



INTERDISCIPLINARITY: A MODERN APPROCH TO ENGINEERING DOCTORATE IN ITALY

Madrid
09-10 February 2012

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SUMMARY

Questions..... Engineers and Society.....The Doctoral Degree

- 1st level AnswersEU Institutions
 - 2nd level AnswersEuropean Engineers Community
 - 3rd level Answers.....Single Country (Italy)
 - 4th level Answers.....Single School (Sapienza, Rome)
 - 5th level Answers.....Individual
- Final Statements

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ENGINEERS AND SOCIETY

Mission.....Role.....Social Function

Which levels of Knowledge..... Competences.....Skills in engineering disciplines are required by today European Society?

3



NOWADAYS STATEMENTS

Scientists discover what is!

Engineers create what has never been!

·
·
·

Scientists have ambition in competition!

Engineers look for social utility!

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And, as the role of God, the final cause, was taken over by **human knowledge**, the whole notion of causal explanation came under attack.

The erosion started with the work of Galileo.

from

"The Art and Science of Cause and Effect"

Judea Pearl 1996

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Most of us know Galileo as the man who was brought before by the inquisition and imprisoned for defending the heliocentric theory of the world. But while all that was going on, Galileo also managed to quietly **engineer** the most profound revolution that science has ever known.

This revolution, expounded in his 1638 book "Discorsi" published in Leyden, far from Rome, consists of two Maxims:

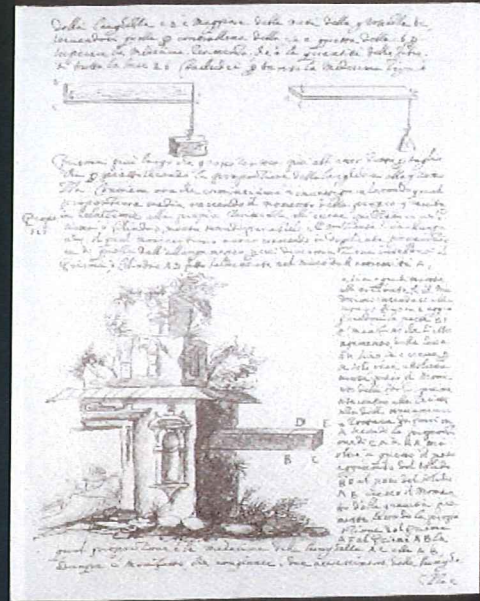
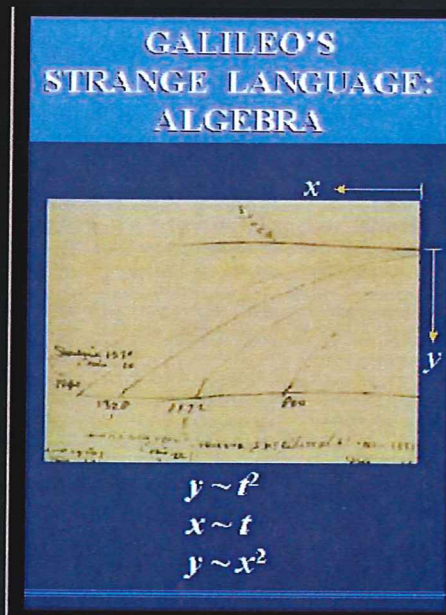
ONE, description first, explanation second—that is, the **how** precedes the **why**; and **TWO**, description is carried out in the language of mathematics; namely, equations. Ask not, said Galileo, **whether an** object falls because it is pulled from below or pushed from above. Ask **how** well you can predict the time it takes for the object to travel a certain distance, and **how** that time will vary from object to object, and **as** the angle of the track changes.



"The Art and Science of Cause and Effect"

Judea Pearl 1996

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Moreover, said Galileo, do not attempt to answer such questions in the qualitative and slippery nuances of human language; say it in the form of mathematical equations.

QUESTIONS

Which levels of Knowledge.... Competences Skills in engineering disciplines are required by today European Society ?

What are the reference Qualifications Frameworks to be adopted for an academic and professional recognition in the European Countries?

What about the Doctoral Degree?




first level answers EU Institutions

- 1999 Bologna Declaration
- 2005 Directive 36/EC Recognition of Professional Qualification
- 2005 QF-EHEA Document
- 2006 EUR-ACE Framework Standards Accreditation
- 2008 EQF-LLL Recommendation
- 2007-2013 EU-Principles Innovative Doctoral Training


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first level answers EU Institutions






ABOUT CLAIU-EU

CLAIU-EU (Council of Association of long-cycle Engineers, of a university or higher school of engineering of the European Union) provides a Forum for consultation and collaboration within Europe among associations of engineers who have broadly been educated to Master degree level. The objectives of CLAIU-EU serve to promote the interests of engineers who have followed a more theoretically oriented education and who are concerned with fundamental concepts and their practical application.



**“The Formation
of the Engineer
– International Models”**

To be held at
**Università “Sapienza”
Faculty of Engineering
Sala del Chiostro
Via Eudossiana 18 - Rome, Italy
Fri/Sat, 11th – 12th February 2011**



FACULTÀ DI INGEGNERIA
ENRICO ENRICHETTI
SAPIENZA
UNIVERSITÀ DI ROMA

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Qualification Descriptors in different Frameworks

Bologna, QF-EHEA	EU, EQF-LLL	EUR-ACE
A. Knowledge and understanding	1. Knowledge	I. Knowledge and understanding
B. Applying knowledge and understanding	2. Skills	II. Engineering analysis
C. Making Judgments	3. Competences	III. Engineering design
D. Communications skills		IV. Investigations
E. Learning skills		V. Engineering practice
		VI. Transferable skills

quoted from

“Engineering education – theoretical vs. applied approach”

CLAIU-EU CONFERENCE, The formation of the Engineer, International Models

Feyo de Azevedo Sebastião (Roma, 2011),,



Comparing levels of Qualifications in different Frameworks

Qualifications Frameworks and Quality Assurance - What is equal, what is different? II - Comparing QFs, the Directive and the EUR-ACE System			
Bologna QF-EHEA CYCLES	European Union EQF-LLL LEVELS	EUR-ACE	EU-Directive of Professional Recognition Art. 11 - LEVELS
Third Cycles	Level 8		
Second Cycles	Level 7	Second Cycles	Art 11° e)
First Cycles	Level 6	First Cycles	Art. 11° d)
Short Cycles Linked to or Within First Cycles	Level 5		Art. 11° c)

quoted from

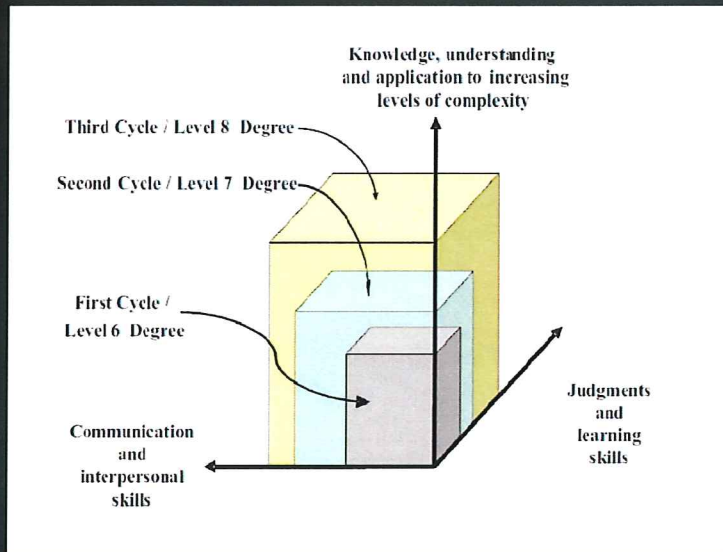
“Engineering education – theoretical vs. applied approach”

