On Friction & Movement

3D-Metamodeling Christopher Polhem's Mechanical Alphabet

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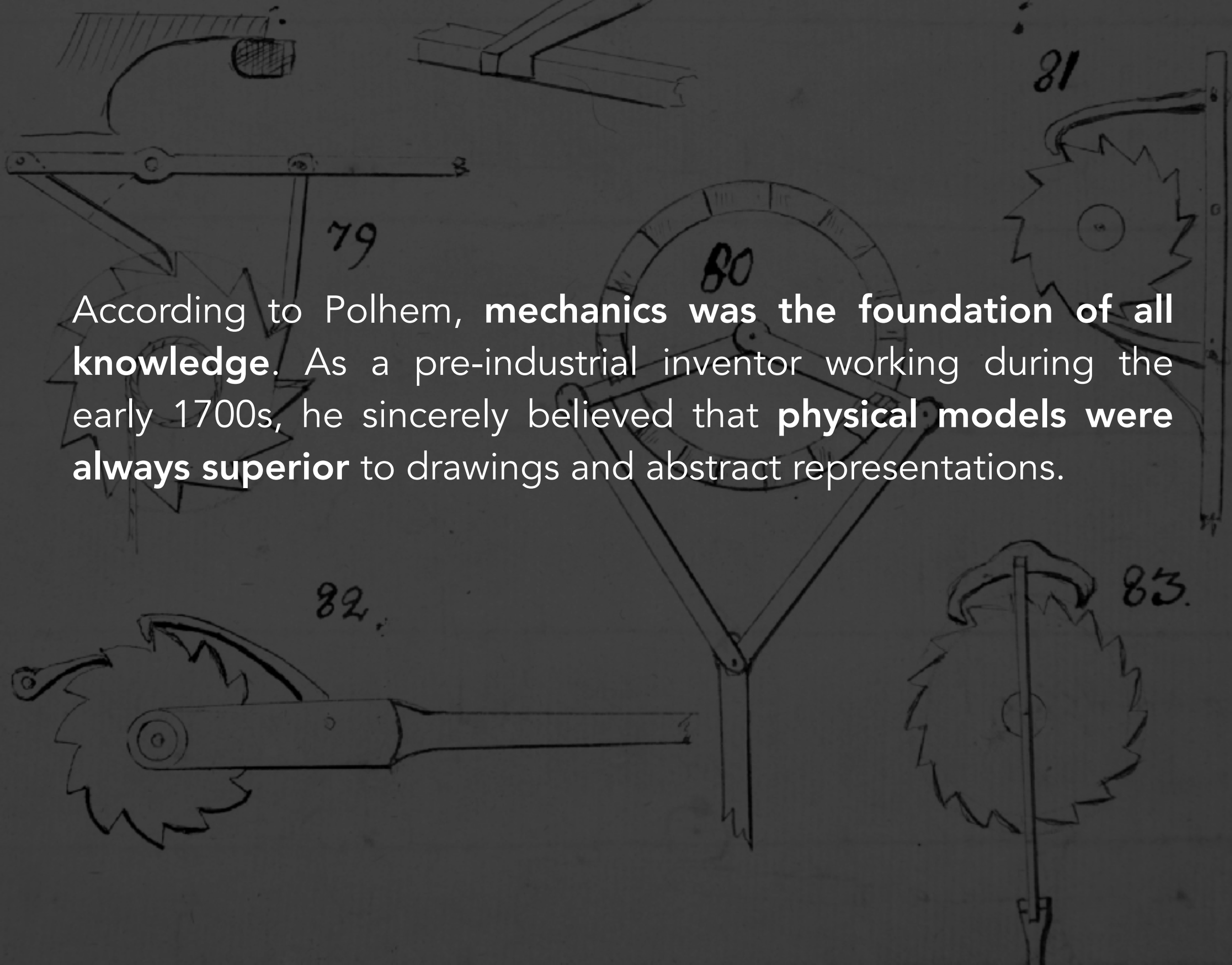
Christopher Polhem (1661-1751)



According to Polhem, **mechanics was the foundation of all knowledge**. As a pre-industrial inventor working during the early 1700s, he sincerely believed that **physical models were always superior** to drawings and abstract representations.

Den förſta Machinen om Vattnets Kraft 3 ädgſtellige fall.

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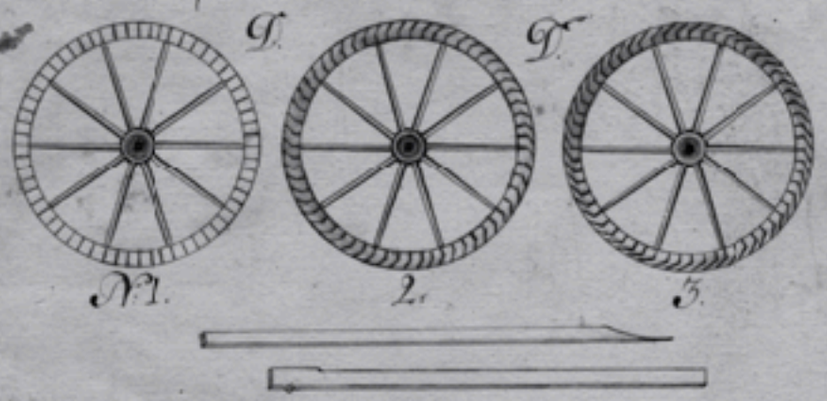
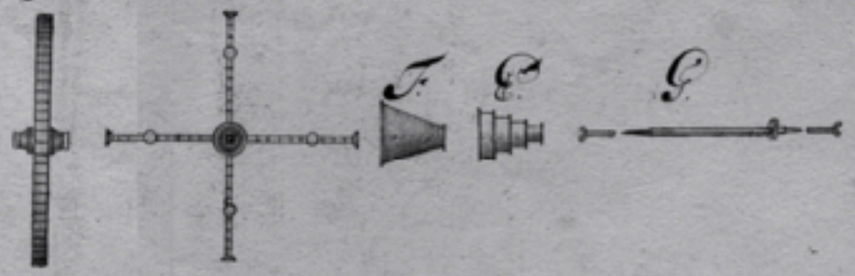
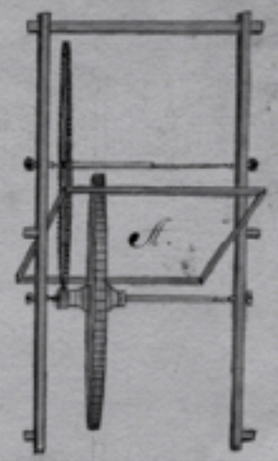
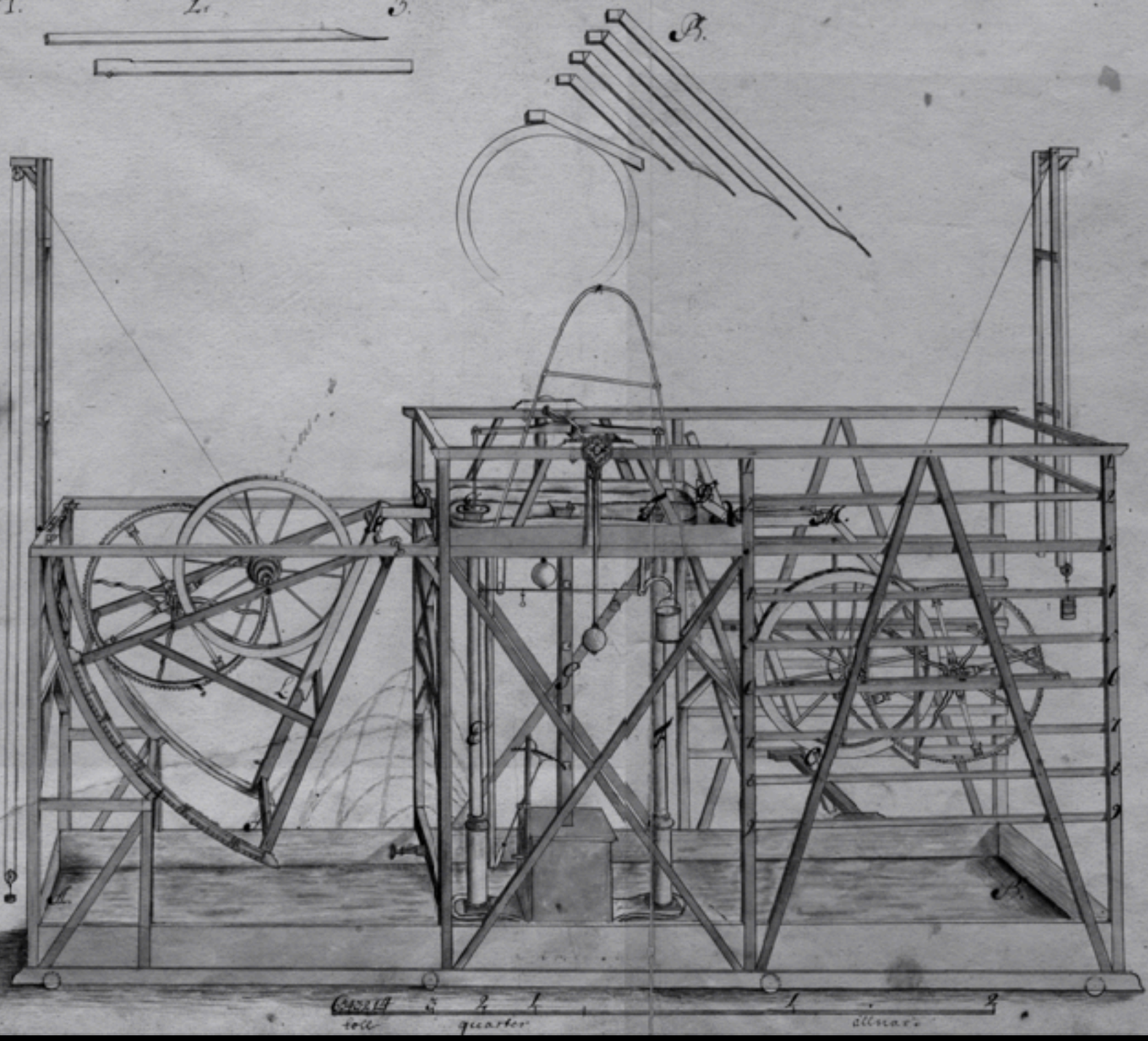
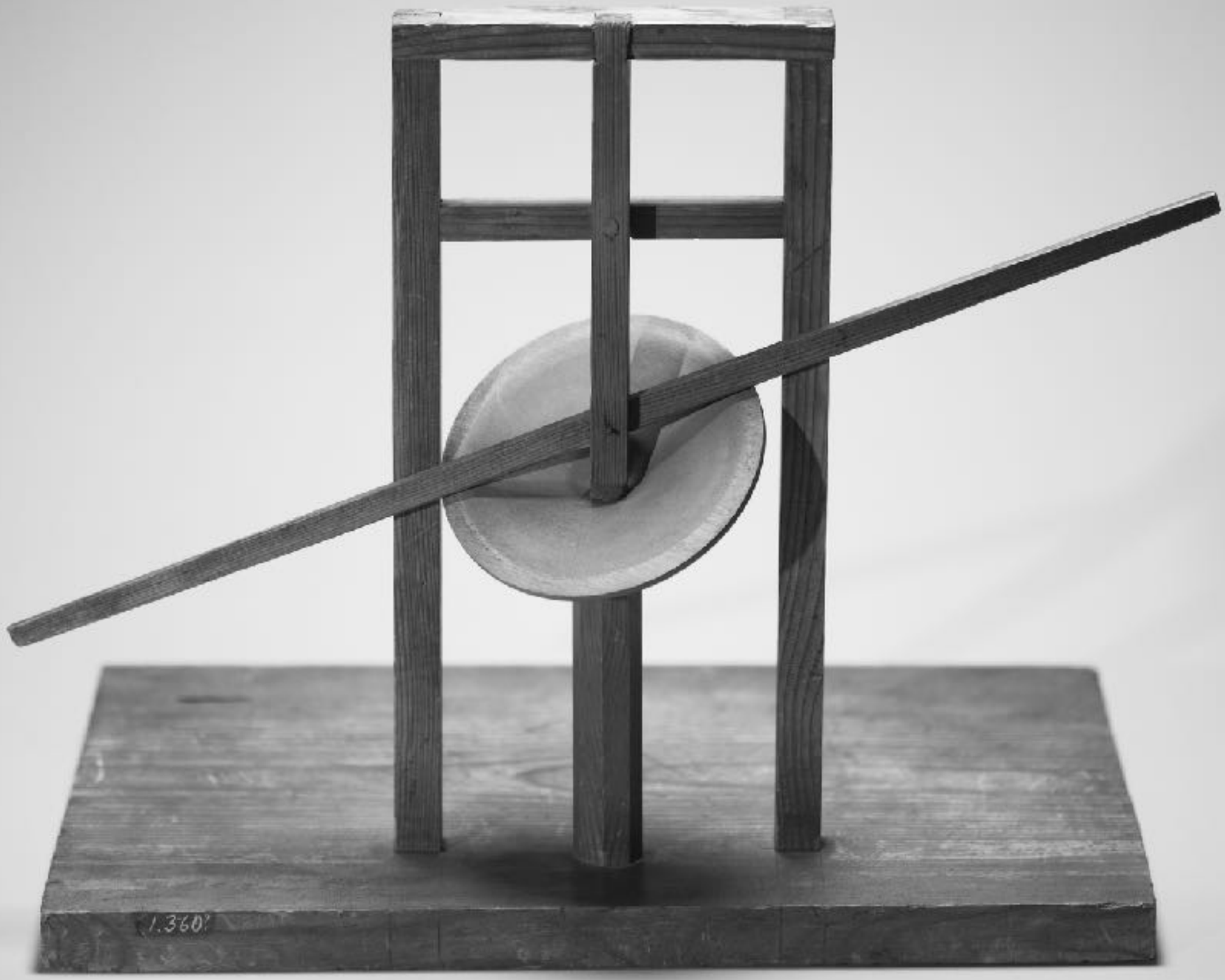






