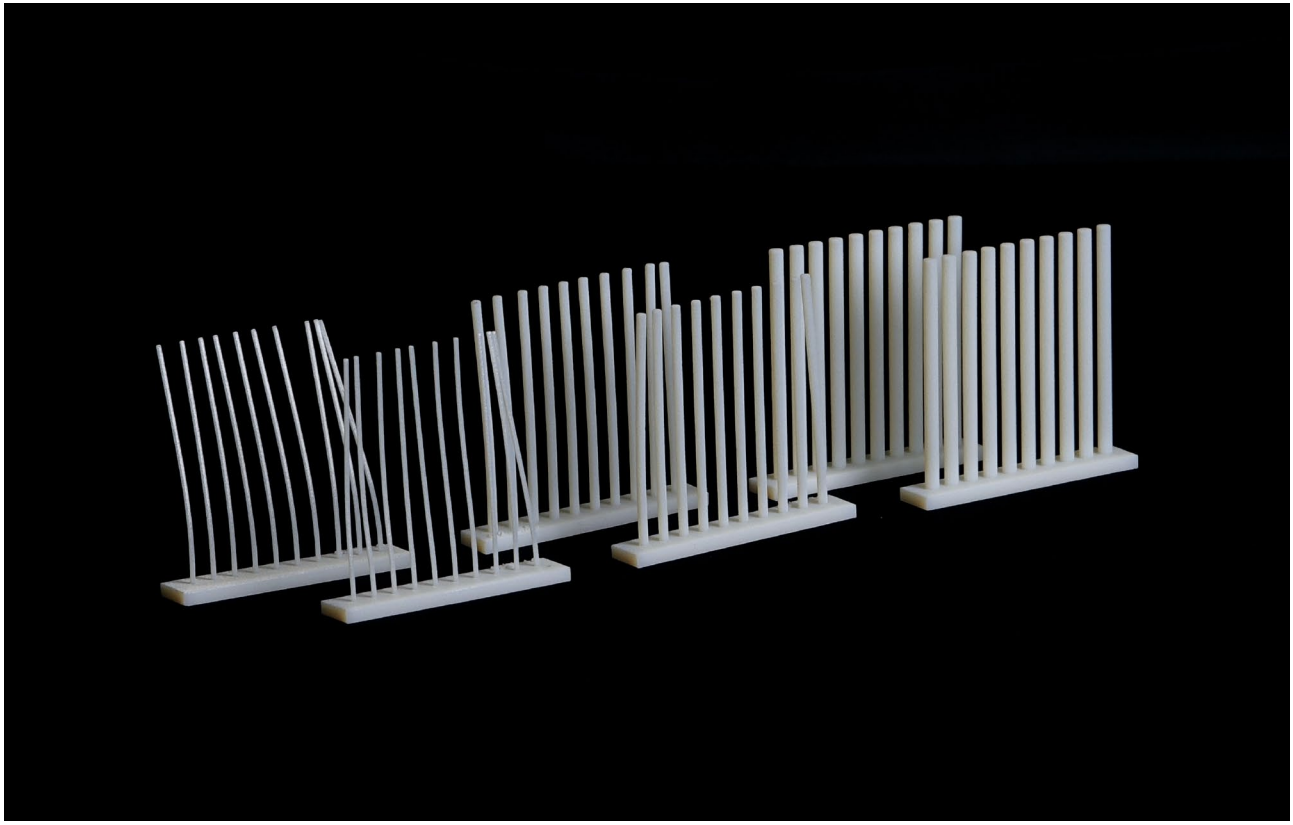
Finalist

3D-Materials for Mechanical Design and Drawing Education --Technical Assistance Through Experience

Tsutomu Araki



Tsutomu Araki “3D-Materials for Mechanical Design and Drawing Education --Technical Assistance Through Experience” 2017, Material: VeroWhite, Size: 55W x 53D x 10H (mm)

This is a collection of teaching materials for mechanical modeling, intended to deepen the students’ thinking, encourage critical assessment, and enhance their capabilities in creating the best products through the educational application of machine designing/ drawing and computer-aided design. We encourage our students to comprehensively experience and be educated by use of these materials for learning technical drawing, through user experience evaluation of student-designed shapes and functions, and trial production of blocks to learn about the processing accuracy or characteristics of 3D modeling machines. These are selected examples of our methods for supporting design and drafting education at our university.