CLAIU-EU CONFERENCE, The formation of the Engineer, International Models

Feyo de Azevedo Sebastião (Roma, 2011),,



Qualification Levels and Education Profiles Analysis



quoted from

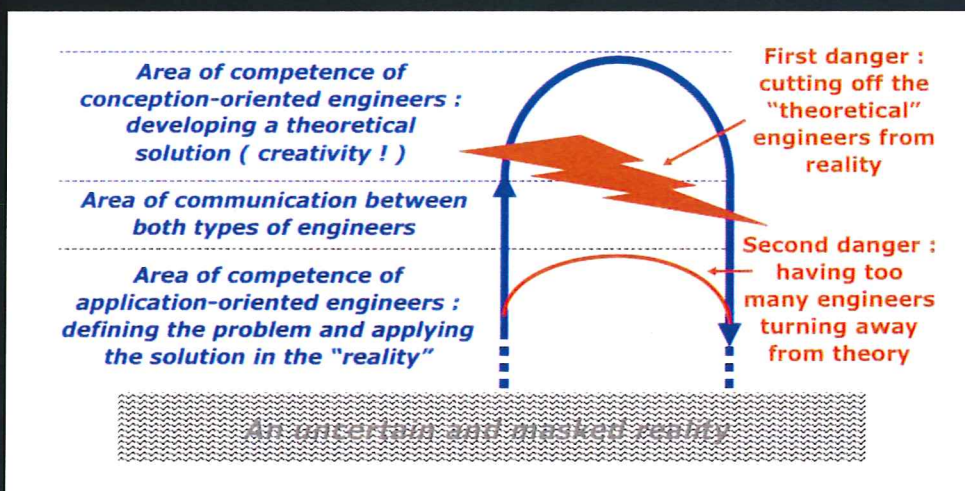
“Engineering education – theoretical vs. applied approach”

CLAIU-EU CONFERENCE, The formation of the Engineer, International Models

Feyo de Azevedo Sebastião (Roma, 2011)



Theoretically Oriented vs Applications Oriented profiles in Engineering Education



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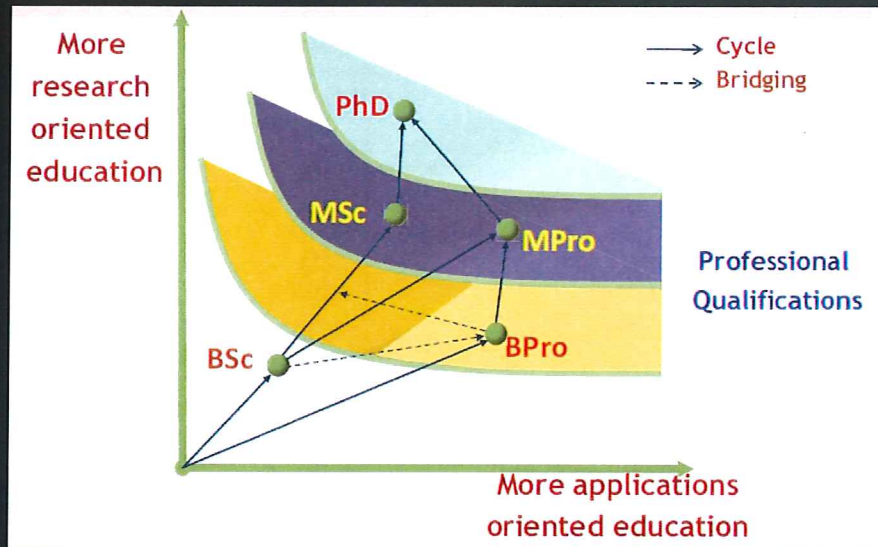
“Conception engineers versus application engineers: the views of industry”

CLAIU-EU CONFERENCE, The formation of the Engineer, International Models

Goossens Marc (Roma, 2011)



Qualification Levels and Education Profiles Analysis



quoted from

“Engineering education – theoretical vs. applied approach”

CLAIU-EU CONFERENCE, The formation of the Engineer, International Models

*Feyo de Azevedo Sebastião (Roma, 2011)*₅



CUN - National University Council (Italy)

Meeting Jan 2012, ROMA

MAJOR ISSUES:

1. Harmonization levels and profile
2. Mobility
3. Triple “I” concept: Interdisciplinary... Intersectorial
.....International
4. Innovative Doctoral Training paths (**strategic factor**)

.....*third level answers*.....

- Accelerate **Harmonization**
- **ANVUR** (National Evaluation University Research Agency)
- **IDTP** (Interdisciplinary Doctoral Training Programs)

INTERDISCIPLINARITY I-MATRIX

Vertical monodisciplinary profiles

C	...	C	...	C	E	M	...
I	...	O	...	H	L	E	...
V	...	N	...	I	E	C	...
I	...	S	...	M	C	H	...
L	.	T	...	I	T	A	...
		R	...	C	R	I	...
		A	...	A	I	C	...
		C	...	L	C	A	...
		T	...				...
		I	...				...
		O	...				...
		N	...				...

C	...	S	...	A	G	...
O	...	T	...	R	E	...
N	...	R	...	C	O	...
S	...	U	...	H	M	...
T	...	C	...	I	A	...
R	...	T	...	T	T	...
A	...	U	...	E	I	...
C	...	R	...	C	C	...
T	...	A	...	T	...	...
I	...	L	...	U	...	...
O	...	.	...	R	...	...
N	...		...	E	...	...

Common Basic Scientific knowledge



OR



Advanced Scientific Tools



ENVIRONMENT
SAFETY
TERRITORY
.....
MANAGEMENT
.....

RISK AND SAFETY
.....
TERRITORY
.....
MANAGEMENT

Horizontal multidisciplinary profile

L6 → L7

Interdisciplinary profile

L8 Doctoral Level



Major Challenges for Italian Engineers:

- A. The protection of the environment and the territory resilience (Po Valley).
- B. The management and control of the dangerous goods transport in the most wide European rail and road tunnels network.
- C. The control and management of the intense maritime activities in several very critical port .
- D. The protection of the many urban areas highly vulnerable to earthquakes and landslides .



