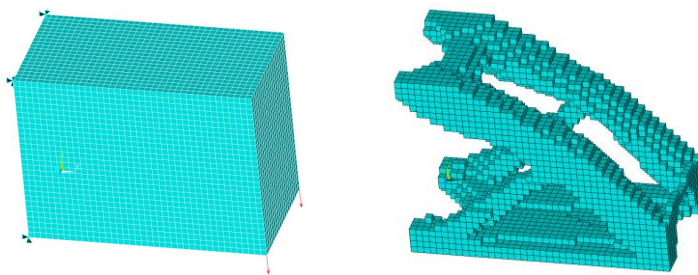


Summary

Topology optimization has already proven its worth in the field of mechanical design. It enables us to minimize the economical and environmental impact of a designed part, while its stiffness and allowable stress remain within acceptable limits.

A possible next evolution of topology optimization is using it in conjunction with mechanism design.

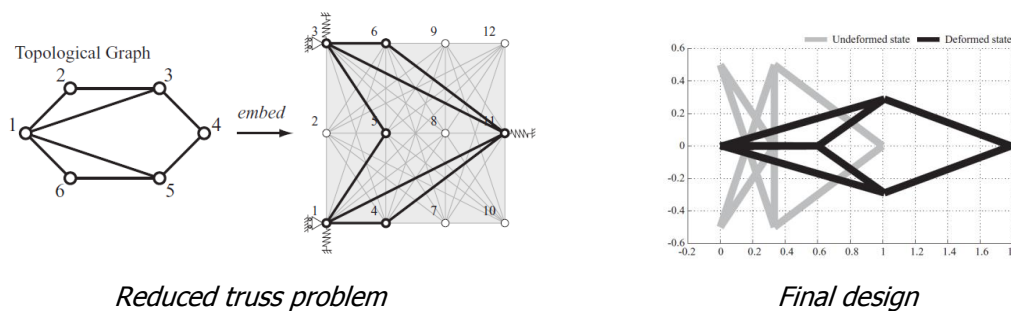
A standard topology optimization model starts off with an oversized design domain, which has many more potential elements and nodes than will actually be used. Topology optimization finds the sub domain within that oversized domain; while a pre-described objective function is minimized or maximized.



Oversized domain vs reduced domain

Research on the design of compliant mechanisms using topology optimization techniques in continuum structures suggests that it should also be possible to obtain results for articulated mechanisms by applying such techniques (Kawamoto et al. 2004).

Kawamoto et al used a relatively simple truss construction in order to explore possible methods of creating articulating mechanisms. Despite the simple construction, it still took numerous iterations before they found the optimal configuration.



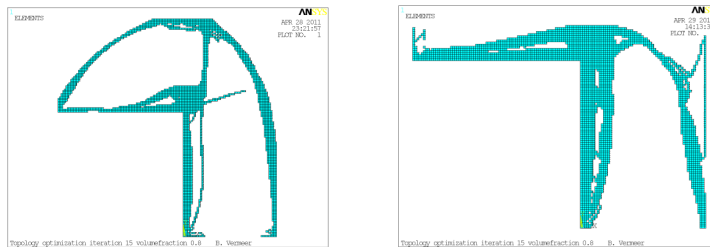
Reduced truss problem

Final design

When designing a new mechanism, it's not uncommon for it to have different types of desired movements. The requirements could be that the mechanism should move freely horizontally, while vertical movement should be eliminated. When you want the mechanism to move freely horizontally, only choosing the elements which will produce the stiffest structure, won't allow for any movement. When you reverse this and only choose the weakest elements, you won't have a supporting structure.

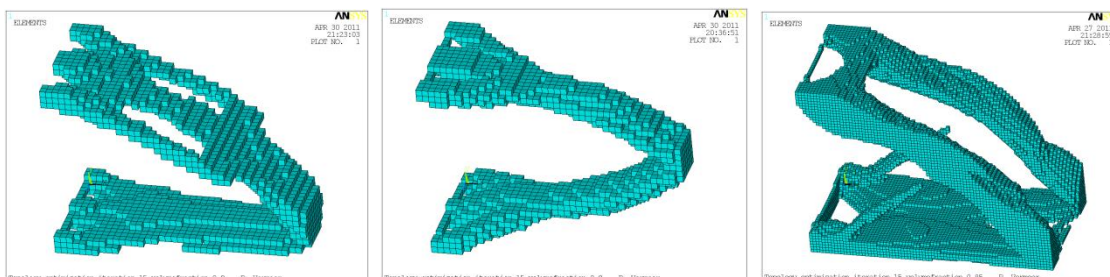
The goal is to find a way to attain the desired conflicting movements, through the use of topology optimization.

The problem of the conflicting desired results was solved by choosing different sensitivities for the different loadcase types, and by allowing those two different loadcase types to be combined through various mathematical operators. For the stiffness loadcase type, the maximum value was chosen. Whilst for the flexibility loadcase type the minimum value was chosen.



Through varying several parameters in the model, their influence on the final model was compared against a 'standard' example, in order to evaluate the effect these parameters have on the final construction. The standard example was a simple solid crane construction, in which horizontal movement should be allowed, while vertical movement should be restricted.

In order to ensure the model is functioning correctly, some features are disabled in order to allow it to operate as a 'standard' topology optimization model. Since validation for combined loadcase types don't exist at the moment.



An Ansys model, which autonomously creates articulating mechanism based solely on imposed boundary conditions and desired objectives, has not been achieved.

However, several significant additions have been made to a standard topology optimization model, which could eventually lead to such a model.