Keywords: Teaching materials, Materials for drawing method, Hands-on experiences, Consciousness of modeling accuracy, Hints for 3D-modeling, Optimization

1 Materials for students to deepen their thought through hands-on experiences

Tsukuba University of Technology (NTUT) is the only higher educational institute for the hearing or visually impaired in Japan. In the Mechanical Engineering Course, we educate hearing-impaired students. And we educate with emphasis on Mechanical Design and Drawing because students with an engineering education typically go on to join a company where they are involved in design and CAD. Tsukuba University of Technology (NTUT) introduced an inkjet type 3D-modeling machine in 2007. Since then, we have been using the machine for the education of design drawing, and collecting data on experience and knowhow for effective use. Utilization of 3D-CAD and 3D-modeling at our university is a means of motivation and communication for high quality design and drafting education for hearing-impaired students. The model introduced here is part of the teaching materials for the development of education.

2 Works of 3D-model as teaching materials

2-1 Handle lever: Teaching material of function of lever

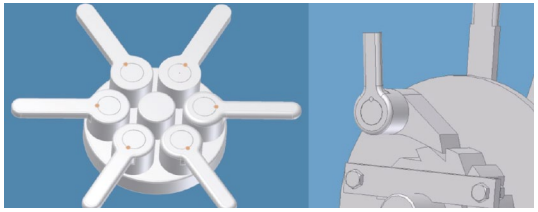


Figure 1: Aseenbled handle levers FILLET R0, R1, R2, R3, R4, R5 on a Exhibition stand (Left side), Usage of a handle lever for Ratchet wheel of Hand winch (Right side)

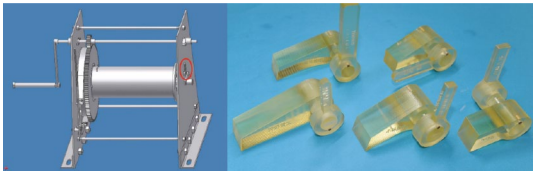


Figure 2: Hand winch's handle lever (Left, in a red circle), Students' design for hand winch's Ratchet wheel (Right)

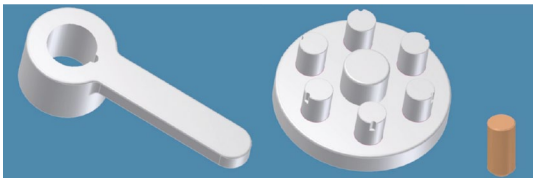


Figure 3: Handle lever R1 model, Exhibition stand and pin

grip condition of each fillet.

Teaching materials to try and feel in one's own hands. Students will be able to optimize their mechanical design. One of the small stacks to improve one's own sense of design.

2-2 M20 Teaching materials of Bolt screw: 3D-model for Exercises on Machine Design Drawing and Practice of Manufacturing Processes as a Teaching material.

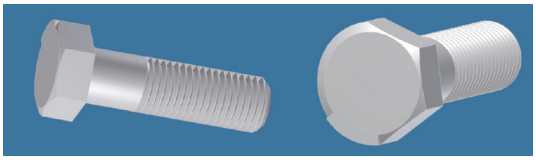


Figure 4: M20 Bolt as a Teaching Material

When producing with a 3D-modeling machine output at 200%.

2-3 Projection teaching material: projection drawing method

Teaching material for explanation of projection method. Made with transparent material. You can see the same explanatory symbol as in the textbook on each side.