Doctorate Schools in Engineering at Sapienza - Rome

1. Civil Engineering and Architecture

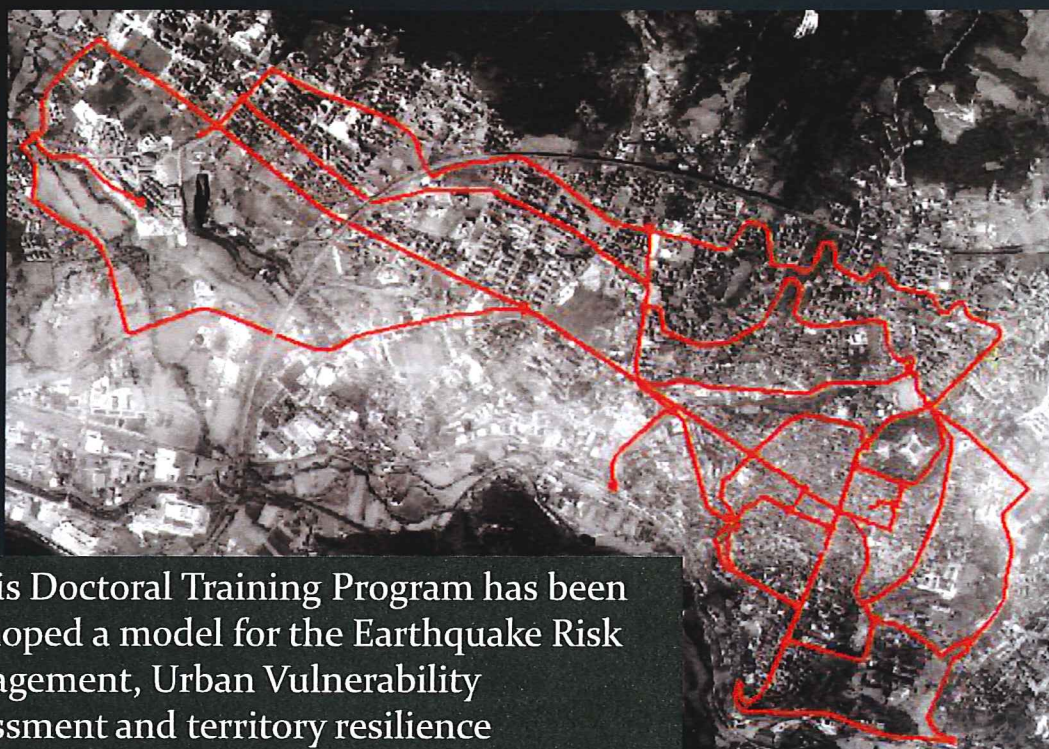
1. Structures, 2. Architecture – Theory and design, 3. Infrastructures and transportation,
4. Environmental and hydraulics, 5. City planning, 5. Territory planning

Doctorate School Mission from the Sapienza declaration:

“Therefore, the Curriculum accomplishes applied research and advanced training tasks this point is especially important in the actual time, in which Italy is getting late in developing and managing civil and transportation infrastructures In fact, Italy needs to reach a sustainable development (respect to environment and safety) so that national economy will compete in Europe that is why the Curriculum offers a very professional path, addressed toward a field that is extremely important in social and economic progress”.



Individual I - Doctoral Path



In this Doctoral Training Program has been developed a model for the Earthquake Risk Management, Urban Vulnerability Assessment and territory resilience implementation.



Doctorate Schools in Engineering at Sapienza - Rome

2. Sciences and Technologies for Industrial Innovation

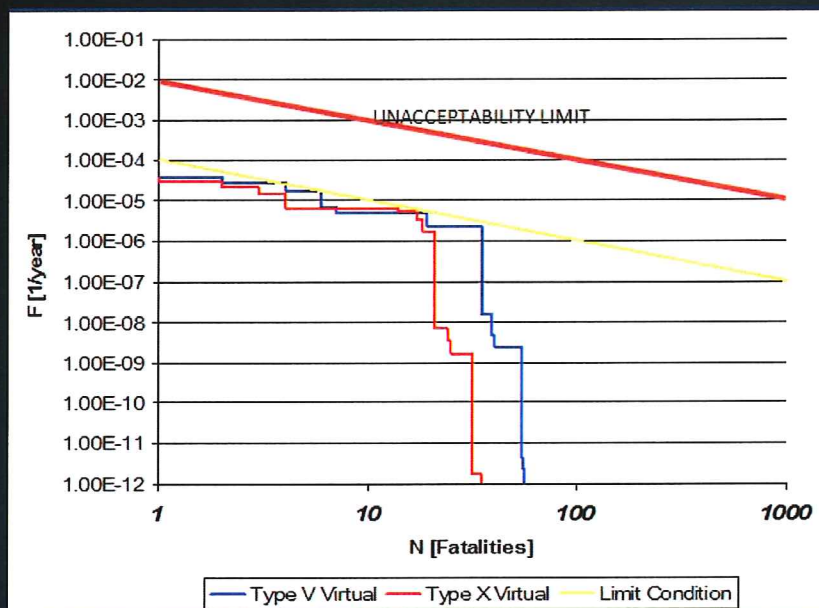
1. Electrical, 2. Mechanical, 3. Nuclear, 4. Chemical, 5. Materials and minerals, 6. Industrial production.

Doctorate School Mission from the Sapienza declaration:

“The course is reserved to master graduates of different areas which are interested in improving their competence/knowledge in the field “Sciences and Technologies for Industrial Innovation”...particular attention will be given to approaches, such as quality, safety, modeling, experimental issues based on an integrated vision. Moreover, due to the particular occupation situation of our country.... workshop.... collaborations.... stages.... in national and international centers are strongly encouraged.”



Individual I - Doctoral Path



The aim of this Doctoral Program has been to develop a model of Quantitative Risk Assessment and Quality Control in the operations of handling and transport of dangerous goods in tunnels.



