

ENGINEERING DESIGN	
Engineering Design	MIDDLE SCHOOL
SCRIPTURE	
<i>Everyone who listens to these words of mine and acts on them will be like a wise man who built his house on rock. The rain fell, the floods came, and the winds blew and buffeted the house. But it did not collapse; it had been set solidly on rock. And everyone who listens to these words of mine but does not act on them will be like a fool who built his house on sand. Matthew 7:24-27</i>	
STANDARD	
<p>S.1. Using the scientific model put forth by St. Albertus Magnus, define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. Solutions should take into account Catholic social teaching, which calls us to consider the needs of others before our own, and the “preferential option” for the poor and vulnerable. (MS-ETS1-1)</p> <p>S.2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. Also consider in this the moral responsibility that just because it is possible, it does not mean it is right. (MS-ETS1-2)</p> <p>S.3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success, all while weighing the impact on the environment and society. (MS-ETS1-3)</p> <p>S.4. Develop a model to generate data for repetitive testing and modification of a proposed object, tool, or process such that an optimal design can be achieved, just as we are cooperating with God’s divine plan in our life to reach the ultimate good He has promised, which requires continual growth, modification, and practice in virtue. (MS-ETS1-4)</p>	
EXAMPLES	
Catholic Scientists/Saints , Catechism , Scripture	
ESSENTIAL QUESTIONS	
<p>1. What is the scientific method and how do you apply it to a problem?</p> <p>2 and 3. How do you determine which design model is the best to solve the problem, but also morally responsible.</p> <p>4. What is the importance of collecting and analyzing data? Why is it necessary to conduct repetitive testing?</p>	
ESSENTIAL VOCABULARY	
<p>Scientific method, inquiry, design problem, hypothesis, controls, independent and dependent variables, systematic process, observation, analysis, evidence, validity, reliability, metric system, communicate results</p>	
STREAM ACTIVITIES	

- Build bridges in teams using the engineering process. Include materials limits, design restrictions and a specific task. The aesthetics of the bridge is essential in the design.
- Build stained glass (or synthetic or similar type art) windows depicting scenes from the Bible. Utilize tissue paper mod-podged onto glass jars; tissue paper on waxed paper; crayon lines to create borders, and then water color paints to fill in the colors; etc. to create the stained-glass window appearance. To relate to math/engineering, create design parameters & constraints related to the required/allowed geometric shapes, number of colors available, or limit the resources available to complete the task. You could also require that it fit within a specific shape or proportions that would match your own church's windows - requiring the students to first measure the church windows, possibly using proportional ratios when direct measurement is not possible.
- Design a simple compound machine that can carry out a function of a repeated task that can be used to collect data.
- Design and build a catapult, use the invention to complete an accuracy task. Research the Catholic Church in the middle ages and the use of weapons of war.
- Design a slingshot and add an accuracy task. Integrate the story of David and Goliath, discussing potential energy and kinetic energy.
- Construct a boat that will carry the most mass. This activity should require a budget with limited materials. Discuss the scripture Luke 5:4-11 - Jesus sends his apostles back out after a night of unsuccessful fishing. They catch so much on the second try that the boats are in danger of sinking. Also relate to Noah and the building of the ark (Genesis 6:14-16) in which God gives Noah his construction design parameters.

Engineering Design

Scriptures:

- *Jesus said to them, "Did you never read in the scriptures: 'The stone that the builders rejected has become the cornerstone; by the Lord has this been done, and it is wonderful in our eyes'?"⁴³ Therefore, I say to you, the kingdom of God will be taken away from you and given to a people that will produce its fruit.⁴⁴^{*} The one who falls on this stone will be dashed to pieces; and it will crush anyone on whom it falls.]" Matthew 21:42-44*
- *The stone the builders rejected has become the cornerstone. Psalm 118:22*
- *Come now, let us set things right, says the LORD: Though your sins be like scarlet, they may become white as snow; Though they be red like crimson, they may become white as wool. Isaiah 1:18*
- *Faith is the realization of what is hoped for and evidence of things not seen. Because of it the ancients were well attested. By faith we understand that the universe was ordered by the word of God so that what is visible came into being through the invisible. Hebrews 11:1-3*
- *Fear of the LORD is the beginning of knowledge; fools despise wisdom and discipline. Proverbs 1: 7*

Catechism of the Catholic Church:

- **159 Faith and science:** "Though faith is above reason, there can never be any real discrepancy between faith and reason. Since the same God who reveals mysteries and infuses faith has bestowed the light of reason on the human mind, God cannot deny himself, nor can truth ever contradict truth." "Consequently, methodical research in all branches of knowledge, provided it is carried out in a truly scientific manner and does not override moral laws, can never conflict with the faith, because the things of the world and the things of faith derive from the same God. The humble and persevering

investigator of the secrets of nature is being led, as it were, by the hand of God in spite of himself, for it is God, the conserver of all things, who made them what they are."

- 426 ..."To catechize is "to reveal in the Person of Christ the whole of God's eternal design reaching fulfillment in that Person.

Catholics making contribution to the topic:

- St. Albertus Magnus (1200-1280) - observed nature scientifically, and defended the compatibility of faith and reason, implementing scientific practices based on Aristotle
- Fr. Roger Bacon (1219-1292) - medieval monk who formalized the scientific method
- Jules Henri Poincare (1854-1912)- engineer
- William of Ockham (c.1288–c.1348) – Franciscan Friar known for Ockham's Razor
- Pope Francis (1936-present) Chemical engineer
- Johannes Gutenberg (1398-1468) Inventor of the printing press

Resources

Books: Introducing Engineering to K-12 Students by ASME,

Engineering Your Future by Great Lakes Press

Apps: Roller Coaster Design, Ratventure, Monorail

"How the Catholic Church Built Western Civilization" by Thomas Woods

Websites:

<http://www.pbs.org/wgbh/buildingbig/bridge/>,

<https://www.unionstation.org/science-pioneers>

Video: <http://www.pbs.org/wgbh/buildingbig/bridge/>

<http://www.engineering.com/Videos/tabid/4624/Default.aspx> Catholic Scientists

http://en.wikipedia.org/wiki/List_of_Catholic_scientists

http://en.wikipedia.org/wiki/List_of_Roman_Catholic_cleric%E2%80%93scientists