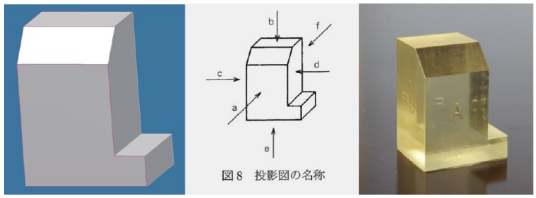


Figure 5: 3D-CAD data, Size: 40W x 30D x 50H (mm) and 3D-modeling (Right side), Figure from textbook (middle side)

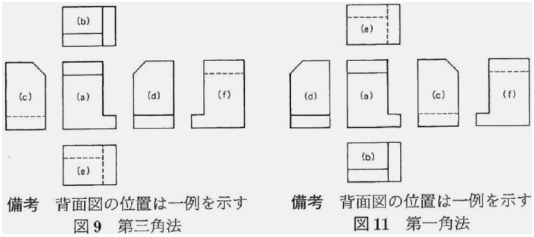


Figure 6: Figure from textbook

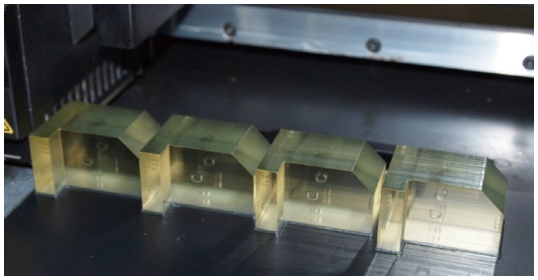


Figure 7: Easy to produce by 3D Printer

2-4 Materials for teaching of drawing: Teaching materials to show how to draw in the same form as the diagrams of textbooks and to gain a better understanding.

Produced as a model to use for explanation of drawing.

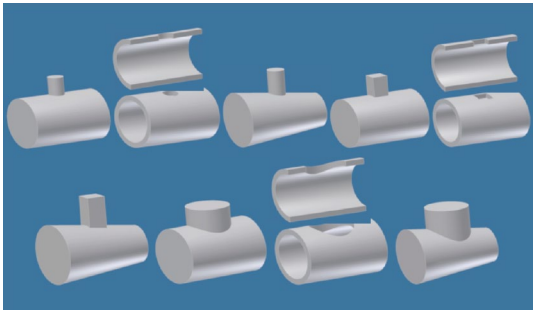


Figure 8: Teaching materials 3D-CAD data for simplified drawing example of intersection same as text book

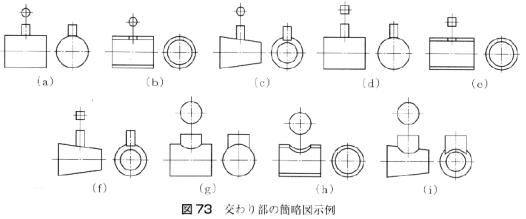


Figure 9: Simplified drawing example of intersection, figure from textbook

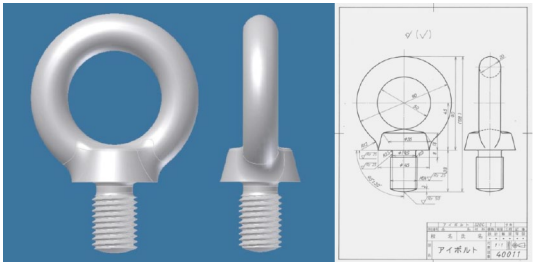


Figure 10: Eyebolt, 3D-CAD data and figure from textbook

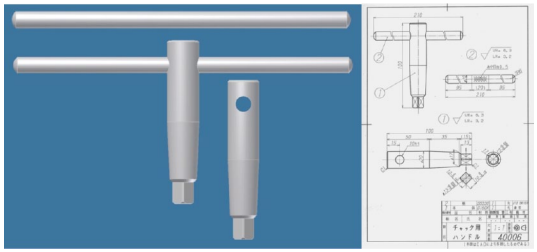


Figure 11: Chuck Handle, 3D-CAD data (assembled data and parts) and figure from textbook

A model for showing the same shape as the drafting sample of the textbook.

Even if the real standard of the same standard exists in the factory, it is often different from the form of the drawing model of the drawing textbook.

For example; “Eyebolt”, “Chuck Handle”.

2-5 Assembling on the 3D-CAD monitor / Assembling real parts by 3D-modeling machine: Experiencing assembling on a monitor of 3D-CAD and assembling real parts which are made by 3D-modeling machine.