FINAL STATEMENTS

- The new open Education environment is **Hopefully** the best for the identification and growth of the young talents according the expectation of Modern Society.
- It is necessary to accelerate **Harmonization**.
- The **Mobility** of L6 - L7 - L8 is likely the proof of EU Existence.
- Doctoral Degree should not be longer considered a mere preparation path to the academic or research careers, but rather the **Highest Qualification Level** in the framework of both Public Administration and Private Sectors.
- The hope is that the new open Education Environment be the best for the identification and growth of the **Young Talents** according the expectations of modern Society.
- In our **Era** Challenges for Engineers required "**Titanic Efforts**"...the Answer should be let Prometheus be Unbound

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Engineers

from myth "**Prometheus**".....to nowadays

Hesiodus

Works and Days



Aeschylus

Προμηθευς δεσμωτης Προμηθευς αδεσμοιο

P. Shelley

Prometeus unbound

W. Goethe

Prometheus

Plato

Τεχνη

K. Marx

Thesis Degree (1841)



PHOTO'S GALLERY

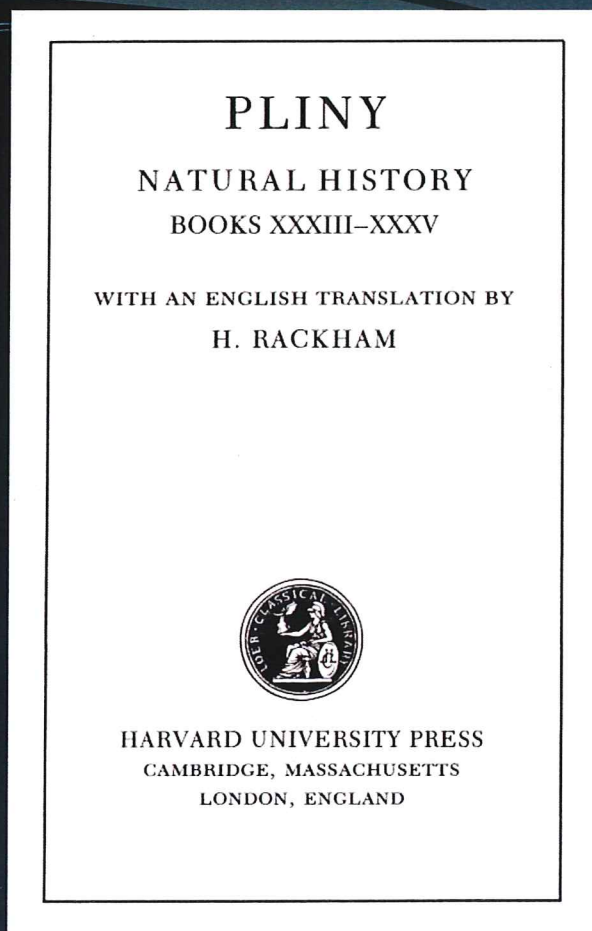
“Titanic” Engineers Workings

Images of
the Ancient Roman
rock and water engineering

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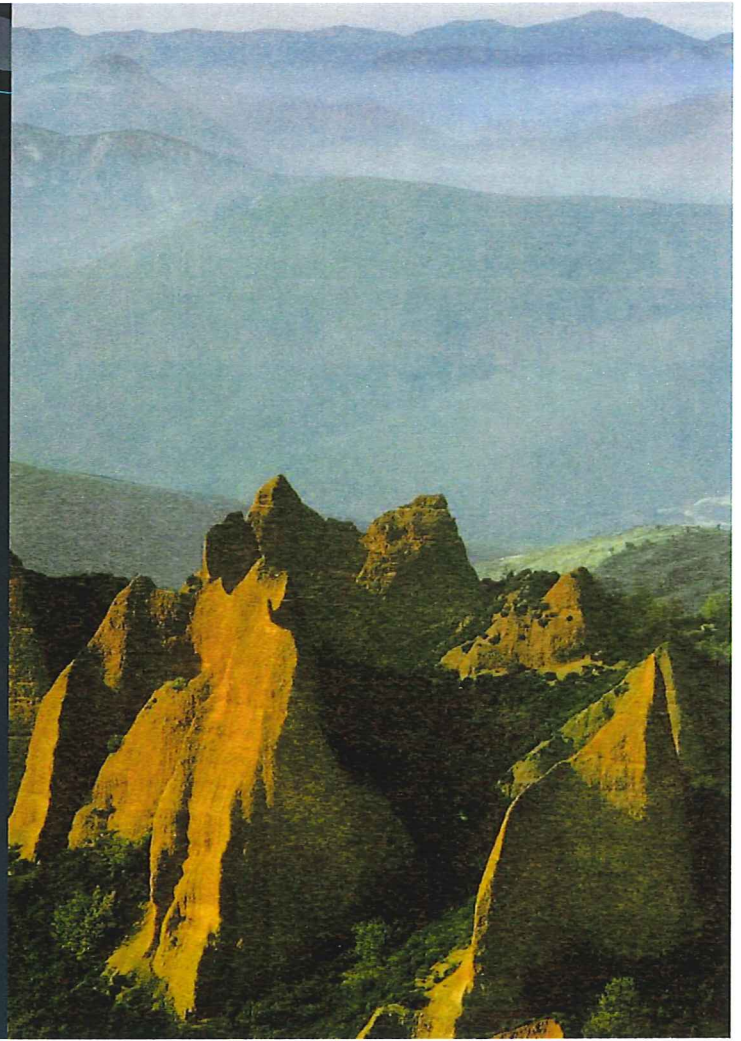
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Las Medulas - Spain

Gold Mine



Exploitation by method of “*ruina montium*”

Book XXXIII of Natural History by Pliny the Elder (A.D. 23-79)

The third method will have outdone the achievements of the Giants. By means of galleries driven for long distances the mountains are mined ...

The name of this class of mines is *arrugiae*...

Consequently arches are left at frequent intervals to support the weight of the mountain above.... When the work is completely finished, beginning with the last, they cut through, at the tops, the supports of the arched roofs.

A crack gives warning of a crash... The fractured mountain falls asunder in a wip gap, with a crash which is impossible for human imagination to conceive, and likewise with an incredibly violent blast of air...

*Terzia ratio opera vicerit Gigantum.
Cuniculis per magna spatia actis cavantur
montes....*

Arrugias id genus vocant...

*Relinquantur itaque fornices crebri
montibus sustinendis...*

*Peracto opere cervices fornicum ab ultimo
caedunt...*

Dat signum rima...

*Mons fractus cadit ab sese longe fragore qui
concipi humana mente non possit, aequae et
flatu incredibili...*

Exploitation by method of “*Ruina Montium*”

Another equally laborious task involving even greater expense is the incidental operation of ~~previously bringing~~ streams along mountain-heights frequently a distance of 100 miles for the purpose of washing away the débris of the collapse; the channels made for this purpose are called *corrugi*...

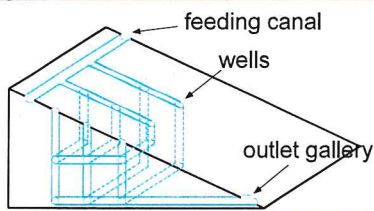
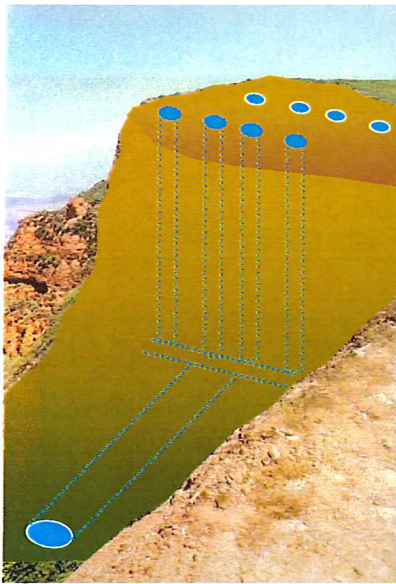
the dip of the fall must be steep, to cause a rush rather than a flow of water...