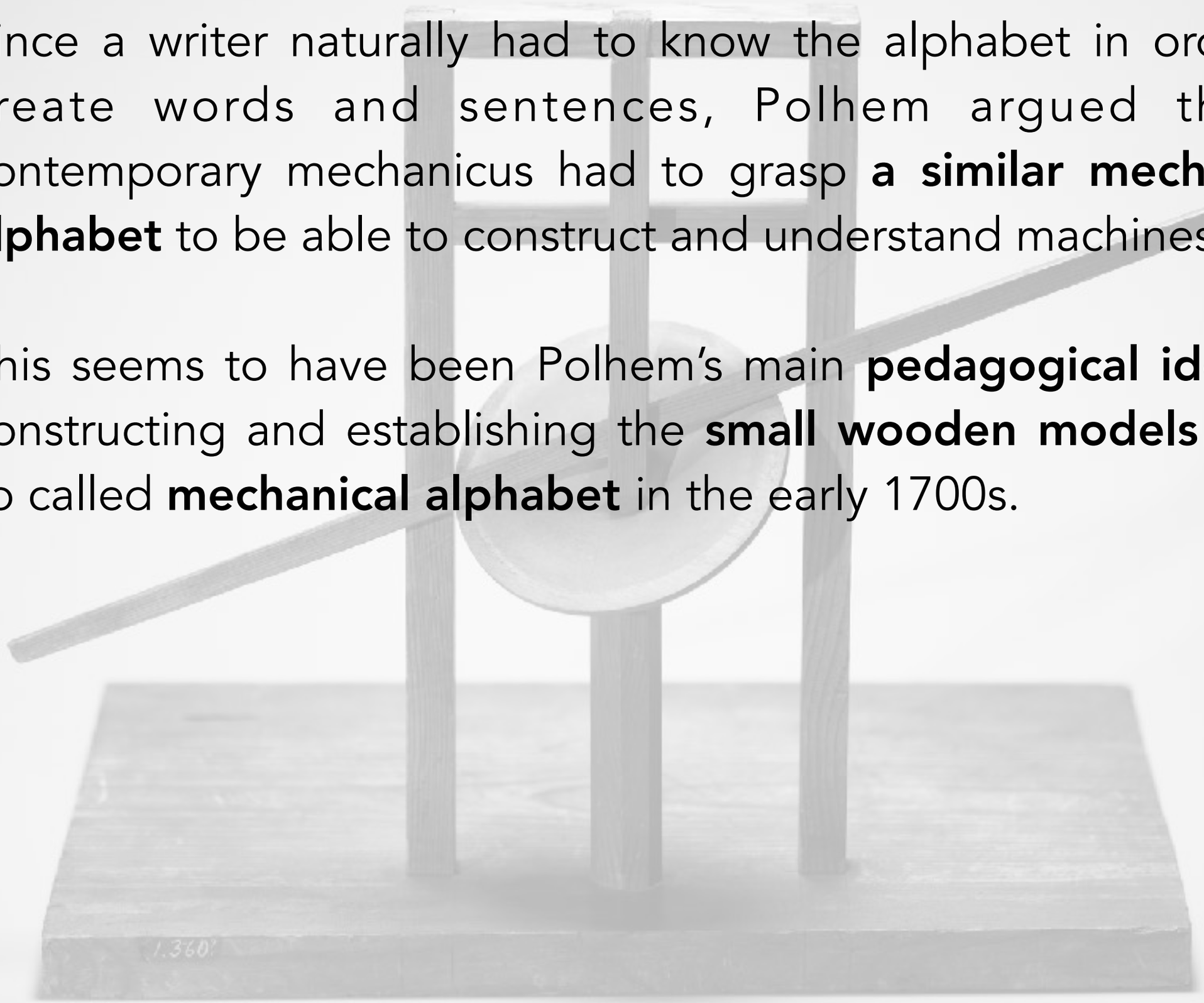


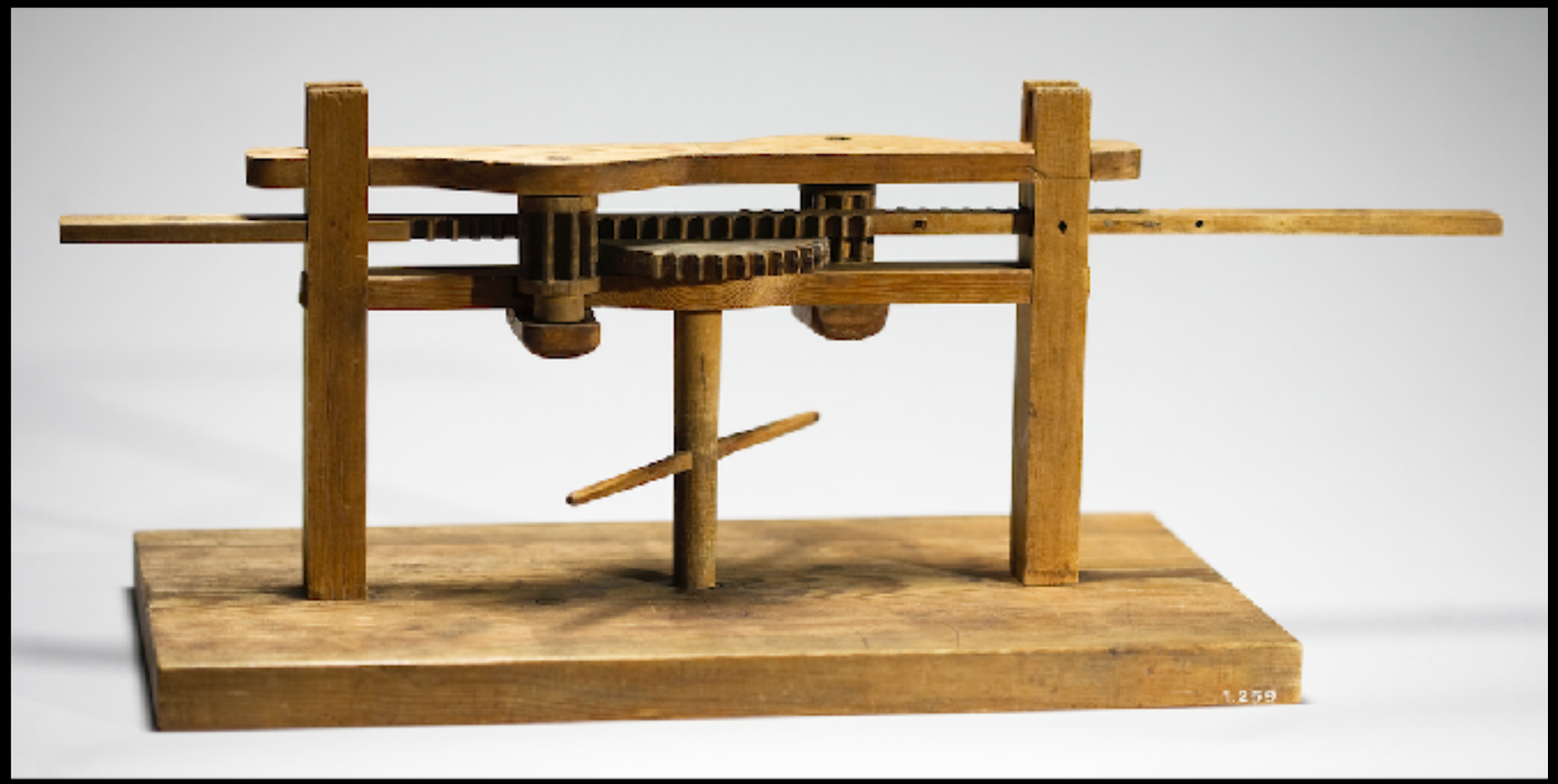
Christopher Polhem's hydro-dynamic "experimental machine" for water pressure measurements (1705).

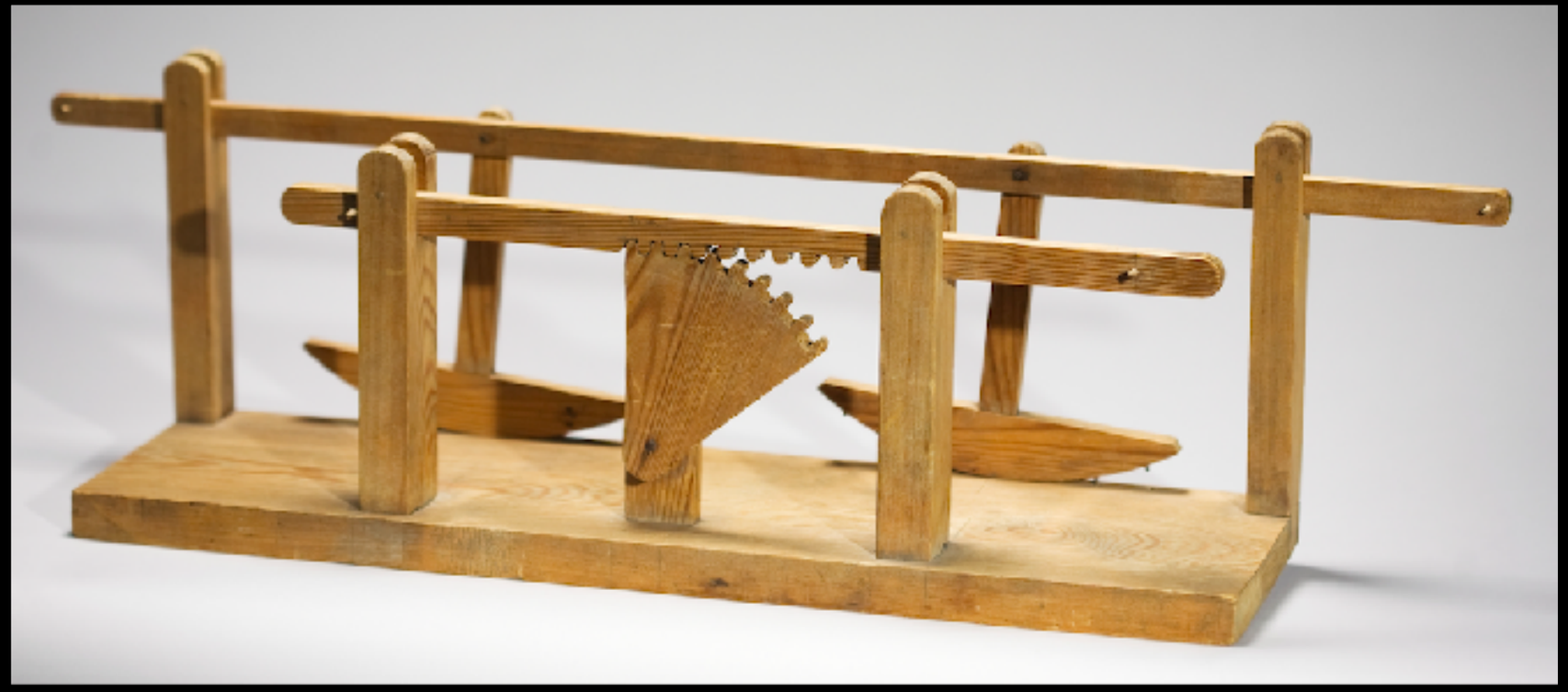

1.360

Since a writer naturally had to know the alphabet in order to create words and sentences, Polhem argued that a contemporary mechanicus had to grasp **a similar mechanical alphabet** to be able to construct and understand machines.