Insert a shaft of diameter 10 mm into a diameter 10 mm hole. Although parts can be assembled on the monitor of 3D-CAD, the producted axis by this size does not enter the hole in the real model of this size. Please try it.

You will be able to recognize that it is necessary to think about dimensional tolerance for the machine design.

2-6 Considering that it is made with a 3D-modeling machine according to 3D-CAD drawing data: Test pieces for effective useage of 3D printer features

Awareness of processing.

Consciousness of modeling accuracy.

a. Models for consciousness of modeling accuracy of 3D-modeling machines

Shafts and bearings are often used for precision mechanism models. Regarding to the dimensional accuracy: It is important to compare the dimensions of the drawing data of length, width and height with the actual size of the height, width and height of the 3D-model, and to know the machining accuracy of the 3D-machine. When manufacturing a cylinder (shaft) or a perfect circle (bearing) by 3D-modeling machine, check the machining dimensional accuracy of the 3D-machine by horizontal placement and vertical placement.

These are models for consciousness of modeling accuracy of 3D-modeling machines.

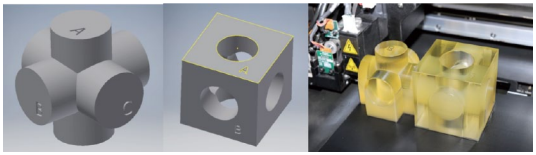


Figure 12: Test pieces by 3D-CAD data and 3D-modeling ϕ25 x 50W x 50D x 50H (mm)

b. Model for the possibility of shaping --Performance check: Precise forming for 3D-machine and Deforming for materials (ϕ1, ϕ2, ϕ3, 50mm(H))

Whether precise shaping is possible at a height of 50 mm

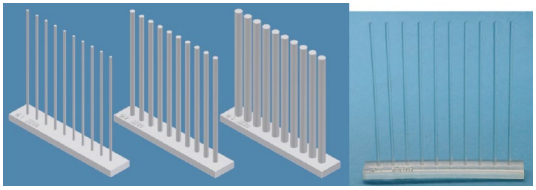


Figure 13: ϕ1, ϕ2, ϕ3 x 50H(mm), ϕ1_3D-modeling

with a diameter of 1 mm. It may be deformed with the passage of time due to the shaped material. For our 3D modeling machine and materials, we can shape them. However, in the case of a 1 mm diameter pillar, it bent after making it.

2-7 A model offers the possibility of manufacturing as an industrial product, even though it can be made with a 3D- modeling machine

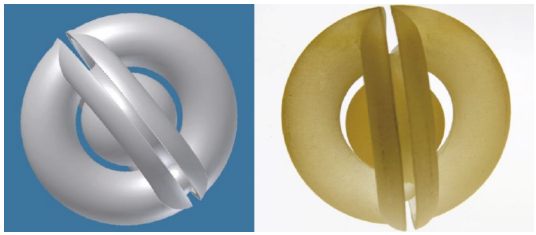


Figure 14: 3D-CAD data (L) and 3D inkjet modeling figure (R)

2-8 A model that allows you to think about devising when making with 3D-modeling (a model that makes you think of the necessity of ingenuity)

Good model for PR-Car use.

Precise model as one sample of 3D-modeling for it can be cheap.

--- Scale: Output size 10% of 3D-CAD modeling data (make it easy to draw output with the desired percentage size).

Make a slit to remove support agent with jet water stream at the bottom of the car that is under the shaft.

Devices for removing support agent that fills the gap for turning the axle and hole tire with jet water stream.

Precise model of one sample of small 3D-modeling; it can be low cost material and therefore easy to share.