At the head of the waterfall on the brow of the mountains reservoirs are excavated measuring 200 ft. each way and 10 ft. deep. In these there are left five sluices with apertures measuring about a yard each way, in order that when the reservoir is full the stopping-barriers may be struck away and the torrent may burst out with such violence as to sweep forward the broken rocks....

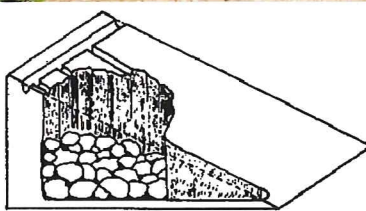
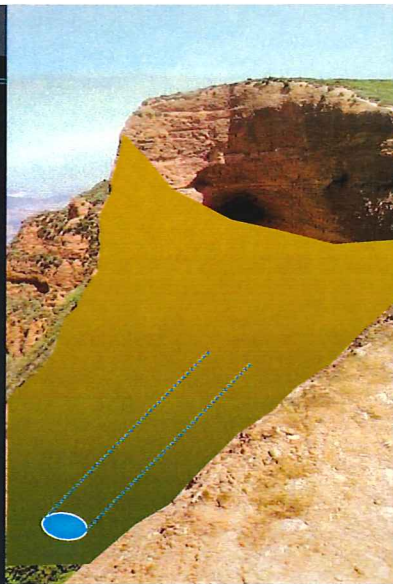
Alius par labor ac vel maioris impendii: flumina ad lavandam hanc ruinam iugis montium obiter duxere a centesimo plerumque lapide; corrugos vocant...

praeceps esse libramentum oportet, ut ruat verius quam fluat...

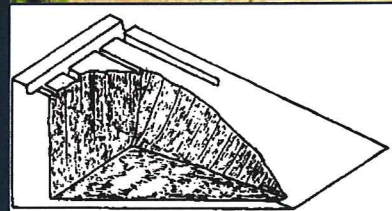
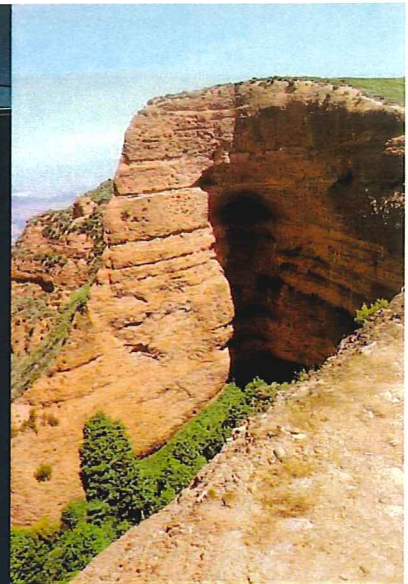
Ad capita deiectus in superciliis montium piscinae cavantur ducenos pedes in quasque partes et in altitudinem denos. Emissaria in iis quina pedum quadratorum ternum fere relinquuntur, ut repleto stagno excussis opturamentis erumpat torrens tanta vi ut saxa provolvat...



excavation of wells and galleries



formation of the collapse crater
“glory-hole” type

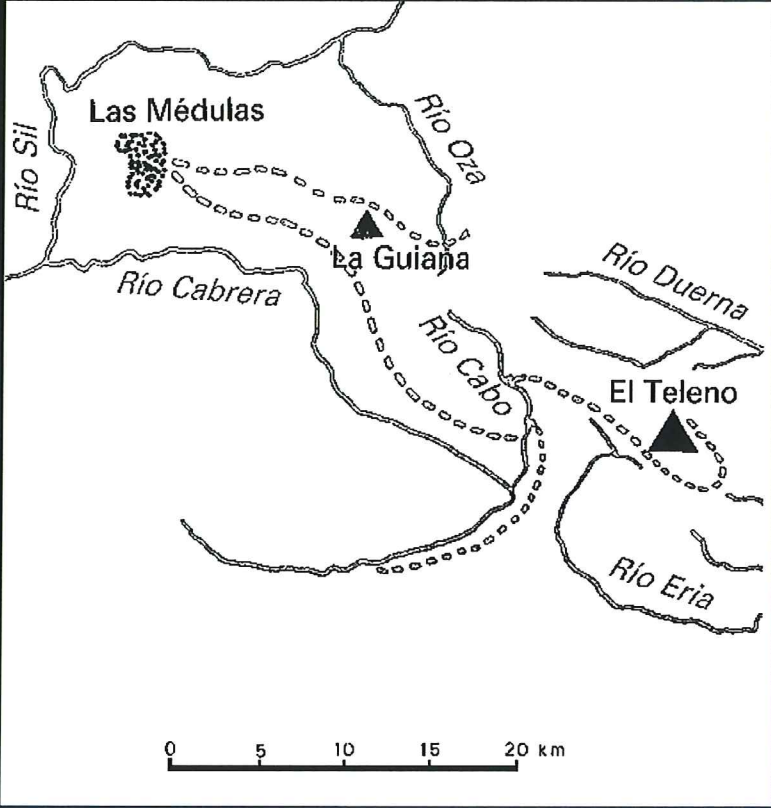


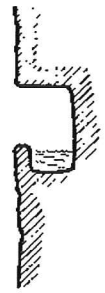
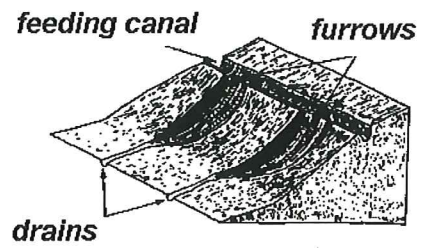
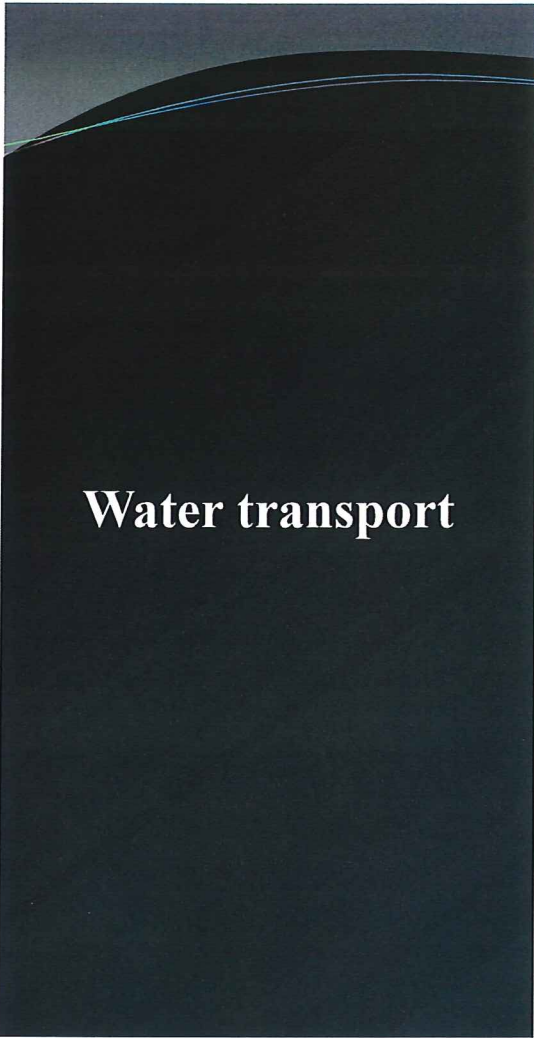
widening of the crater

