Lessons from the Salvadori Classrooms
LESSON TITLE: Form and Furniture
PREPARED BY: Jonathan Katz and Kubi Ackerman (revised by Michael Bettencourt)
TOPIC: School
SSLAM: School / Math / Pull Apart

Form and Furniture

Content Focus: Math

- Calculation: Averages
- Measurement: Angles and Distance
- Ratio and Proportion
- Scale

Content Focus: Science

- Human Body
- Matter: Properties

Content Focus: Technology

- Engineering Design

Content Focus: Built Environment

- Architectural Drawing / 2D
- Form
- Measuring/Estimating
- Scale/Proportion

Performance Outcome(s)

- Make a scale drawing of a chair of your own design based on the dimensions of your body.

Standards/Interdisciplinary Connections

					
S	**S**	**L**	**A**	**M**	**T**
Science	**Social Studies**	**Language Arts**	**Art - Visual**	**Math**	**Technology**

How To Read The Symbols: The symbols in **bold** indicate the subject standards that this lesson satisfies.

Lesson Outline (multiple lesson project)

1. Motivation
2. The Challenge
3. Measure Your Body
4. Process Your Data
5. Design and Present Your Chair
6. Reflection
7. Extensions And Variations
8. Middle School Standards

Salvadori Prerequisites

- FOUNDATION - BASIC SKILLS: Measuring/Estimating (Activity #3); Working with Scale (Activity #1); Architectural Drawing / 2D (Activity #1, Activity #2)
- FOUNDATION - ARCHITECTURE 101: Form (Activity #1); Scale (Activity #1)

CONCEPTS

- Most furniture is designed to correspond to the average proportions of their intended users, while ergonomic furniture also accommodates the form, position, and movement patterns of the human body.
- The design of chairs is influenced by many factors, including the context in which the chair is to be used, cultural and aesthetic norms, cost, the materials from which it is made, and the preferences of the designer.
- Measuring the dimensions of organic three-dimensional shapes such as bodies requires creative measurement approaches.

RESOURCES

Books

- *Chairs (20th Century: Landmarks in Design, Volume 3)*, George Nelson (ed.), Acanthus 1999

MATERIALS

Facilitator

- **O**: Q&A

- ⭘: Activity Sheet: Sit and Measure

Student

- ⭘: Student Guide: Chairs, Assessment
- Yardsticks or tape measures, protractors and or bevel, pencils, paper

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MOTIVATION

Everyone assume his or her most comfortable sitting position in a chair.

- *Is that how you usually sit in your chair? If not, why not?*

Now assume a sitting position that makes you feel alert.

- *Is this position any different from your most comfortable position? If so, how?*
- *Is the chair you are sitting in right now comfortable? What makes it comfortable or uncomfortable to you?*
- *What would you change about the chair you are sitting in right now?*
- *What are some of the things that the people who designed the chair had to consider as they designed it?* ⭘: Q&A
- *How do you think the designers of the chair came up with the dimensions for the chair?* ⭘: Q&A
- *Do you know what the word **ergonomic** means?* ⭘: Q&A

THE CHALLENGE

Measure the dimensions of your fellow group members as they are seated in their chairs. Use your measurements to design an ergonomic school chair and make a scale drawing of your design.

MEASURE YOUR BODY

- *What are the most important human dimensions that we must consider if we want to design an ergonomic school chair?* ⭘: Q&A
- *What other body measurements might we need?* ⭘: Q&A
- *How would these measurements influence the dimensions of the chair?* ⭘: Q&A

- *How might you get those measurements?* ⭘: Q&A
- *What do you think we should do about the fact that the measurements will be different for different people?* ⭘: Q&A

Groups list the most important human dimensions as well as other measurements they will need to determine the design of the chair. Students mark and label these dimensions on their activity-sheets to guide them through the measuring process.

- *Given that the chair you design is to be used in a classroom setting, what position do you think you should be in as you take these measurements? Should it be your most comfortable position? A position that keeps you awake and alert? Should it be a combination of the two?* ⭘: Q&A

Students measure each other while seated in the position that they have decided would be most appropriate for a school chair. With groups of four or more, students can pair up to expedite the measuring process.

PROCESS YOUR DATA

- *Now that you have measured the dimensions of every member of your group as they were seated, how do we use this information? (Remember that the chair you will design should be as comfortable as possible for everyone in your group.) In the case of your group, would it be more helpful to calculate the average of the measurements or find the mean?* ⭘: Q&A

Groups use the method they deem appropriate to convert the individual measurements they took into standard measurements for the group as a whole. Students record these measurements on their activity sheets. ⭘: Activity Sheets

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DESIGN AND PRESENT YOUR CHAIR

Distribute the student guide to chairs from around the world. ⭘: Student Guide: Chairs

Discuss the chairs in the guide.

- *How are the chairs similar? How are they different?*
- Which of these chairs do you think would be most appropriate as classroom chairs? Which would be more appropriate in a living room? In a dining room? Why? ⭘: Q&A
- What are the characteristics you would want a classroom chair to have?