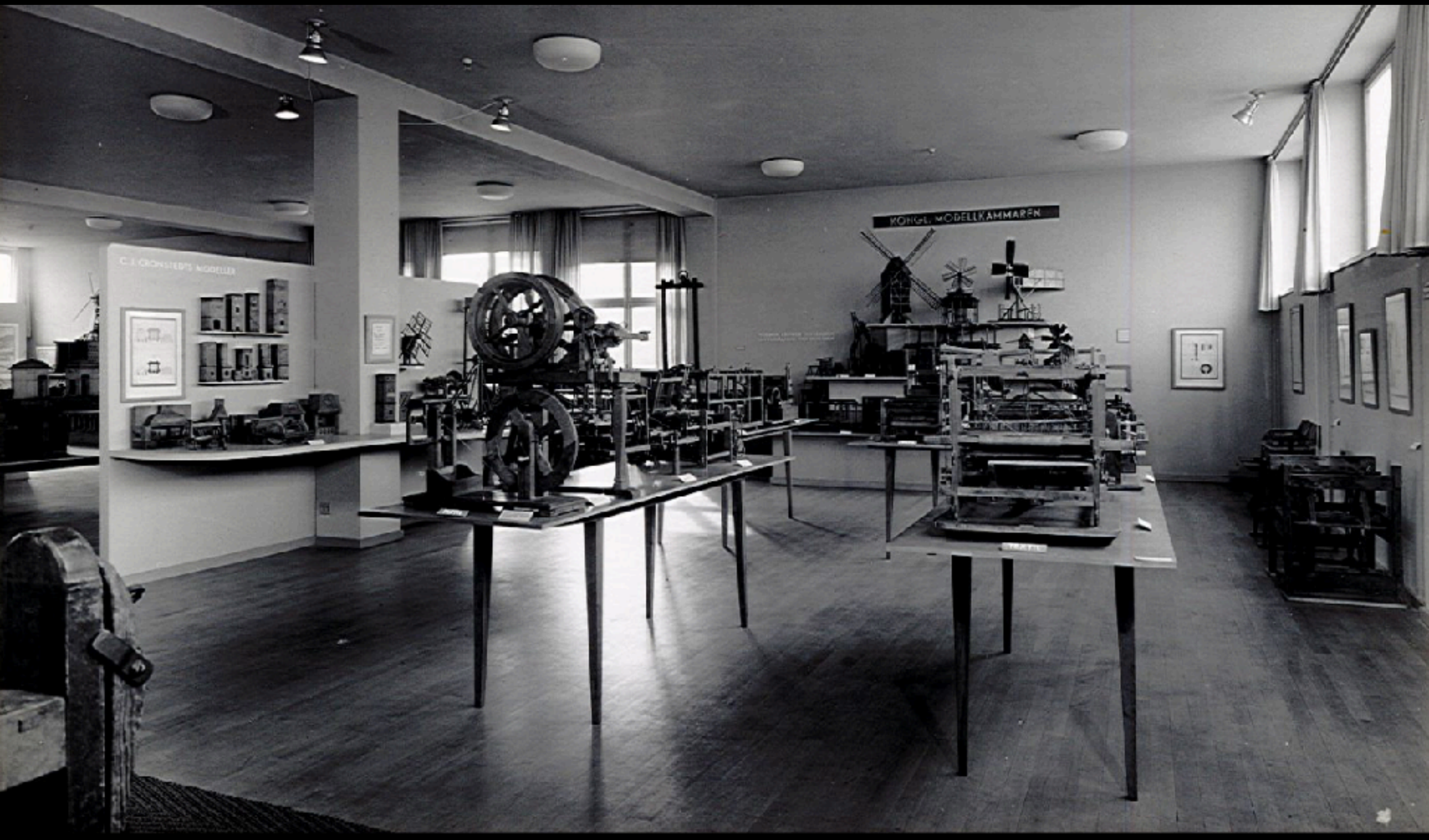
This seems to have been Polhem's main **pedagogical idea** for constructing and establishing the **small wooden models** in his so called **mechanical alphabet** in the early 1700s.





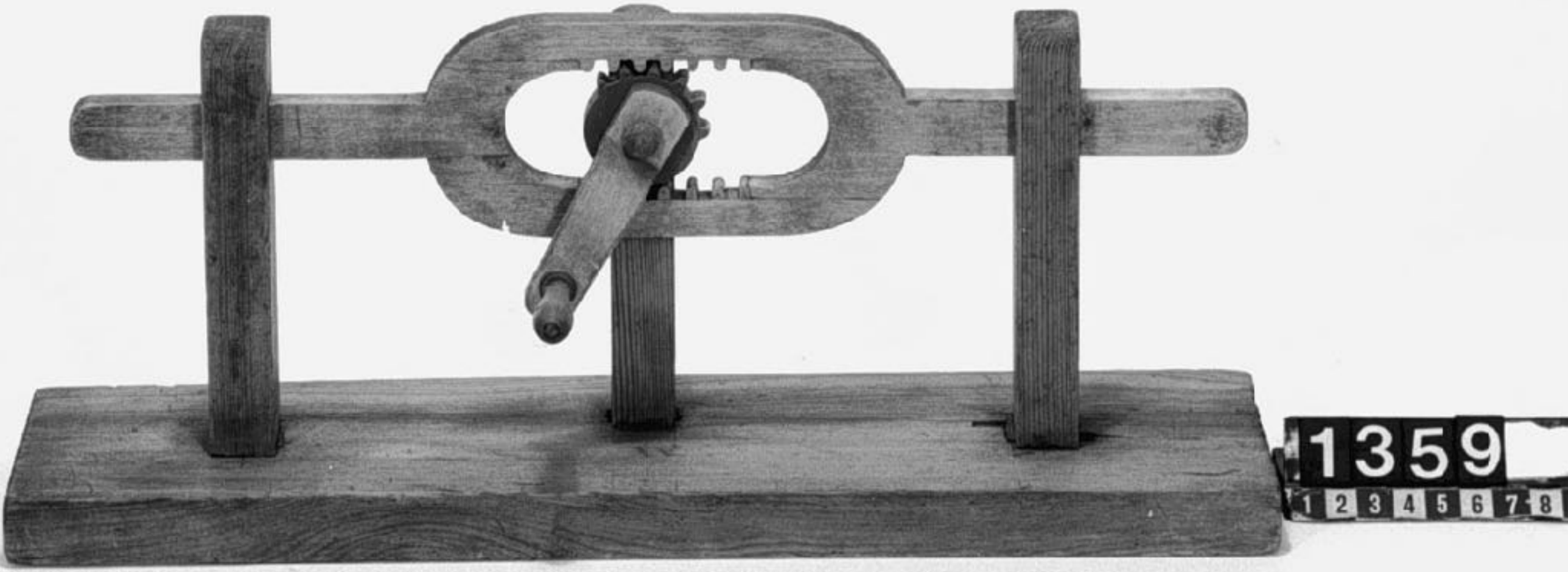


Models from Christopher Polhem's "mechanical alphabet" from the early 1700s. Actual models—whether in the form of originals or copies—can today be found at the Mining Museum in Falun as well as at the Swedish National Museum of Science and Technology in Stockholm.



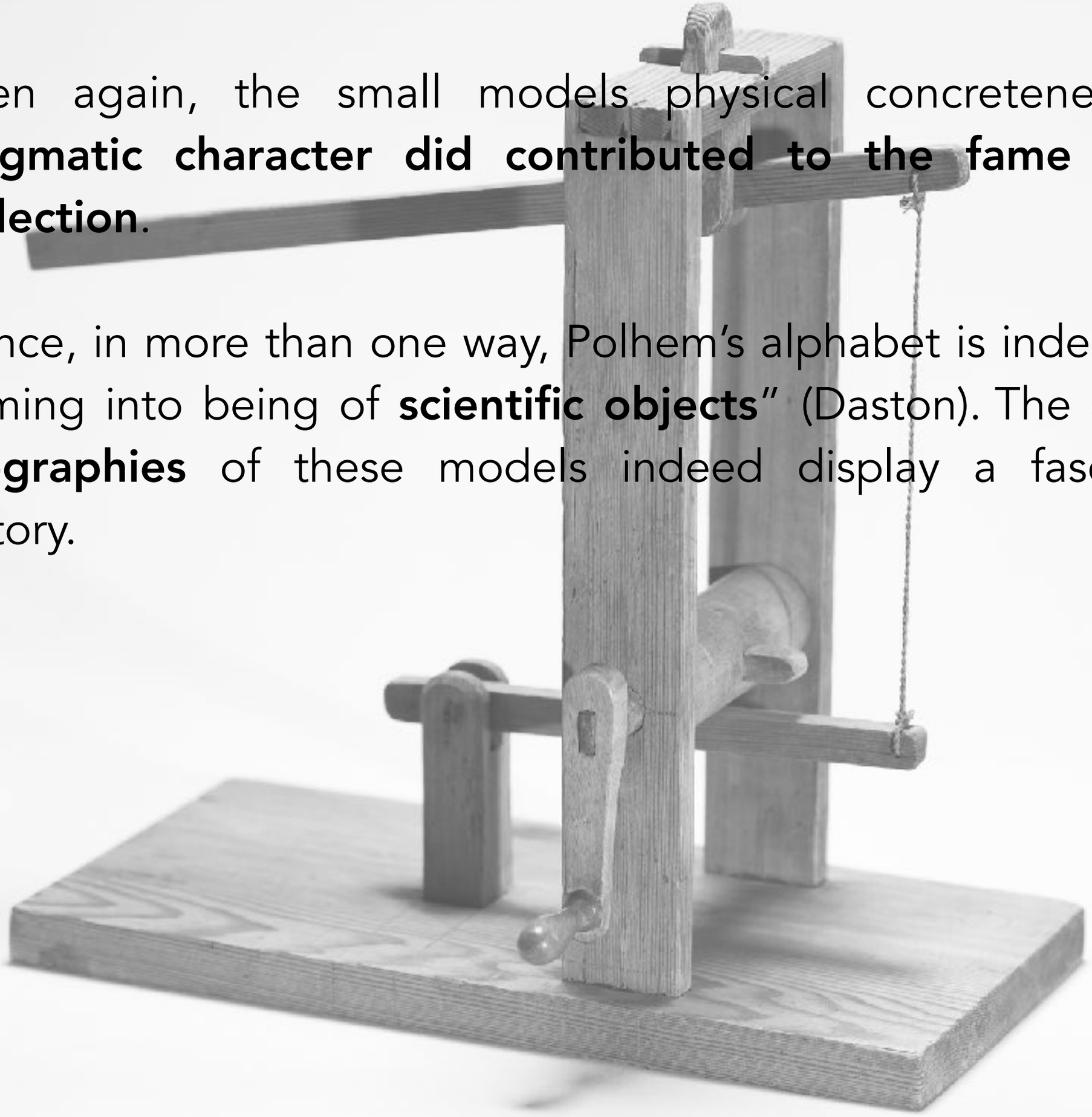
A representation of the Royal Swedish Model Chamber (with some original models) displayed at the Swedish National Museum of Science and Technology in 1947.

Swedish historians of science, however, have had a hard time to figure out **exactly what kind of letters**—or sentences—that Polhem's alphabet actually referred to.



Then again, the small models physical concreteness and **enigmatic character did contributed to the fame of the collection**.

Hence, in more than one way, Polhem's alphabet is indeed "the coming into being of **scientific objects**" (Daston). The **cultural biographies** of these models indeed display a fascinating history.



TAL

OM

NYTTAN

AF ET

Laboratorium Mechanicum,

HÅLLIT FÖR

KONGL. VETENSKAPS ACADEMIEN

AF

CARL KNUTBERG,

CAPITAINE MECHANICUS,

DÅ HAN DER BLEF SÅSOM LEDAMOT INTAGEN

DEN 16 NOVEMBER 1754.

På Kongl. Vetenskaps Academiens befallning.

STOCKHOLM,

Tryckt hos LARS SALVIUS, 1754.