Exploitation by method of “*Ruina Montium*”

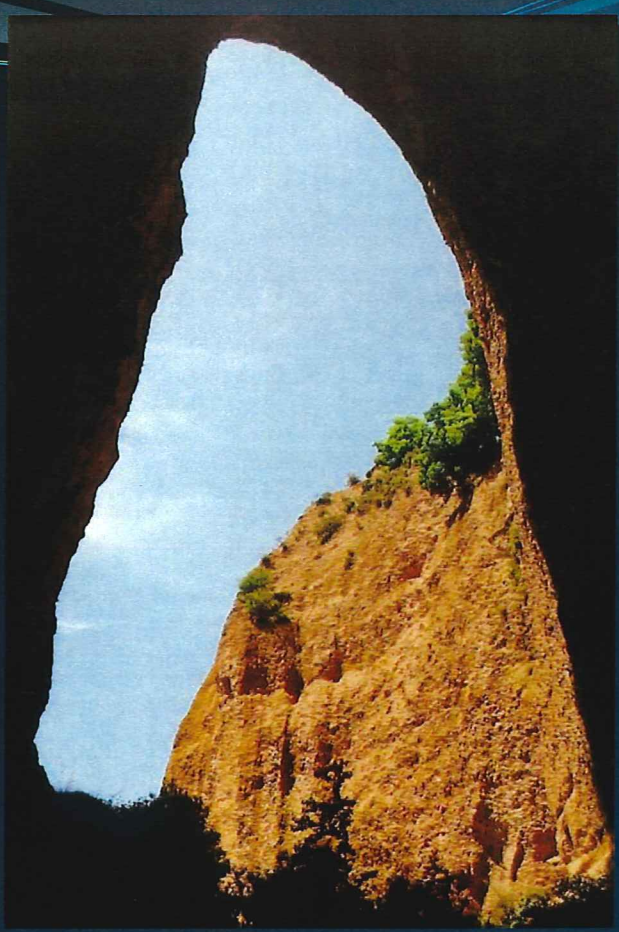
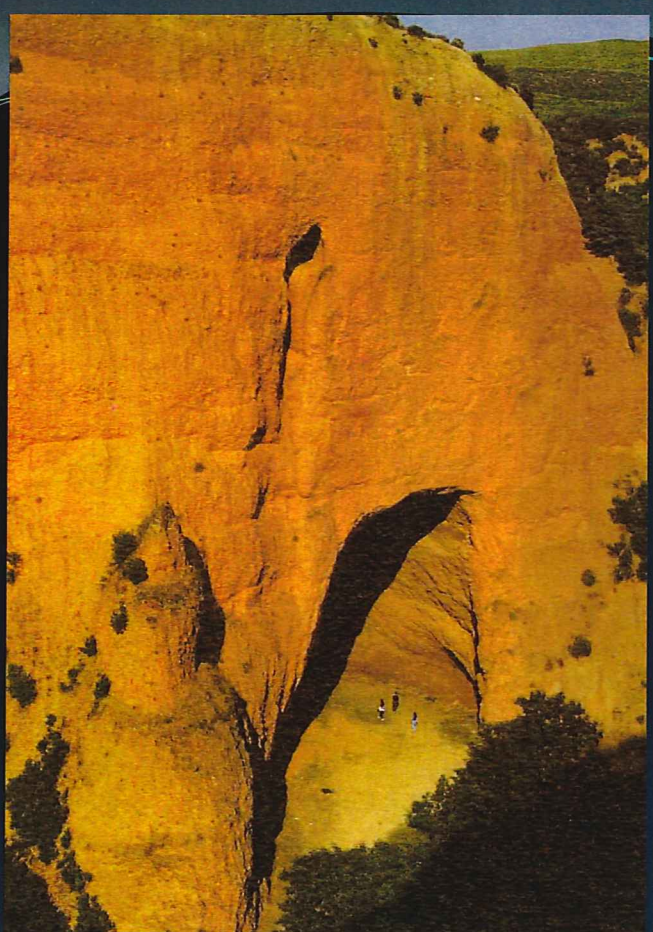
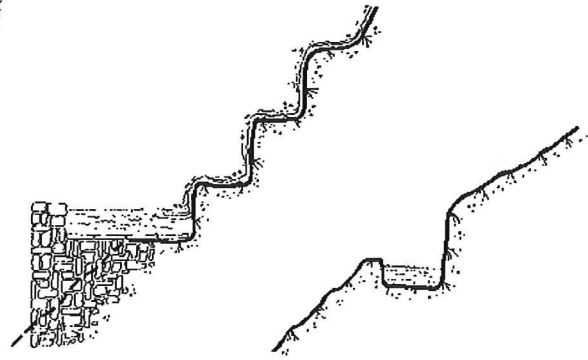
Las Medulas - Spain

Map of the mine area





different types of canals





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FRONTINUS
THE STRATAGEMS
AND
THE AQUEDUCTS OF ROME

WITH AN ENGLISH TRANSLATION BY
CHARLES E. BENNETT

LATE GOLDWIN SMITH PROFESSOR OF LATIN IN
CORNELL UNIVERSITY

THE TRANSLATION OF THE AQUEDUCTS BEING A
REVISION OF THAT OF
CLEMENS HERSCHEL

EDITED AND PREPARED FOR THE PRESS BY

MARY B. McELWAIN

PROFESSOR OF LATIN IN SMITH COLLEGE



CAMBRIDGE, MASSACHUSETTS
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LONDON
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MCMMLXXX

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“De aqueductu urbis Romae” by Frontinus

Frontinus was a literary man, soldier, theoretical of agricultural and hydraulic science.

He studied the aqueducts of Rome on orders of the Emperor Nerva. His book “The aqueducts of the city of Rome” is the collection of the notes that he took carrying out the task.

