



## LESSON GUIDE

# Chess Set



<b>Level</b>	Advanced
<b>Academic Connections</b>	Design Thinking, Prototyping, Design for Manufacturability
<b>Core Concepts</b>	Design, Design Optimization, Print Optimization, Computer Aided Design (CAD)
<b>Duration</b>	2 – 3 weeks

Design a chess set that includes six unique game pieces: pawn, rook, knight, bishop, queen and king.

### LEARNING OBJECTIVES

By the end of this workshop, the student will be able to:

- Identify and apply the steps in the design process.
- Gather and apply information pertinent to design planning.
- Create concept and scaled sketches.
- Use appropriate design tools to create CAD drawings.
- Print full-scale 3D models at an advanced level.

### ESSENTIAL QUESTIONS

- Was the feel/shape of the pieces a consideration for your design?
- What makes your chess pieces unique? Is a common theme apparent?

### PROJECT GUIDELINES

- A consistent theme must be incorporated in each of the six pieces.
- Each chess piece must be clearly identifiable.
- Concept sketches: pencil, freehand, or digital
- Scaled sketches: pencil or digital
- 3D CAD drawings
- Render images (optional)
- 3D printed models (complete set if possible)

### REQUIREMENTS

- Educator PC with access to:
  - Microsoft PowerPoint
  - QuickTime
- Internet connection
- Projector
- 3D printers
- CAD design tool

### DESIGN TIPS

#### CHESS PIECE SIZING

The scale of a chess set is critical. Sizes vary widely, so matching pieces to an appropriately sized board can be difficult. Chess pieces typically range from 2.5 to 6 inches tall, with almost every quarter-inch increment in between.

To some extent, size is a matter of taste. Some chess players prefer to center their chess pieces in huge squares, while others prefer a tighter fit. Of course, the bases of the pieces must fit inside the squares; that's essential for any set.

Consider these three factors when sizing up your chess pieces and board:

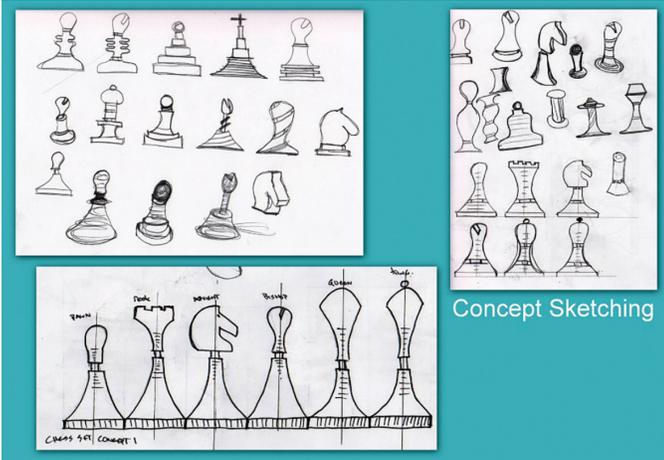
- **King and pawn height** The height and base diameter of chess pieces are correlated. Following rough guidelines, a chess set with a 4-inch tall king would fit onto a board with 2.5 inch squares quite nicely. In the case of disproportionate chess pieces (very short and fat, or very tall and thin), this wouldn't hold true.
- **Diameter of squares on the chess board** It's important to know the size of the individual squares on the board because chessboards vary widely in their design. A chess board may have wider or narrower borders than another, resulting in squares that are slightly smaller or larger.
- **Base diameter of the king** The king should be the widest piece on the board. To size your pieces, consider the size of the individual squares on the board in relation to the base diameter of the king. Ideally, the king's base diameter should be 75% to 85% of the diameter of the squares. So a 2-inch square would easily fit a king with a 1.5-inch base.

# CHESS SET

## PROCESS WORKFLOW

### REFERENCE MATERIAL

Williams, Gareth John. Master Pieces: The Architecture of Chess. Studio, 2000.

