of Santa Maria del Fiore
25. The architect. Design methods. The treatise of Alberti
26. The building of El Escorial (A. López)
27. Form and construction of Renaissance domes. Saint Peter’s dome

The 17th and 18th Centuries
29. The birth of scientific structural analysis. From Galileo to Coulomb
31. Theory of masonry arches and vaults in the 18th Century: from traditional to scientific design
32. Building construction in Spain: the treatise of Fray Lorenzo de San Nicolás and its influence

The 19th Century
33. The new materials: cast iron. Use in buildings and bridges.
34. The new materials: Wrought iron. Tensile joints and the new trussed structures

35. Great roofs. Structural theory trussed structures. Plane and spatial trusses
37. Skyscraper construction (end of the 19th Century, beginning 20th Century)
38. New materials: the invention of reinforced concrete. First applications and tests
39. Masonry vault and dome theory
40. Tile vault construction: the work of Guastavino in Spain and America

The 20th Century (until ca. 1950)
41. Reinforced concrete. Building frames, first shells, bridges
42. Design of thin shell roofs. The work of F. Dischinger
43. The structures of Torroja (J. Antuña)
44. Tensile structures. From their beginnings to Frei Otto
Sample of topics of “research” for graduate students

<table>
<thead>
<tr>
<th>1.</th>
<th>Transport of colossi and obelisks in ancient</th>
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<th>The structure of the dome of St. Sophia</th>
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<td>Statics of Greek temples</td>
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<td>The structure of the Mosque of Cordoba</td>
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<td>4.</td>
<td>Use of iron in the Greek construction</td>
<td>12.</td>
<td>Hispanic cross-arched vaults</td>
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<td>5.</td>
<td>The architect in Roman times</td>
<td>13.</td>
<td>Viollet-le-Duc and the medieval rationalism</td>
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<td>6.</td>
<td>The structure of the Pantheon</td>
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<td>The design of Milan Cathedral</td>
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<td>7.</td>
<td>The construction of Roman bridges</td>
<td>15.</td>
<td>The construction of medieval foundations</td>
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<td>8.</td>
<td>The education of Byzantine architects</td>
<td>16.</td>
<td>The practical geometry of medieval builders</td>
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Texts of initial reference:


10. Özdural, Alpay. "Omar Khayyam, mathematicians, and 'Conversazioni' with artisans"
Graduate students of Construction History in the Architecture School, Madrid

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Tentative list of
Dissertations read on Construction History in Spanish Universities

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<td>Politécnica de Catalunya</td>
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<td>Politécnica de Valencia</td>
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Conclusions

The Construction History is a discipline in its own right as it serves to explain and understand one of the oldest human activities, building construction.

It has a promising future which will only become a reality if we work with a full awareness of the dangers and difficulties of building a new discipline.

The first task will be to achieve full university status, with core, full-time teachers, researchers, departments and research institutes. These teachers should have a good preparation and great generosity.

The second task is to form the apparatus of bibliographies, critical editions, detailed studies, reference guides, etc., which will ease the first task.

Finally, a considerable work of original research is needed. But as we are breaking new ground, the field has still no “impact” and the difficulties of an emerging discipline are almost insurmountable.