When he finished, he had recovered for the public, by eliminating fraud and theft, 400 million liters of water per day on a total volume of one billion liters. “*detegitur decem milia quinarium intercidisse*”

He visited all the sources of the aqueducts, calculated their capacity, codified the possible diameters of pipes, valves and calices. The standardization he laid down “*secundum quod fistulae omnes derigi debent*” could cause envy in many plants today.

He discovered nine different types of thefts of water : “*calix non signatus*” .. “*amplioris moduli*” .. “*fistulae solutae*” .. “*venalem extrahunt aquam*” .. “*in rogatorio modulo minus, in acceptorio plus*”

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Water pipes in Pompeii



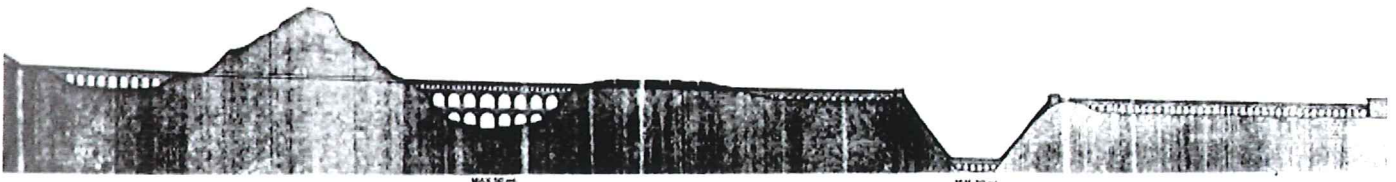
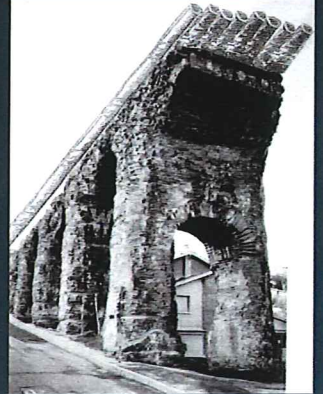
Aqueducts

Nimes aqueduct

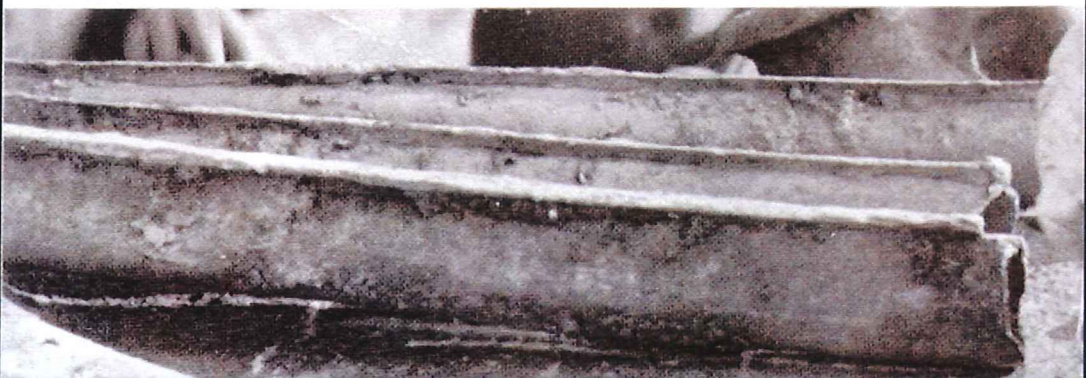
The masonry aqueduct of Nimes (France) is 50 km long with a total incline of 17 m (0.3 mm/m). It overcomes the Gard river with a bridge 50 m high that is still there and is one of the most beautiful wonder of the world. The problem of distribution of water in the city has been solved with a system of paraties which have worked until now.

Lyon aqueduct

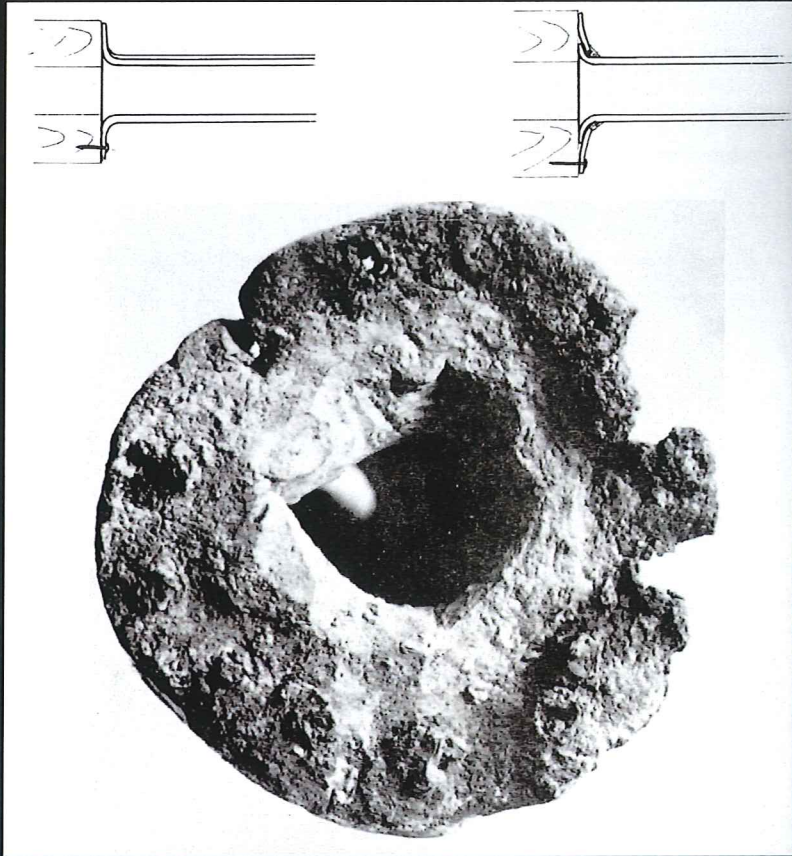
For the city of Lyon (France) have been realized four aqueducts. The last one, called Adriano aqueduct, is 70 km of length, and it overcame a dowflow higher than 100 meters. With a siphon system and with pressured water it was possible to overcome hills and rivers.



