Oberth Level
Synopsis

Prerequisite: Tsiolkovsky level

Goals/Description: The Oberth Level course applies student's Tsiolkovsky level understanding and learning; expands the development of 21st Century skills; and requires the design, development, and testing of a transonic rocket.

The year begins with the history of space exploration, with focus on current initiatives by government and private industries to further that exploration. Academic rigor is increased as students are required to develop a mathematical flight profile in Excel proving the rocket will achieve the performance design goal. The mathematical profile predicts all flight dynamics, determines propulsion performance, and forces applied to the rocket during testing. Students present the flight profile to either local engineers or engineers at New Mexico Institute of Mining and Technology. Flight profiles undergo critique and additional work as needed.

Students use the industry approved Research Design and Development Loop (RD&D Loop) to design and build a rocket with the goal of breaking the sound barrier and being recovered intact within close proximity to the launch pad (speed of sound adjusted for elevation and temperature).

The students, as a project team, develop the overall vehicle design using computer modeling–the design incorporates all the mathematical content mastered through the flight profile development as well as content mastered in the Tsiolkovsky Level concerning rocket flight. After being selected to component teams (propulsion, air frame and fins, recovery, etc.), students are instructed about timeline management, critical decision-making and project management. Specific component teams develop a timeline for production of their component, then begin the research phase concerning the problem aspects of their component. Problem aspects include function, mass envelope, simplicity etc. A final design is developed, usually based in mathematical calculations that allows the team to move forward in the design process. The mathematical calculations are reviewed by a professional in aerospace industry offering criticism of the calculations but no insight into how it may be improved. The mathematical design is then converted to a working drawing representing the design of the component. The team begins extensively researching materials and developing decision matrices based on component function. Material variables include safety, cost, application viability, acquisition time etc. The team then presents a Critical Design Review (CDR) to the overall project team. If a "thumbs-up" is received from the overall project team, it is time to move forward to the development of the component. If not, redesign is needed until it is accepted. After materials acquisition and individual components are complete, all systems (components) must the integrated to complete the class project. Prior to launch, the vehicle must pass the Flight Readiness Review (FRR) to ensure adherence to all safety guidelines. After vehicle has been tested students enter the final phase of the project by evaluating vehicle performance. Students use a Fault Tree Analysis (FTA) to aide in the writing and presenting of a complete Post Mission Analysis (PMA). The PMA is presented to peers, parents, and school administration if available and is used as the final exam.

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Scope & Sequence

<u>1st Semester:</u>

- History of Space Travel
  - Early History
  - Breaking the Sound Barrier with Chuck Yeager
  - Apollo Era
  - Current Developments
- Review RD&D Loop
- Ball Toss Modeling/Excel Basics
- Transonic Fight Profile Math Model
- Flight Profile Presentations
- Research and Component Testing
- Preliminary Design Review

<u>2nd Semester:</u>

- Component Research
- Critical Design Review
- Fabrication/Testing
- Systems Integration/Fabrication
- Flight Readiness Review
- Vehicle Test
- Fault Tree Analysis
- Post Mission Analysis
- Current Events Projects