Human Computer Interaction
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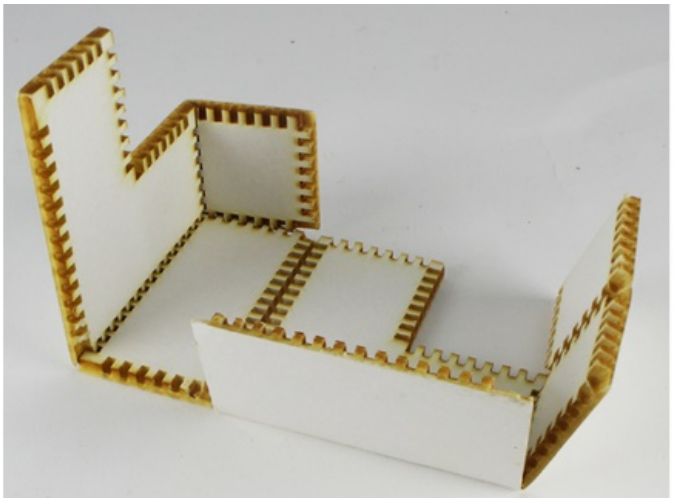
Masterprojekt Wintersemester 2020

Super Fast Fabrication of 3D Models—by Folding Laser-Cut Foam Core

The objective of this project is to create a novel laser cutting technique that allows users to fabricate 3D models from sandwiched paper/foam/paper boards (aka "foam core", "foam board", or "kapa board"). We have created a few examples by hand to validate that they perform well—now we want to generate them in software.



Your software will achieve this by producing three types of cuts. First, cut all the way through the material to produce a 2D plan of the model. This is similar to folded cardboard models [1]. Second, cut only the top two layers in order to create living hinges that allow the material to be folded downwards, turning 2D plans into 3D models. This is similar to laser scoring [2]. Third, remove material along those hinges, allowing the foam core to be folded upwards, despite its thickness. This third part of the technique is the novel element. More specifically, remove the materials in the form of patches located alternatingly left and right of the hinge, as illustrated above. This results in what we want to call *hidden box joints.*

The main benefit is that the resulting models assemble faster than any other known laser cutting or folding technique. (1) (Unlike laser cut models), models created using your software impose no need for hunting and pecking for parts on users, as elements to be joined are already connected in the 2D cutting plan. (2) All folding is especially fast, as all joints are pre-scored. (3) (Unlike folded cardboard models), models created using your software have no need for tabs and thus no need for creasing or gluing tabs; instead plates are jointed by forcing the two halves of a box joint into each other, which only takes a second.

In addition, models made from hidden box joints (1) withstand very high loads (40kg), i.e., 40x more than standard folded 160gr/m2 cardboard. (2) They offer a clean look, as foam core has a plain white appearance and since all box joints are hidden.

(3) Models allow for the integration of hinges. (4) Models are much more tolerant to variations in kerf than plywood or acrylic, as the foam material that is force fit is compliant.

You will demonstrate the functionality of your software by automatically generating a range of test models from laser-cut packaging to certain types of architectural models.

If everything works out, your software will allow laser cutting as a whole to transition from the look-agnostic maker community (which apparently does not mind the visible burnt finger joint look of traditional laser cutting) to a completely new population of users for whom appearance plays a role.

Technologies involved in this project

1. You will write in JavaScript/Typescript
2. 3D Graphics
3. You will write 3D Interactive tools to edit, align, assemble 2D plates in a 3D environment
4. You will write algorithms that deal with np-problems
5. You will integrate into a medium-size software system (Kyub, 120.000 lines of code, kyub.com)

If time allows, you will conduct a user study, in which participants assemble models generated using your software, models made by folding cardboard, and models made by assembling plywood. If everything works out, models generated using your software will assemble *way* faster.

Contact

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References

[1] Straub, Raphael, and Hartmut Prautzsch. Creating optimized cut-out sheets for paper models from meshes. KIT, Fakultät für Informatik, 2011.
[2] https://origamiusa.org/thefold/article/pre-scoring-machines-demystified