Pipes

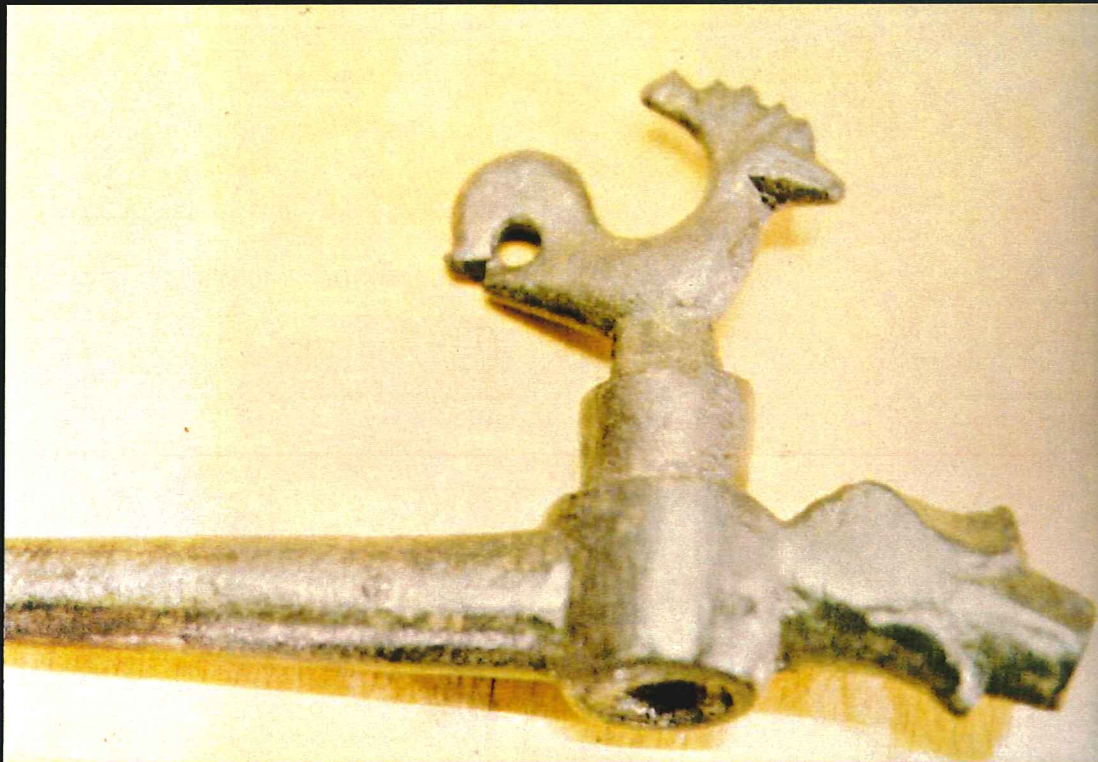


flanges



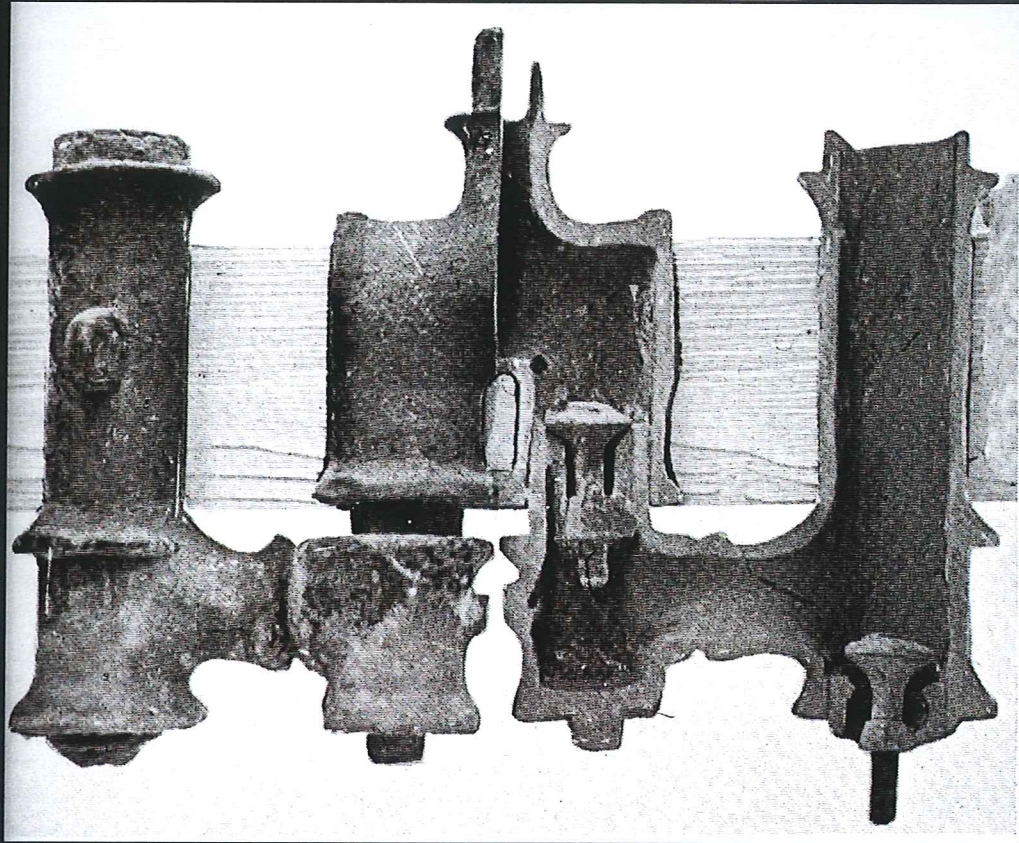
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Valves

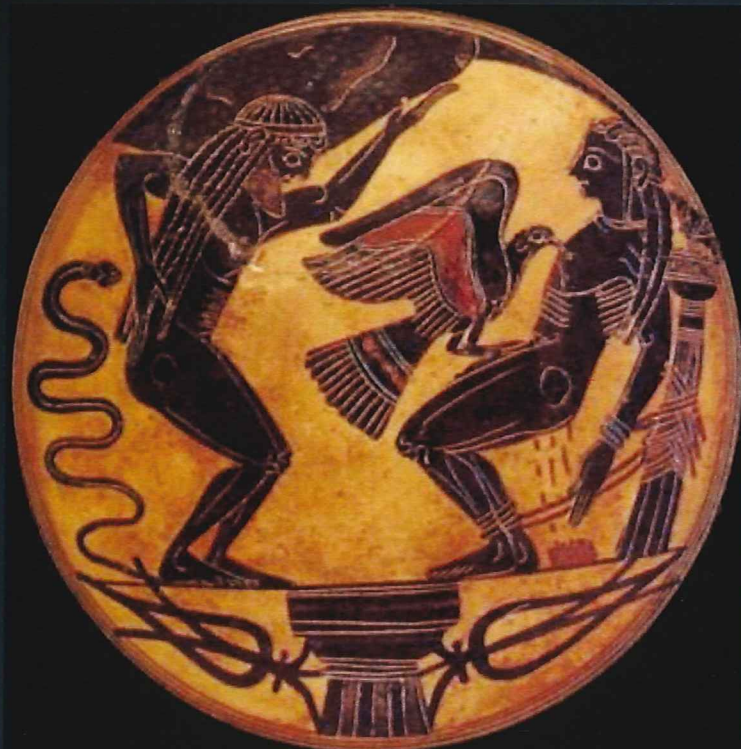


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Pumps



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