INVENTARIUM

ÖFVER DE

MACHINER

OCH

MODELLER,

SOM FINNAS

VID

KONGL. MODELL-KAMMAREN

I STOCKHOLM,

BELÅGEN UTI GAMLA KONGSHUSET

PÅ

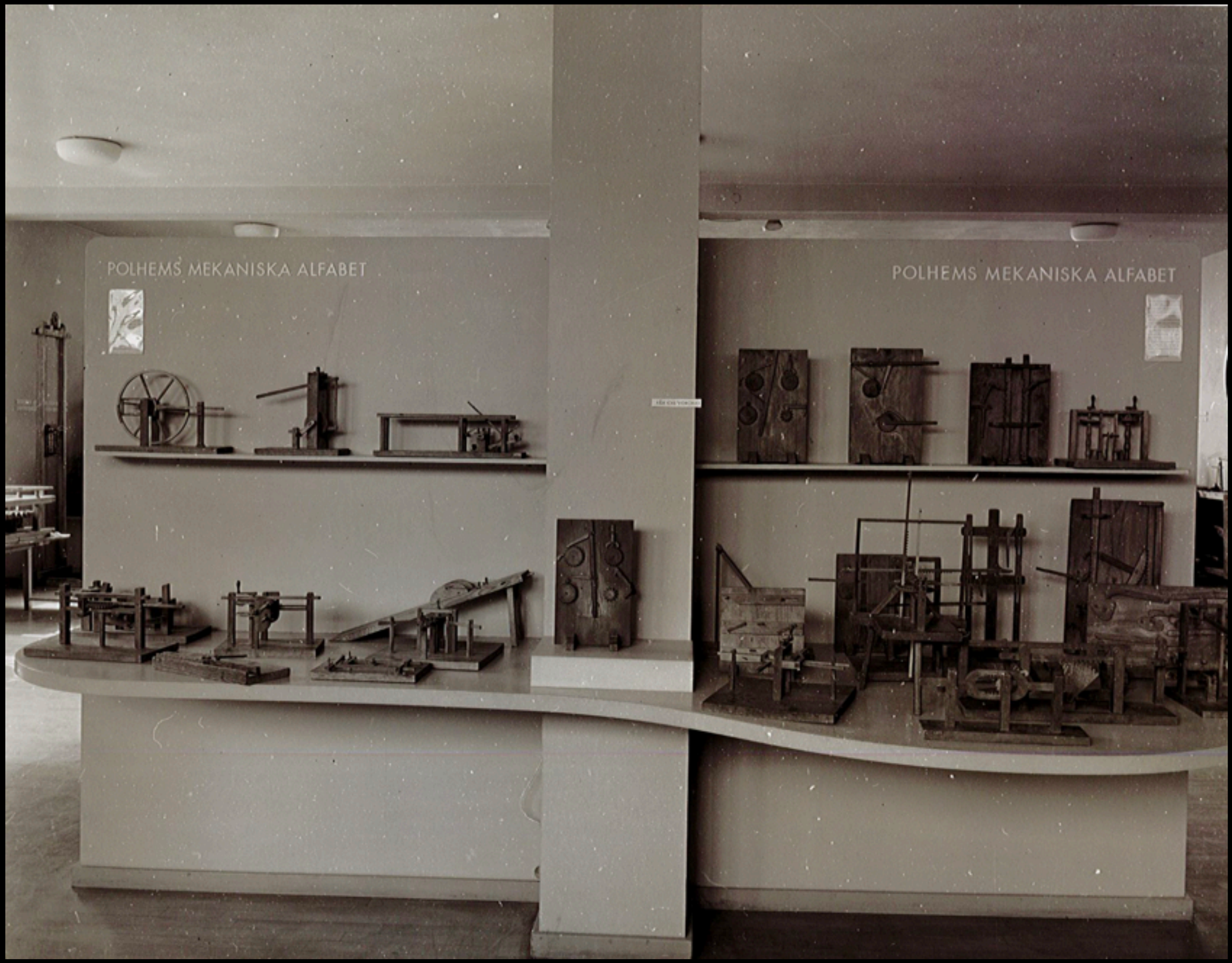
K. RIDDAREHOLMEN.

STOCKHOLM,

TRYCKT HOS ANDERS J. NORDSTRÖM. 1779.

Book frontispieces of Carl Knutberg's, *Tal om nyttan af et laboratorium mechanicum, hållit för kongl. vetenskaps academien* (Stockholm, 1754), as well as the inventory (of models and machines) at the Royal Swedish Model Chamber in 1779 (compiled by Jonas Nordberg), *Inventarium öfver de machiner och modeller, som finnas vid kongl. modell-kammaren i Stockholm, belägen uti gamla kongshuset på k. Riddareholmen* (Stockholm, 1779).

During the 19th century both the model chamber and the mechanical alphabet were used as **pedagogical equipment** at KTH. In the 1920s, Polhem's alphabet—and other remaining artefacts from the model chamber—were transferred to the newly established Swedish National Museum of Science and Technology.


POLHEMS MEKANISKA ALFABET
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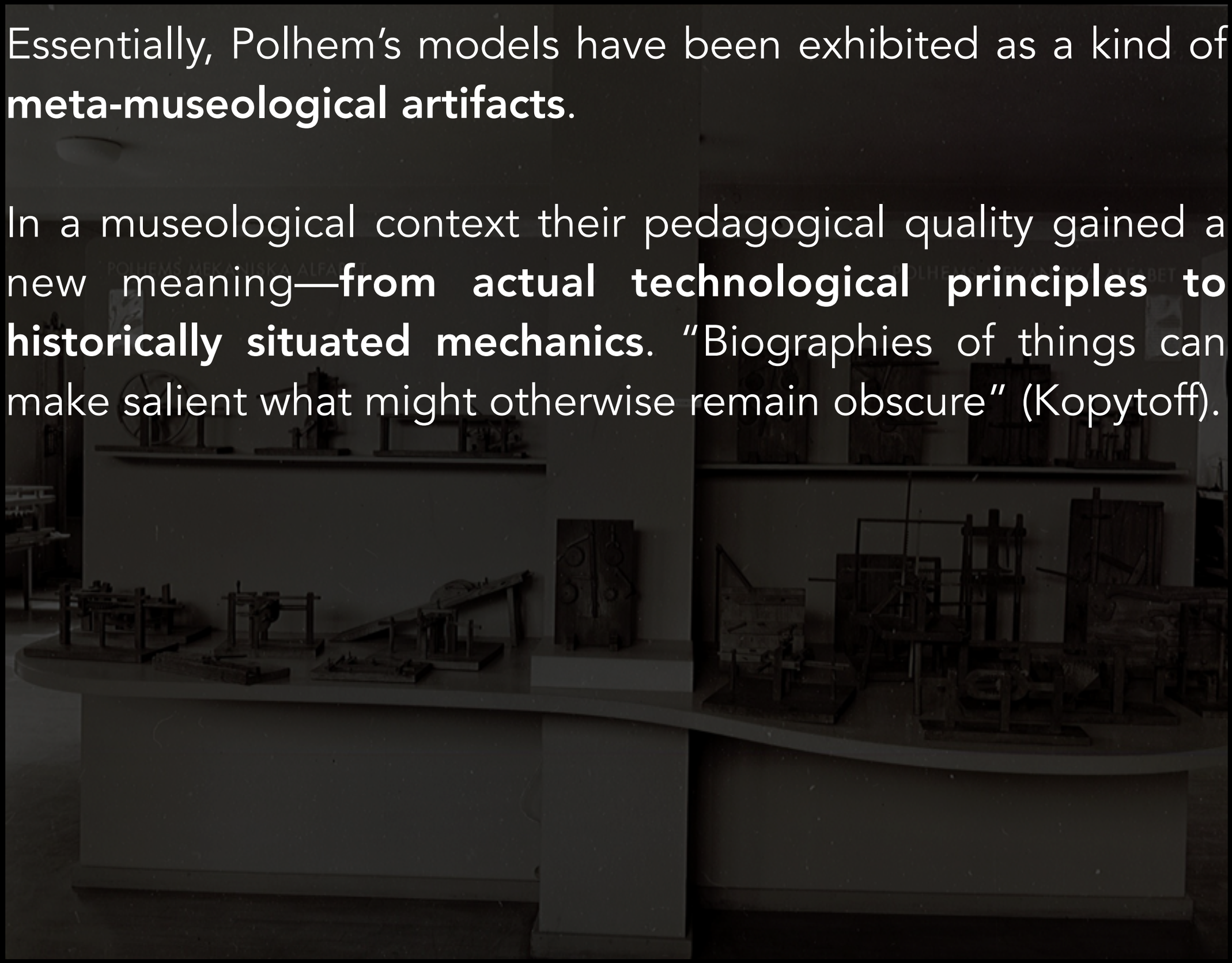
Essentially, Polhem's models have been exhibited as a kind of **meta-museological artifacts**.

In a museological context their pedagogical quality gained a new meaning—**from actual technological principles to historically situated mechanics**. "Biographies of things can make salient what might otherwise remain obscure" (Kopytoff).



Med utgångspunkt i Tekniska museets samlingar utforskar vi den digitala teknikens möjligheter att omgestalta industrialiseringens berättelser om samhälle, människor och miljöer.

Modell 1: Sahlins arkiv

Vår bild av industrialismen är fast cementerad i berättelser om framsteg, materiell utveckling och manliga bedrifter. Hur kan digital teknik hjälpa till att finna nya ingångar till befintliga samlingar, samt att nyansera och problematisera bilden av industrialismen?

Modell 2: Dædalus

Dædalus är en årsbok som alltsedan 1931 har publicerats av Tekniska museet. Projektmodell 2 handlar om att massdigitalisera denna tidskrift och studera dess totala textmängder i jakt efter lingvistiska och teknik-, miljö-, medie- och genushistoriskt signifikanta mönster.

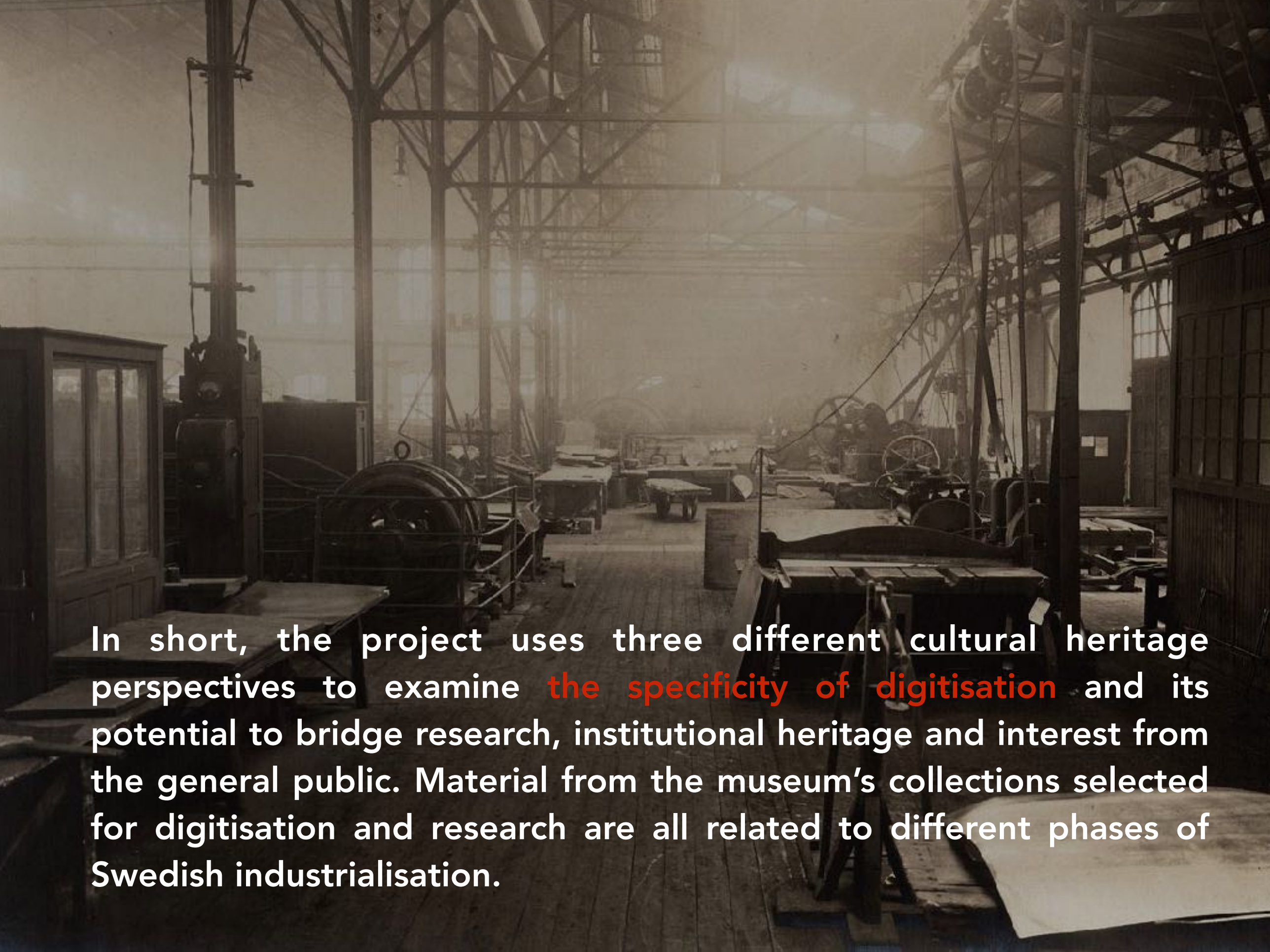
Modell 3: Polhems alfabet

Kan man utvinna ny historisk kunskap ur Christopher Polhems mekaniska alfabet som digital modell – och samtidigt använda artefakterna för pedagogiska ändamål som svarar mot samtidens behov?

http://digitalamodeller.se/

The research project “Digital Models. Techno-historical collections, digital humanities & narratives of industrialisation” is a collaboration between the Swedish National Museum of Science and Technology—located in Stockholm and with a national responsibility Sweden’s technical and industrial heritage—and the digital humanities hub, Humlab at Umeå University.

