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## How do students approach design without prototypes?

Unlike more common designbuild-test capstone design projects, naval architecture students do not have recourse to a complete physical prototype to help them understand design interactions and visualize the complete design artifact. This vessel synthesis problem is a type of "physically large and complex" system design, as defined by Andrews (2012). The students must synthesize the vessel in their own mind from pieces in different software or formats. This process is a challenge to the students. It relies on a mix of curricular and extra-curricular skills that have not been subject to detailed experimental investigation.



# Data was collected over two cohorts to identify factors which influence mental synthesis

The objective of this project is to identify factors which influence this mental synthesis model formation and the trial new learning methods to support its formation.

	<ul> <li>Identify major factors and initial teaching response</li> <li>Initial web-based survey of senior students</li> </ul>
April 2014	<ul> <li>3 focus groups with senior students</li> </ul>
	<ul> <li>More detailed data collection</li> </ul>
	<ul> <li>Design detailed data collection for 2015 class</li> </ul>
Summer-Fall 2014	<ul> <li>Design initial teaching responses</li> </ul>
	<ul> <li>Trial new methods and collect more data</li> </ul>
	<ul> <li>Bi-weekly web journals from students</li> </ul>
Class	<ul> <li>Trial implementation of new teaching methods</li> </ul>
	<ul> <li>Final data processing and report</li> </ul>
	<ul> <li>Study detailed responses</li> </ul>
Summer 2015-2016	<ul> <li>Finalize future course improvements</li> </ul>

# **Studying Student Experience of Complex Design Projects with No Prototype**

# **Focus group responses showed little discussion of** overall synthesis strategy

Students asked about experiences in three 90-minute focus group Transcripts from focus groups were dual-coded by two readers to examine which topics were most discussed. Coding was compared via Cohen's Kappa inter-rater reliability with good results. Struggles on specific topics dominated with little discussion of overall synthesis strategy.



All members of three highestranked design teams

- Design is a small part of discussion
- Podcasts and offline resources
- mentioned
- Specific tools not mentioned

## All members of three lowest ranked design teams

Hull and hull manipulation programs more common

different took actually y

- Known area of struggle Suggests tool
- refinement may help

Group	Cohen's Kappa
1	0.66
2	0.80
3	0.79











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Andrews, D. J. 2012. "Art and Science in the Design of Physically Large and Complex Systems." Proceedings of the Royal Society A: Mathematical, Physical and Engineering Science 468 (2139): 891–912. doi:10.1098/rspa.2011.0590.