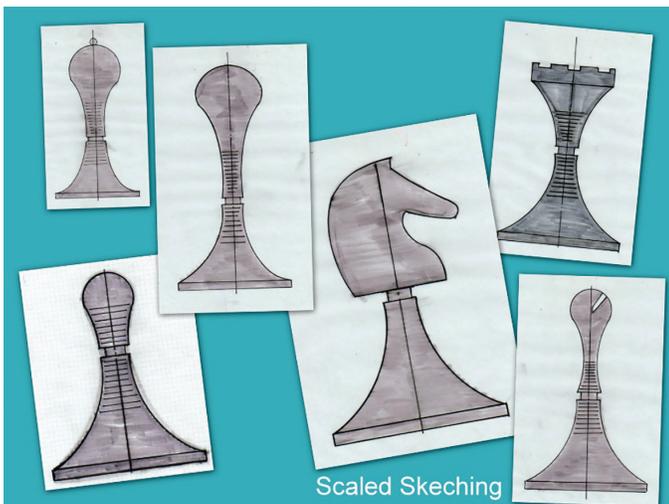


Complete chess set with board.

### FORMALIZATION



These exemplary student projects followed the same project workflow.



### DEVELOPMENT

Students will import the scaled sketches directly into a CAD program. These scaled sketches will be used to create the profile of each chess piece. The REVOLVE feature of any CAD software will produce a 3D surface, generating the desired shape. Other features included in CAD software will allow students to add details to the chess pieces.

# CHESS SET

## ASSESSMENT CRITERIA

### DRAWING AND USE OF CAD

	LEVEL 1 (60-69%)	LEVEL 2 (70-79%)	LEVEL 3 (80-89%)	LEVEL 4 (90-100%)
<b>Knowledge/ understanding</b>  <b>3D concepts</b>	3D CAD drawings are incomplete. Dimensions are not present; 3D design features and tools have not been used.	Dimensions are used inconsistently. There is limited use of 3D design features and tools covered in class.	Most dimensions are present and meet the design criteria. Most 3D design tools and features have been used properly.	All dimensions are present and meet the design criteria. All 3D design tools and features have been used correctly.
<b>Thinking/inquiry</b>  <b>Level of difficulty</b>	Chess pieces demonstrate little to no effort toward complexity.	Most chess pieces show a low degree of complexity.	Most chess pieces show a moderate degree of complexity.	All six pieces demonstrate a moderate to high degree of complexity.
<b>Application</b>  <b>Integrity of design</b>	Chess pieces don't reflect the original scaled sketches at all.	Chess pieces reflect some elements of the original scaled sketches, such as the general shape or theme.	Chess pieces reflect most elements of the original scaled sketches, but some features could not be accomplished.	Chess pieces are identical to the original scaled sketches.

### DESIGN OF PIECES

	LEVEL 1 (60-69%)	LEVEL 2 (70-79%)	LEVEL 3 (80-89%)	LEVEL 4 (90-100%)
<b>Knowledge/ understanding</b>  <b>Understanding of the factors involving sizing: piece height, diameter of squares on the board and base diameter of the pieces.</b>	Most dimensions are incorrect or set at the wrong scale. Student fails to recognize the relationship between height and diameter.	Several dimensions are incorrect or set at the wrong scale. Student partially understands the relationship between height and diameter.	Most dimensions are correct and set at the right scale. Student seems to recognize the relationship between height and diameter.	All dimensions are correct and set at the right scale. Student unquestionably recognizes the relationship between height and diameter.
<b>Thinking/inquiry</b>  <b>Originality</b>	The pieces are traditional and predictable; they may imitate existing designs without showing any original thought.	The pieces clearly show elements borrowed from other sources, but build upon them to produce something new.	The pieces are unique and demonstrate independent thought and personality.	The pieces are highly imaginative. They incorporate surprising or elaborate features that reflect creativity and personality.
<b>Application</b>  <b>Theme and consistency</b>	Student fails to incorporate a theme.	A loose theme is present, but may not be evident in all pieces.	A theme is clear and evident, and incorporated into every piece.	A surprising or unexpected theme is clear, and carefully incorporated into every piece.

# CHESS SET

## SUGGESTED NEXT LESSONS

### CREATURE

Design the head of an original creature. Post-finish your model with paint of your choice.



### COMPUTER MOUSE

Keeping the users of your product in mind, design a wireless mouse that will provide optimum comfort and performance.



### CAMERA ACCESSORIES

Design gadgets that can help take photos or videos. These can be added to conventional cameras, cellphones and action cameras.



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