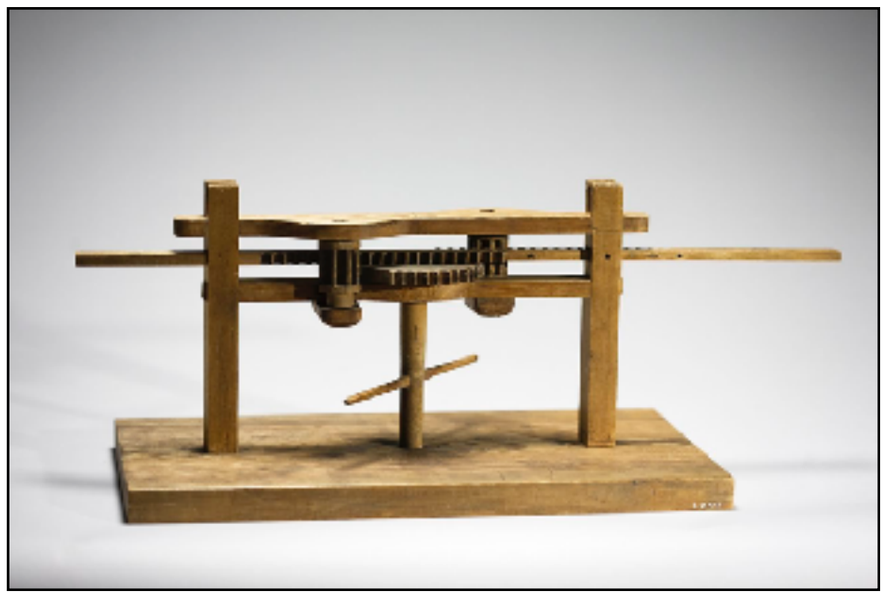
Based on selected parts of the Technical museum's collections the project explores the potential of digital technologies to reframe Swedish industrialisation and its stories about society, people and environments.



In short, the project uses three different cultural heritage perspectives to examine the specificity of digitisation and its potential to bridge research, institutional heritage and interest from the general public. Material from the museum's collections selected for digitisation and research are all related to different phases of Swedish industrialisation.

(A). Parts of the business leader and industry historian, Carl Sahlin's (1861-1943) extensive collection.

(B). All editions of the museum yearbook, *Daedalus* (1931-2014).



(C). 31 wood models from Swedish pre-industrial inventor Christopher Polhem's mechanical alphabet from the early 1700s.

3D Metamodeling

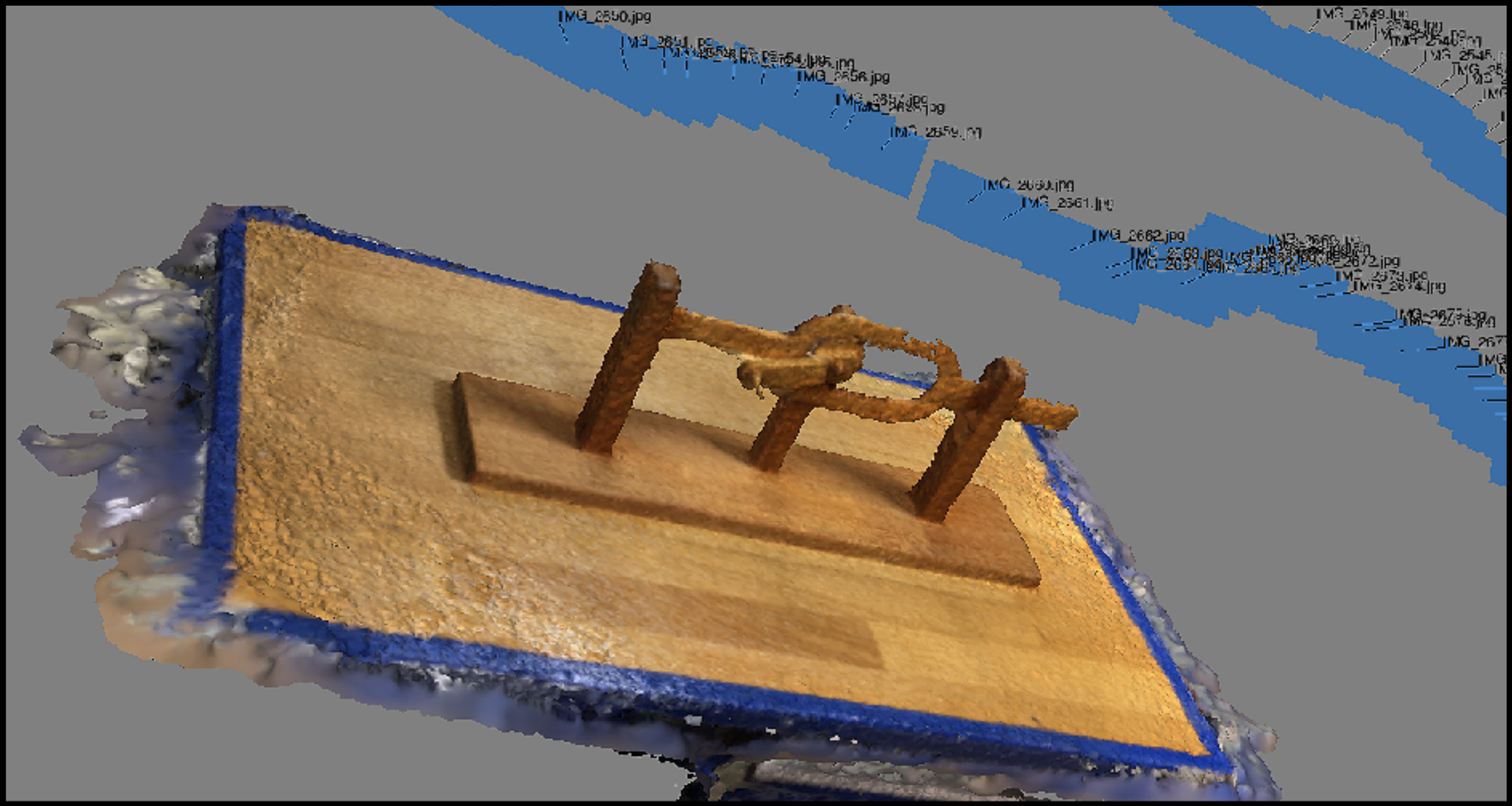
In order to investigate **the specificity of three-dimensional scanning, rendering and modeling**, we decided **to apply five different forms of 3D visualisations** of Polhem's alphabet—executed in **altered media modalities**.

I. Stupid Scanning

We used an ordinary iPhone—and the Agisoft Photoscan software—to repeatedly photograph one of Polhem's models.

Senaste import

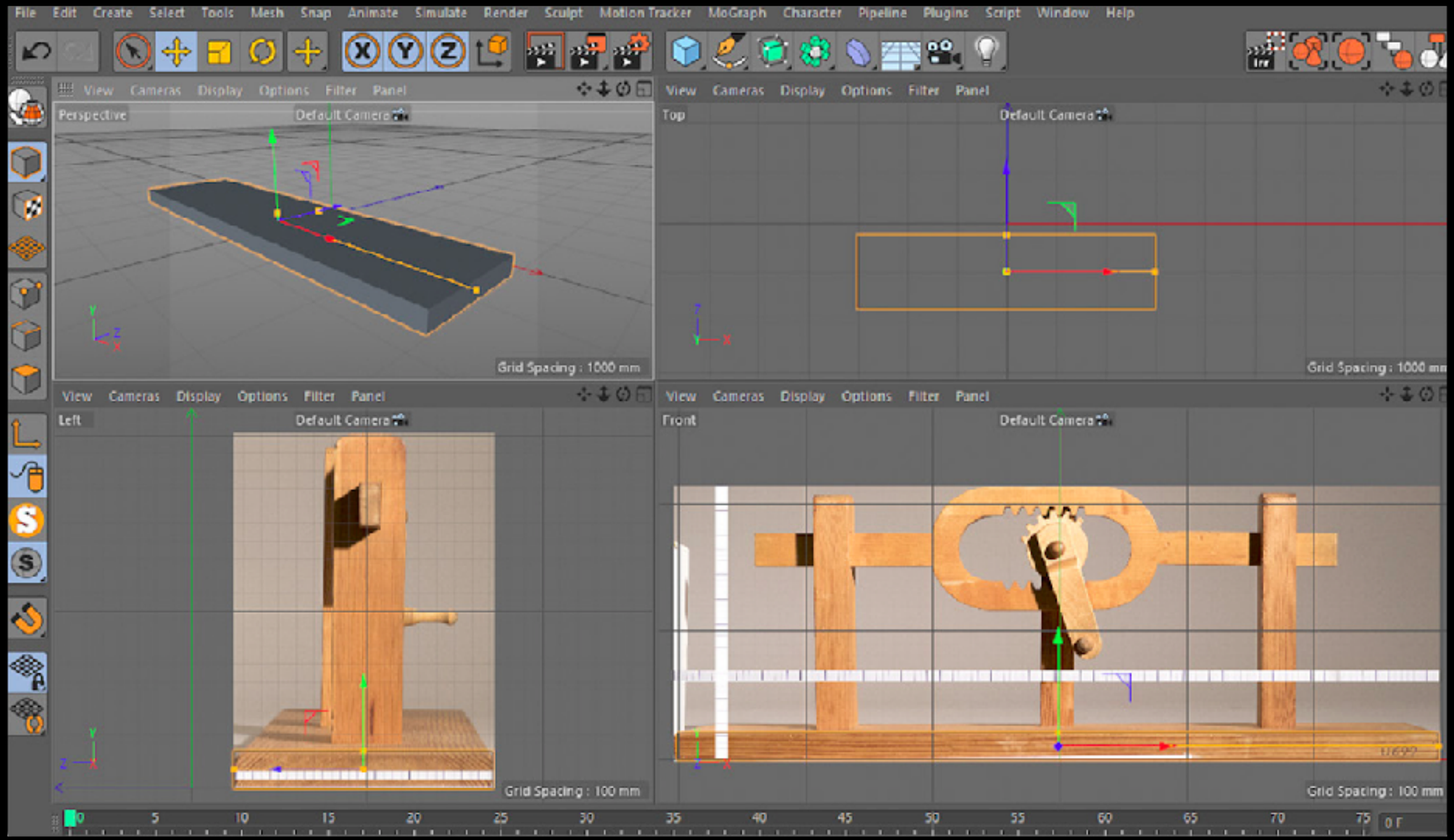
150 bilder



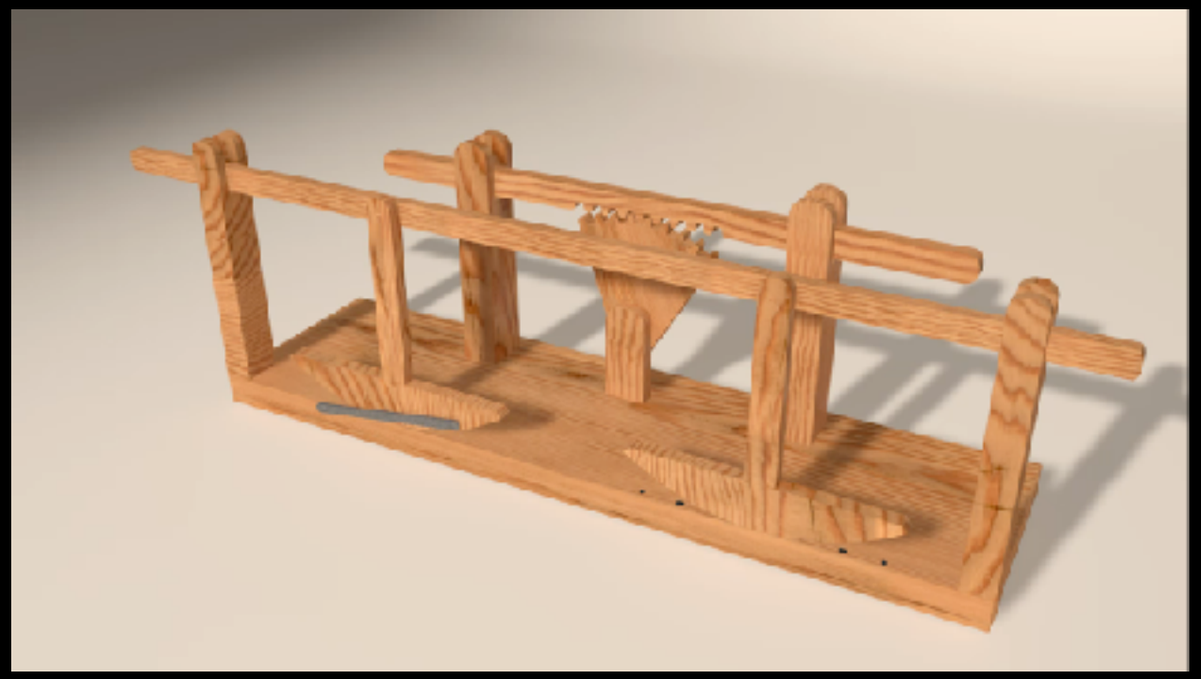
Simple scanning of one wooden model from Polhem's mechanical alphabet—using an iPhone and the software Agisoft Photoscan. The IMG.jpg-markers indicate where photographs were taken.

