

VIRTUAL AND PHYSICAL MODELING

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VIRTUAL MODELING – Unique Advantages and Value Added

PEDAGOGY

- Matches the preferred learning style of many of today's students
- Enables students with limited drawing skills to render successfully
- Helps students capture interim versions of their designs
- Helps teachers assess the evolution of students' ideas and their progression of learning
- Allows students to communicate by generating rendered design ideas for projected or printed PowerPoint presentations
- Eliminates waste of material resources
- Ability to engage in many iterations quickly provides a *shameless way* for students to build needed knowledge in timely fashion

STEM CONTENT KNOWLEDGE AND SKILL

- Permits students to easily vary *geometric* attributes of a shape (e.g., length, width, height) and define resulting areas, perimeters, and volumes.
- Scaffolds students' ability to visualize 2- and 3-D shapes
- Allows for easy repetition to support development of skill in using the software
- Enables the use and integration of other software (e.g., Excel, PowerPoint)
- Enhances the ability to use (and understand the use of) software as a powerful modeling tool

DESIGN

- Fosters creativity and higher quality through ease of iteration
- Allows for trying out alternatives without additional costs (in terms of time, capital, materials, equipment)
- Allows students to learn from trying out "What-if" scenarios with little risk
- Permits easy editing and duplicating of complex virtual objects, angles and shapes
- Provides instantaneous visual feedback to help make design choices more informed.
- Permits precise scaling and dimensioning of geometric shapes and elements
- Rapidly calculates geometric areas to help students check calculations

SOCIAL NETWORKING

- Students can share virtual models over networked computers
- Work can continue in other places such as at home

OTHER ADVANTAGES (but not necessarily unique to virtual modeling)

- The software offers specific features, including ease of editing and replicating shapes and angles; allowing students access to an almost unlimited supply of clip art and other on-line resources; and representational reality.
- Reinforces key concepts and skills learned in class (e.g., modeling, design, ratio and proportion, scale, making and interpreting "nets").
- Develops higher-order thinking skills (e.g., synthesis, analysis, evaluation) in the context of solving engaging problems
- Consistent with contemporary method of designing
- Supports creativity through a vast library of already-rendered objects, and provides the capacity to save versions and return to them later.

PHYSICAL MODELING – Unique Advantages and Value Added

PEDAGOGY

- Students feel significant ownership of their constructed model
- Tactile and kinesthetic experience of the design complements and improves comprehension of the problem
- Physical model conveys ideas in unique ways that complement on-screen designs, especially for people with limited visualization skills.
- Doing physical measuring reinforces measuring skills.
- Geometry is experienced in a more meaningful, real-world way

STEM CONTENT KNOWLEDGE AND SKILL

- Skill in the use of hand tools and machines and in the processing of materials is developed
- Promotes skills in effective management and use of limited materials to achieve a specific purpose
- Errors in math and design thinking are made visible through making the physical model
- Physical model provides a reality check to screen-based modeling (e.g., gravity can be absent in screen-based modeling).

DESIGN

- Building a prototypical physical model is an essential component of the design process.
- A physical model provides additional feedback to designers, i.e., it informs designers where the virtual model may not be accurate and keeps the virtual design honest.
- A physical model better captures the irregularities and vagaries of a complex, real-world environment.
- Work with 3-D physical model is a necessary complement to work with virtual models (e.g., it is sometimes easier to view the impact of changes in object placement in the physical model).
- A physical full-scale prototype permits testing of designs under real-world conditions.
- Allows testing of prototype qualities not easily modeled on the computer. An example is *ergonomics* (the “fit” between the design and human users).
- Contributes added realism for purposes of visualization, presentation, and marketing
- Promotes creative thinking in that students may find it easier to create and develop their ideas when handling physical materials.

SOCIAL NETWORKING (but not necessarily unique to physical modeling)

- Enhances communication skills through group discussion and planning
- Students recognize that teamwork is a necessity to get the job done effectively and in time