Figure 15: Good model for PR-Car use; tire axle also rotate

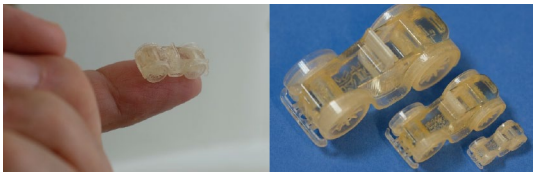


Figure 16: Size 10%: 22W x 10D x 9H (mm), (Left side) Size 30%, 20%, 10% model, (Right side)

3 Usage of the New Method to Make Specimen for Photoelastic Test

It was found that a 3D-modeling machine can easily produce specimens for photoelastic tests. Any shapes of specimens can be produced based on a 3D-CAD drawing, as if they were printed by a printer. This enabled us to implement photoelastic tests without difficulty. The apparatus used here is a simplified one made of a tracing stand furnished with LED plate illumination of white light shining on the specimen from behind. As students got more familiar with tests, the items they need to consider in design increased

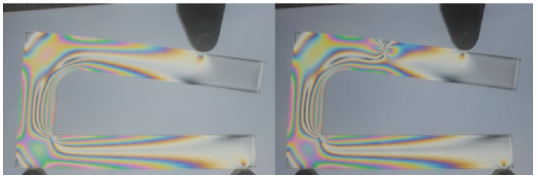


Figure 17: 3D-modeling machine can easily produce specimens for photoelastic tests. With notch at the upper part and stress concentration can be seen (Right side), none (Left side)

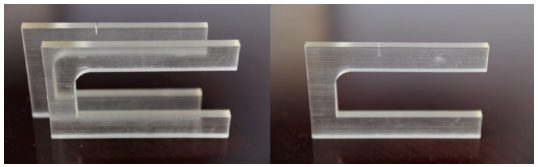


Figure 18: Photoelastic tests with notch and none (Left side), With notch inside the photoelastic test (Right side)

much more. We expect to have further opportunities to develop new areas of the utilization of CAE including 3D-CAD and 3D-modeling.

Various shapes and notches can be made freely. I believe that the scope of further utilization will expand as a teaching Modeling Machine which offers a chance to think and try doing by ourselves.

4 The first 3D-CAD experience teaching material at our university

--Making a mini-hanko (personal stamp): Basic 3D-CAD operations and 3D RP modeling

Manipulation of 3D-CAD and production of 3D-model using mini-stick teaching materials. As a teaching material to make sense of modeling experience in one class period "Making a mini-hanko". Hanko means one's own name stamp.

Through the making of a mini-hanko by 3D-CAD and 3D RP modeling, students can learn about the basic operations of 3D-CAD, as well as the development flow from data drawing to manufacture. Of course, using and trying is real modeling. Production costs are low, production time is short. The production of a strapped mini-hanko that students can actually use afterwards serves as a summary of the basics of CAD.

By guiding students through a production process of their own interest, we hope students can get a hold of the techniques of technical design drawing and CAD usage positively.

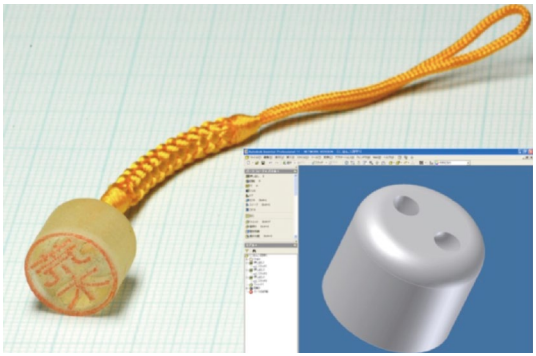


Figure 19: As a teaching material to make sense of modeling experience in one class period "Making a mini-hanko"

5 Software & System

Software: Autodesk Inventor

Modeling machine: Objet EDEN260, inkjet modeling machine

References

[1] Araki, T., Nakamura, N., Honma, I., *Educational Assistance Through Modeling in Tsukuba University of Technology--Professional Education for the Hearing or Visually Impaired*, Computer Aided Drafting, Design and Manufacturing (CADDM), China Graphics Society, Vol.25, No.4, pp.58-65, 2015.

[2] Araki, T., Hirano, S., *Development of cooperative education and basic engineering education: aided by 3D CAD and 3D RP modelling*, Int. J. Computer Applications in Technology, Vol.51, No.1, pp.80-85, 2015