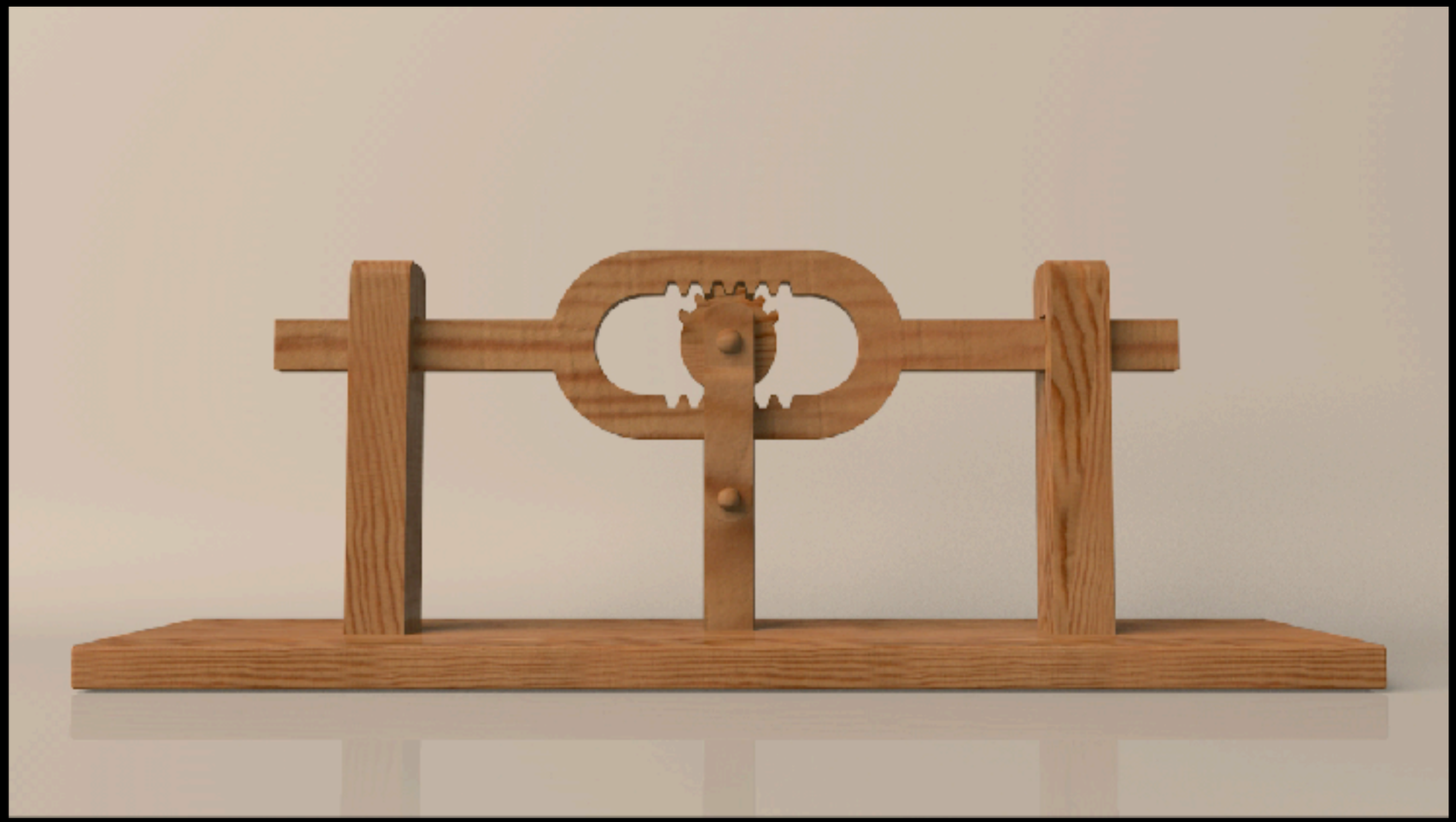
II. Computer Animated Models

We collaborated with the professional Swedish animator Rolf Lindberg who computer-animated some models (rather than scanning them).



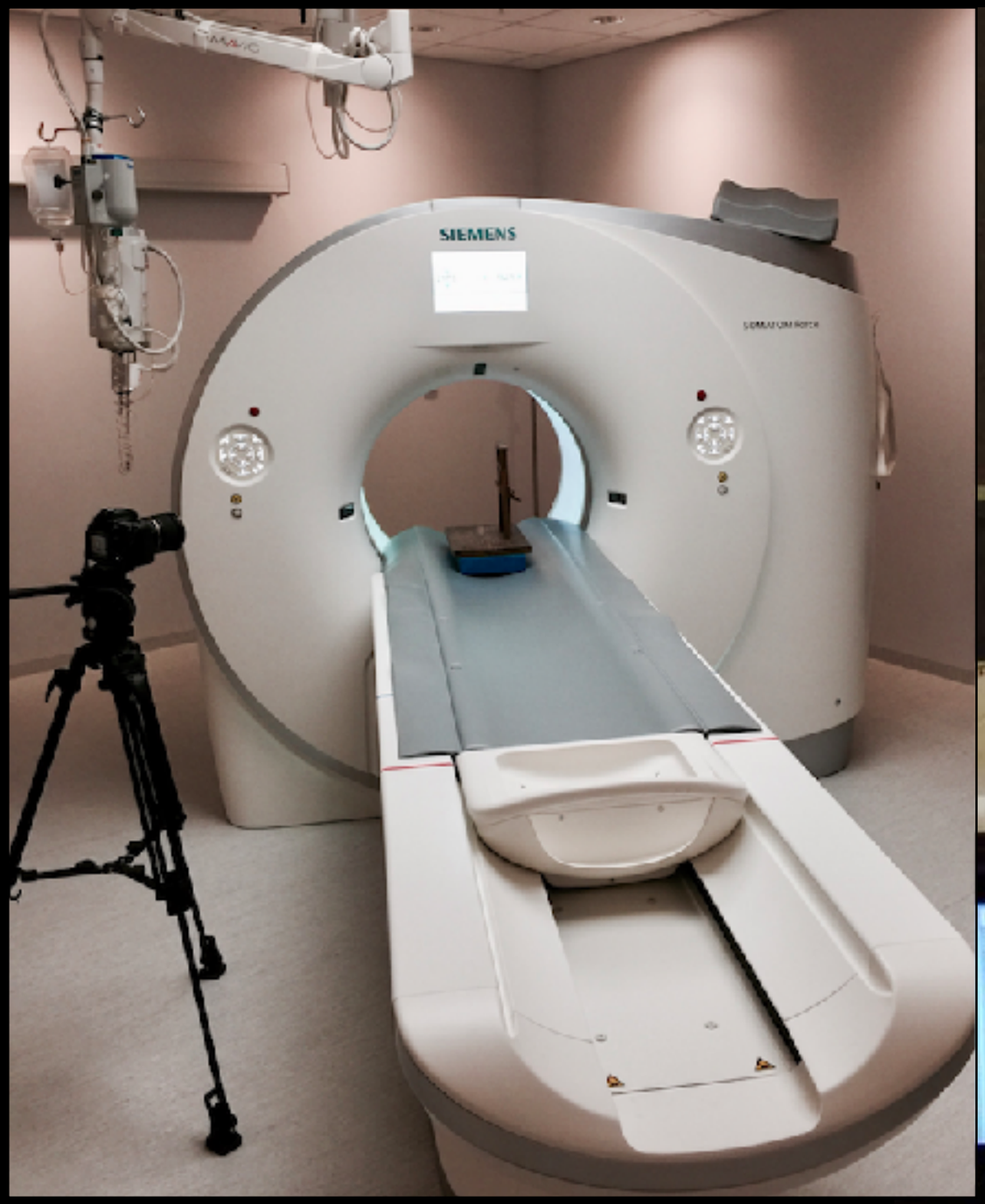
Rolf Lindberg simulated a model from Polhem's mechanical alphabet—by way of a few photographs—and constructed a brand new virtual object in the software Cinema 4D.





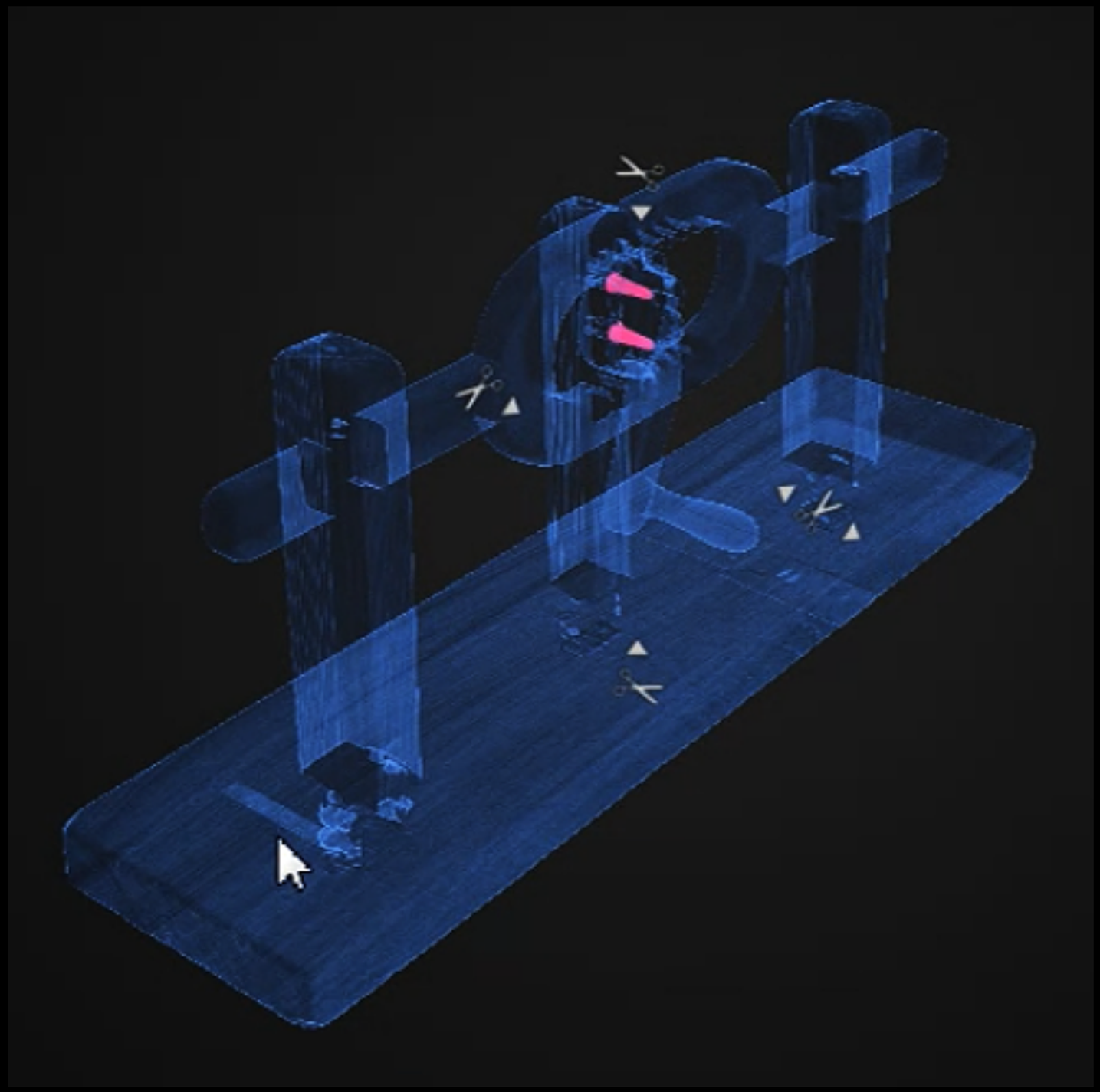
III. CT-Scanning Models

We CT-scanned some models—that is, X-ray computed tomography—at Linköping University Hospital in a collaboration with the Center for Medical Image Science and Visualization.



