Reusing decommissioned curved objects to create new surfaces

Master-level internship

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(a) Wind turbine blade

(b) Reused as pump track modules [3]

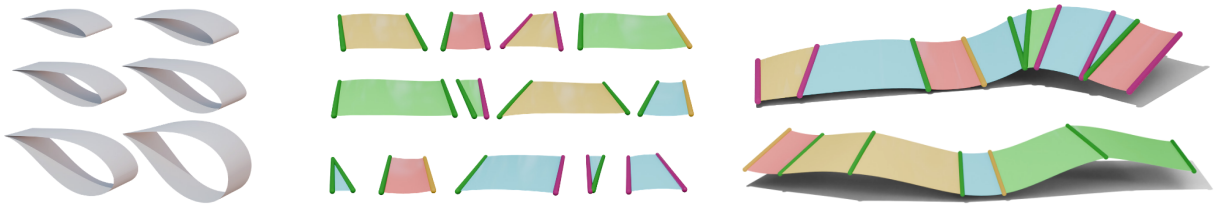
Figure 1: Motivation. *Wind turbine blades are large curved objects that are difficult to recycle (a). We are working on digital design tools to create new objects by reusing panels from decommissioned curved objects. We first target 1-dimensional ribbons such as cycling tracks (b) and then plan to consider 2-dimensional surfaces such as building roofs.*

Context

Composite materials allow the creation of large and lightweight curved structures, such as wind turbine blades, ship hulls, aircraft fuselages. But composite materials are difficult to recycle and are anticipated to result in a cumulative waste of tens of million tons in the next few decades [1,2]. In collaboration with researchers in sustainable industrial design, we aim at developing novel digital design tools to create new objects by reusing parts of decommissioned curved objects, with the goal of reducing composite waste as well as consumption of raw materials.

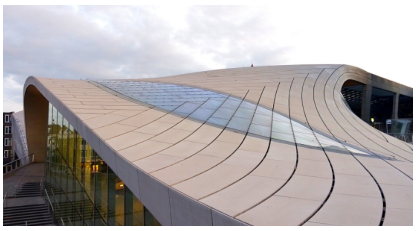
Approach

We have recently developed a first proof of concept, where we reused panels of wind turbine blades to create modules for a cycling pump track (Fig.1, [3]). Inspired by this demonstrator, we have developed an algorithm that optimizes the cutting of curved panels such that they form modules that users can connect seamlessly to create diverse tracks, as illustrated in Fig.2.



(a) Blade parts (b) Extracted modules (c) Modular tracks

Figure 2: *From a set of blade parts (a), our algorithm extracts modules with compatible boundaries (b), which users can chain to create diverse tracks (c). Our goal is now to offer users better control on the new shape, and to extend the approach to the creation of large surfaces.*



The first goal of this internship is to develop an interactive design tool that lets users define the overall shape of a track, and that solves for the sequence of modules that best approximates this track. If successful, we will then extend the tool to create larger surfaces, possibly by assembling them as a succession of parallel tracks (as illustrated with the roof of Arnhem Centraal station, shown as inset).

Work environment and requirement

The internship will take place at Inria Université Côte d'Azur, which is located close to Nice and Antibes. The research group GraphDeco conducts research on diverse topics in computer graphics, including geometric modeling, physical simulation, rendering: https://team.inria.fr/graphdeco/

Candidates should have studied computer science. Knowledge in computer graphics, and in particular geometry processing and numerical optimization is a plus.

References

[1] Pu Liu and Claire Y. Barlow. Wind turbine blade waste in 2050. Waste Management 62 (2017). https://www.sciencedirect.com/science/article/abs/pii/S0956053X17300491

[2] Anaële Lefeuvre, Sébastien Garnier, Leslie Jacquemin, Baptiste Pillain, and Guido Sonnemann. Anticipating in-use stocks of carbon fiber reinforced polymers and related waste flows generated by the commercial aeronautical sector until 2050. Resources, Conservation and Recycling 125 (2017). https://www.sciencedirect.com/science/article/abs/pii/S0921344917301775

[3] Jesse Pupping, Marzia Riso, Mariana Popescu, Adrien Bousseau, Jelle Joustra. From blades to tracks: a case study in structural reuse of curved surfaces for circular design. ACM Symposium on Computational Fabrication (SCF 2025). https://www-sop.inria.fr/reves/Basilic/2025/PRPBJ25/