CT-scanning a model from Polhem's mechanical alphabet at the the Center for Medical Image Science and Visualization at Linköping University Hospital.


SIEMENS
SOMATOM Force
Image Acquisition Workplace
Image Acquisition Workplace



Inside Polhem—CT-scanning a model in collaboration with the company **Interspectral** made it possible **to see inside models** without breaking them.

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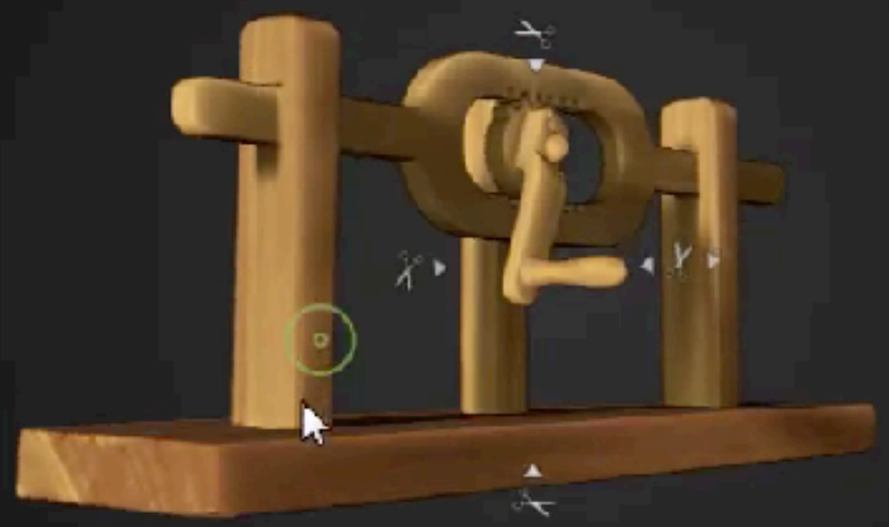


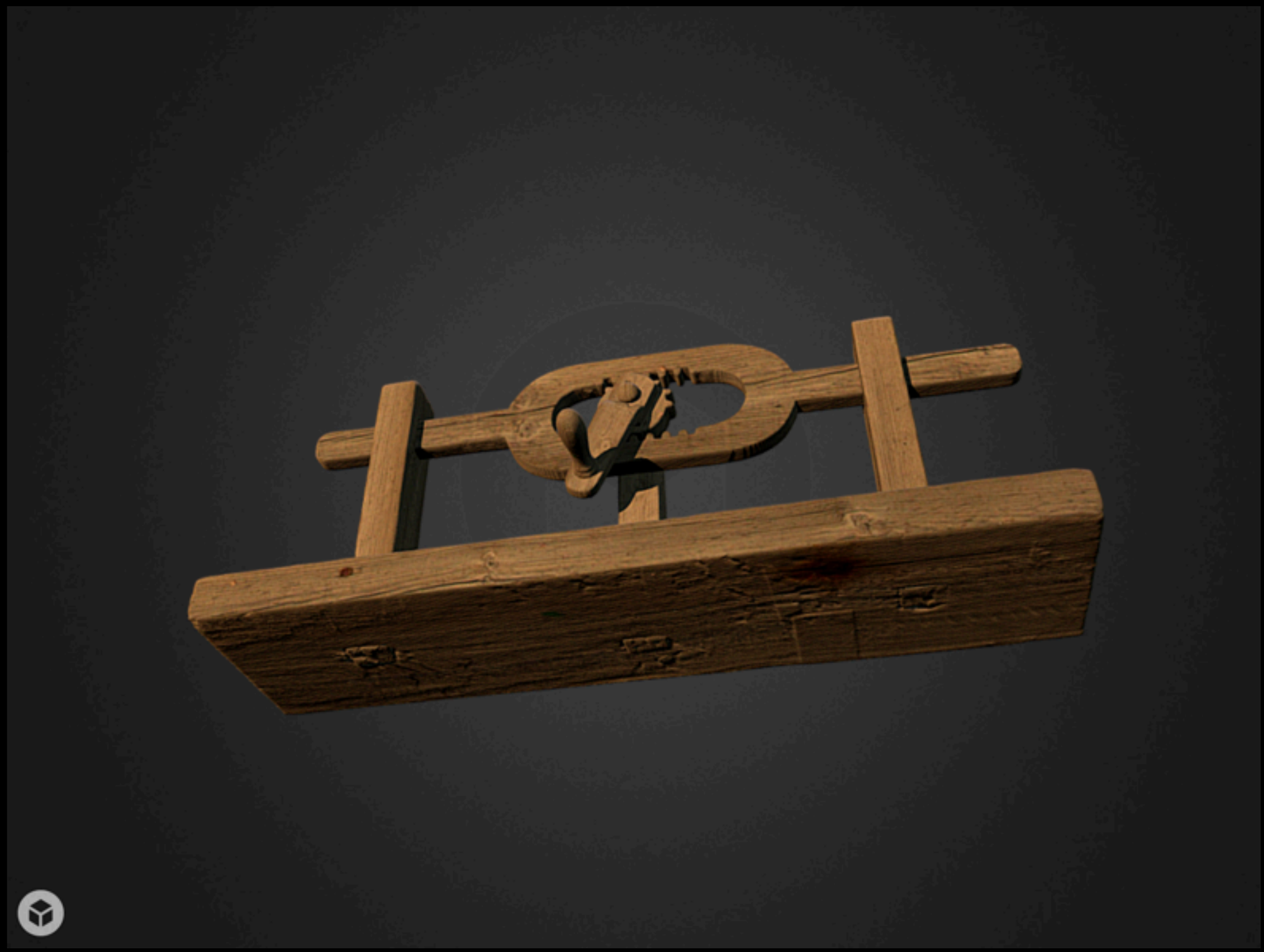
Solid Wood

Shell & Metal

IV. Student Scanning

We collaborated with two students that—training to become 3D technicians—who used **photogrammetry to make 3D visualisations of all models**.

Student photogrammetry



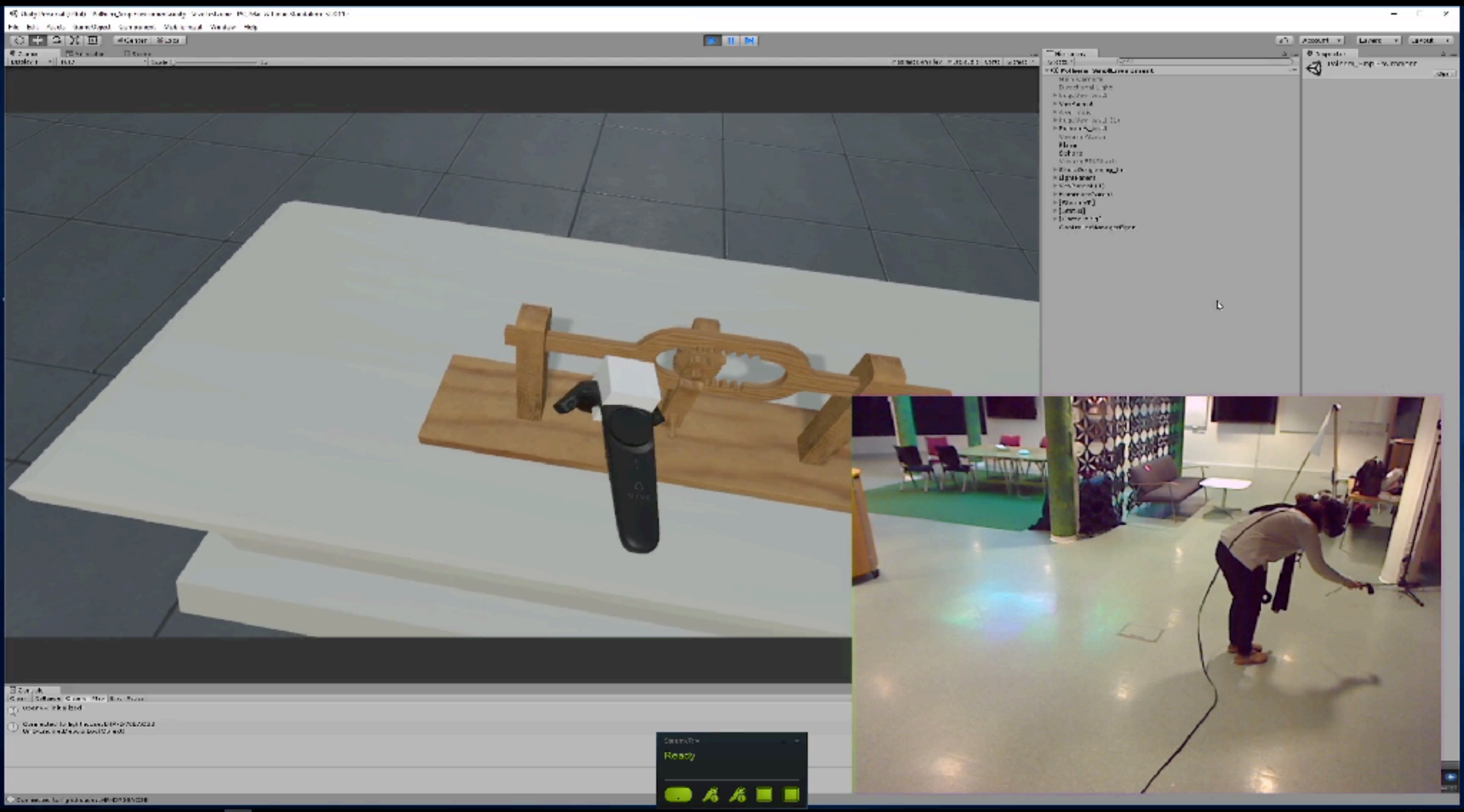
http://digitalamodeller.se/modell-3-polhems-mekaniska-alfabet/visualiseringar-av-modeller/

V. Remodeling the Swedish Model Chamber in VR

At Humlab we **re-modelled Polhem's mechanical alphabet by building a virtual reality model**—for HTC Vive glasses with the software Unity—of the **Royal Swedish Model Chamber around 1760**.

Trough the CT-scans we were able **to separate individual parts of models for reconstruction**—and in VR we thus inserted some of our differently digitised models.

VR simulation beta




2D Debug

To Conclude—3D Metamodeling

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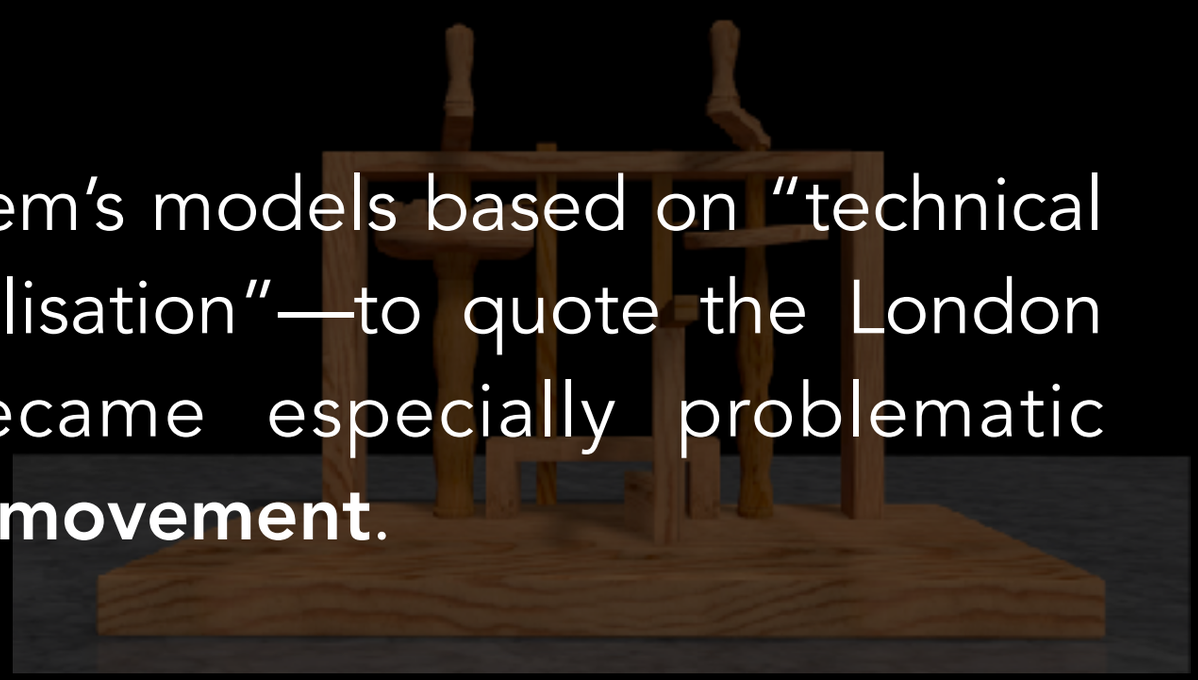
Essentially, the purpose of these try-outs of multiple scanning procedures—or perhaps models of models—was **to raise awareness within the heritage domain** that 3D digitisation and visualisations can be done in various ways.

To Conclude—3D Metamodeling

Using Polhem's mechanical alphabet as a case, different 3D digitisation methods will hence result in **representations that share some attributes with the original models**—but not all of them.

The difficulty in rendering Polhem's models based on "technical rigour in digital heritage visualisation"—to quote the London charter on 3D heritage—became especially problematic regarding animations of **model movement**.

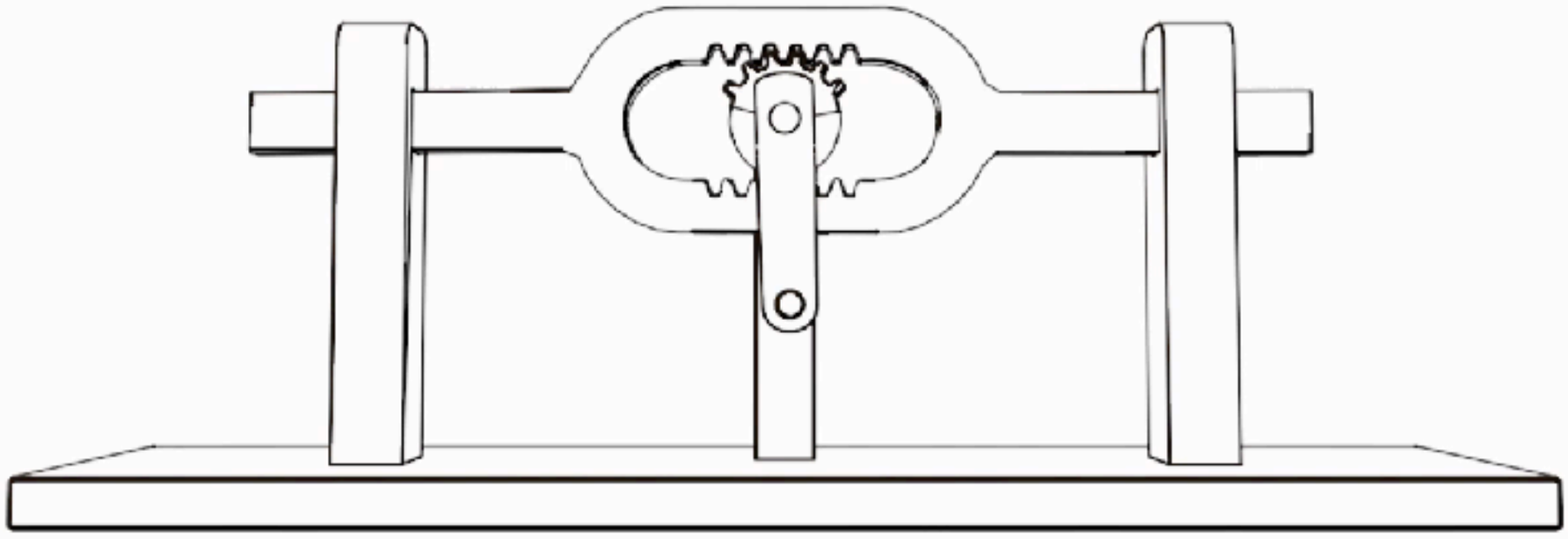


3D Metamodeling Movement

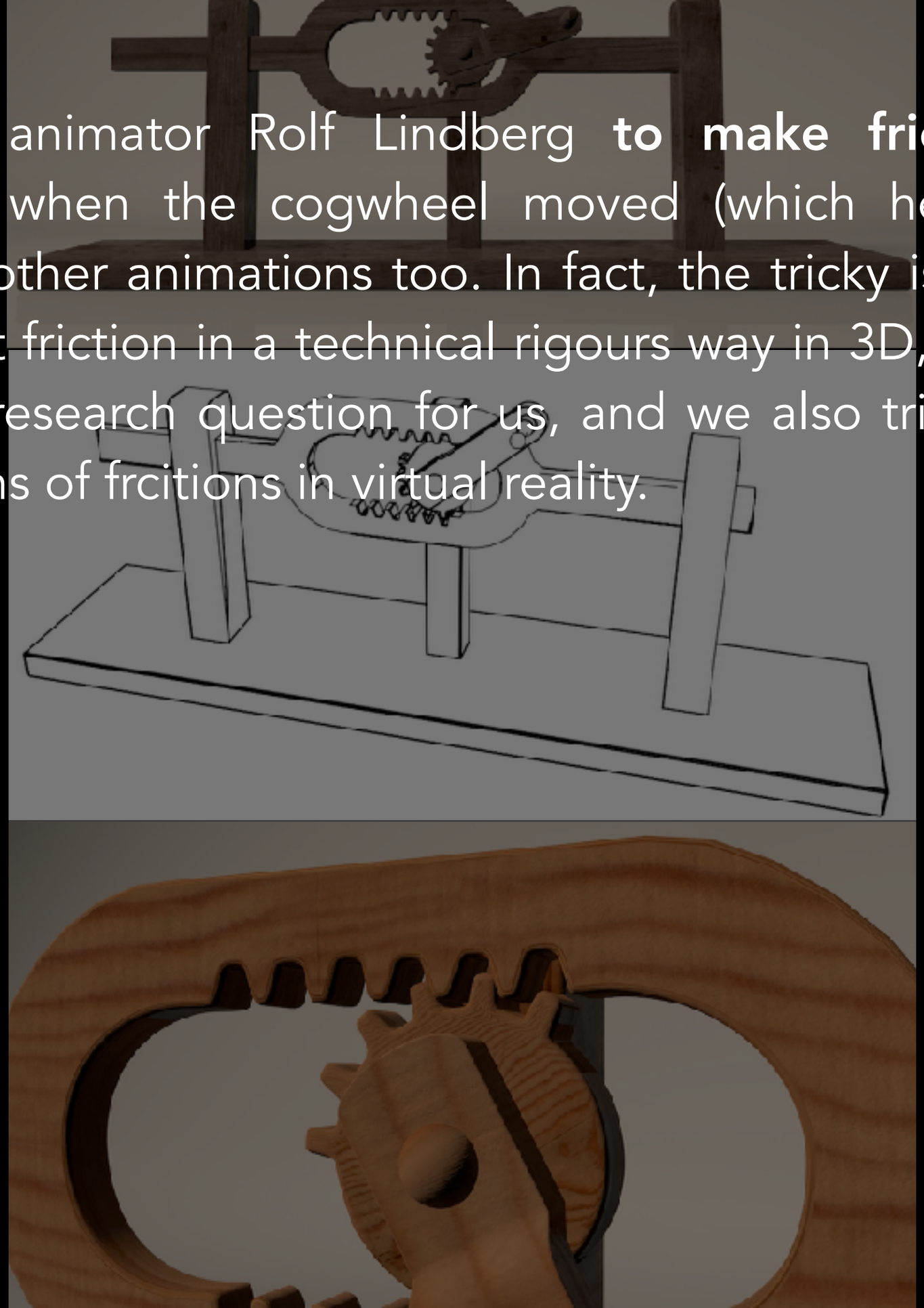
You can, for example, **move a 3D model around—but not move its parts**. In an animation, on the other hand, all parts move—but you **cannot steer movement yourself**. In **virtual reality you can do both**—but at the expense of transporting yourself to nowhere.

3D Metamodeling Friction

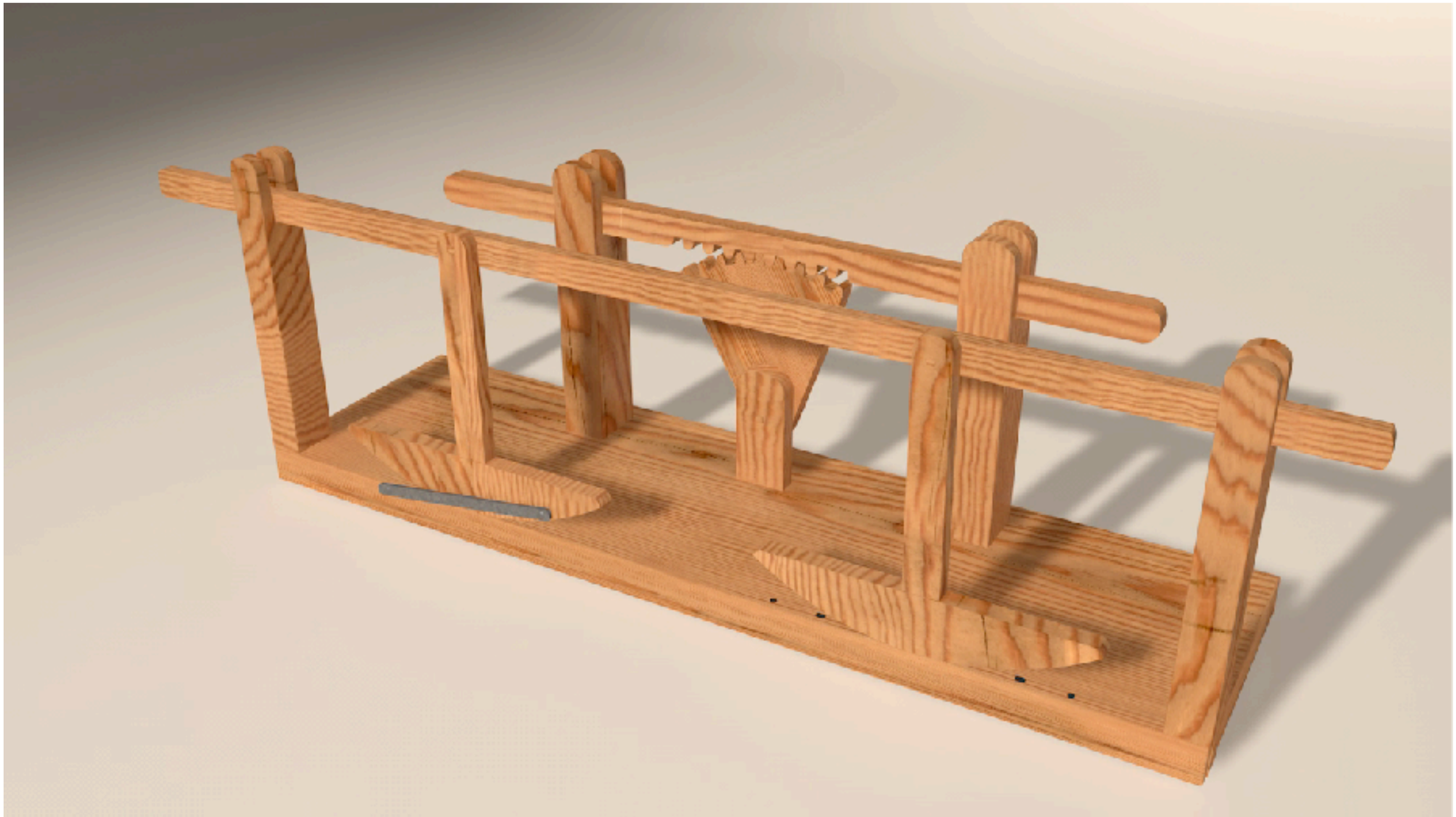
Friction was another matter related to movement. Naturally, **computer code** could make the cogwheel, for example (in one of the models), run completely smooth. In the original model, however, **the cogwheel caused a lot of friction; the model was built by wood after all**.



We asked animator Rolf Lindberg **to make friction more noticeable** when the cogwheel moved (which he did), and similarly in other animations too. In fact, the tricky issue of how to represent friction in a technical rigours way in 3D, became an interesting research question for us, and we also tried to insert various forms of frcitions in virtual reality.



3D Metamodeling Friction



3D Metamodeling Friction

As is often the case, digital representations are often too good. The problem is common in the heritage domain—how to deal with and think about the **exact representation of color, tinting and toning** for example, whithin **restoration of silent films**?

3D Metamodeling Friction

From a heritage perspective the question always comes down to **interpretation**. In a similar manner, **friction in relation to movement in Polhem's models also became a question of interpretation**, even if (in this case) we could actually look at the original models and see how they behaved friction wise.

3D Metamodeling Friction

Within the contemporary heritage domain the relation between **data and object** is currently being negotiated—at least as far as 3D visualisations are deployed and explored. They will, however, always cater (in one way or the other) to **interpretation of museological objects** selected for representation—even if institutions are **totally explicit and open about their digital practises.**

– thanks!

www.pellesnickars.se