Groups make a list of the characteristics of their ideal classroom chair. Some things they may want to consider:

- *Will the seat recline at an angle?*
- *Will it have arm-rests?*
- *Will it have a head-rest?*
- *Will it have a foot-rest?*
- *What material(s) will it be made of?*

Each student sketches a design for a classroom chair that includes the characteristics the group has decided upon. Groups review the sketches and then choose one design to develop further.

Students transfer the measurements they derived in the previous steps (recorded on their activity sheets) onto the sketch.

Groups create drawings of the chair at a scale of 3''=1'. These should include two "elevations" (a front view and a side view) and a "plan" (a top view).

Groups present their drawings to the class, explaining the rationale for their design, the design features it incorporates, the materials the chair would be made from, and why they believe it to be a superior classroom chair.

REFLECTION

- *What were some of the difficulties you faced in measuring the human body? How did you overcome them?*
- *What method did you use to deal with the different measurements you had from the different group members? Did you think the chair you designed using the results of this method would be comfortable for everyone in the group? Is there any group member who would be at a disadvantage? Why?*
- *Was it difficult to design a chair with the dimensions you had calculated previously? If so, why?*
- *Would it be practical to mass-produce your chair? Why or why not?*
- *How well did you meet your challenge? What would you do differently next time?*

EXTENSIONS AND VARIATIONS

- To further explore the concept of ergonomics, students design and perform a "test" to evaluate the comfort and function of different chairs within the school.

- Students mathematically investigate the relationship between the human body and other types of furniture or devices in a classroom setting (e.g. desks, pens, computer keyboards) or in the home setting (e.g. couches, tables, doorknobs)
- Students design a stackable classroom chair.

MIDDLE SCHOOL STANDARDS

Science

- Science and Technology (E)
- Science in Personal and Social Perspectives (F)

Social Studies

- People, Places, and Environment
- Science, Technology, and Society

Language Arts

- Speaking, Listening, and Viewing (E3a, b, c)

Art - Visual

- Media, Techniques, and Processes
- Connections Between Visual Arts and Other Disciplines

Math

- Number and Operations Standard
- Algebra
- Data Analysis and Probability Standard
- Connections

Technology

- Nature of Technology (1, 2, 3)
- Design (8, 9)
- Abilities for a Technological World (11, 13)

Form and Furniture

MOTIVATION

- What are some of the things that the people who designed the chair had to consider as they designed it?

  There are many different things that designers must consider when designing classroom chairs. These include:

  Comfort – chairs must be designed to correspond to the average body size of students of a particular age group and must encourage a body position that keeps students comfortable and alert. Some chairs are adjustable to accommodate different body types.

  Cost – chairs must be affordable, which requires that they be manufactured from relatively inexpensive material, that they be made from a small number of relatively simple parts, and that they are easy to assemble and disassemble for transportation purposes.

  Size - chairs must be of a modest size so that large numbers can fit in a confined space. If desks are attached to the chairs, they should be attached in such a way so as to enable a variety of different chair arrangements.

  Safety - chairs must be solid and sturdy, and made from materials that cannot easily break, chip or splinter.

- How do you think the designers of the chair came up with the dimensions for the chair?

  There are standard codes for the design of classroom chairs that determine the following dimensions (the figures are variable depending on age group): seat length, seat height, distance from the seat to the bottom of the backrest, minimum backrest height, armrest spacing, seat width, and table width. These figures were calculated by measuring the average dimensions of children within each age group.

- Do you know what the word **ergonomic** means?

  "Ergonomic" refers to a type of design in which furniture, tools, or equipment is designed and manufactured to increase productivity by minimizing fatigue and discomfort. In ergonomic design, objects are designed to facilitate a particular bodily position that has been determined to be most comfortable, healthy, and amenable to productivity.

MEASURE YOUR BODY

- What are the most important bodily dimensions that we must consider if we want to design an ergonomic school chair?

  Among the most important dimensions students should include:
  - the length of the lower leg from knee to heel
  - the length of the thigh
  - the length of the torso from seat to neck

- the length of the arms
- the width of the lower body when seated (as measured between the outside edges of the knees)

- What other bodily measurements might we need?

  Other measurements could include:
  - the angle of the knee formed by the thigh and calf
  - the angle of the hips formed by the torso and thigh
  - the angle of the neck formed by the back and head
  - the angle of the shoulder formed by the torso and the upper arm

- How would this data correspond to the dimensions of the chair?
  - The height of the seat is determined by the length of the lower leg and the angle of the knee.
  - The distance from the seat to the arm-rest is determined by the angle of the shoulder.
  - The distance from the seat to the head-rest is determined by the length of the torso.
  - The angle between the seat and the backrest is determined by the angle of the hips.
  - The angle between the backrest and the head-rest is determined by the angle of the neck.
  - The distance from the back-rest to the end of the arm-rest is determined by the length of the arms and the angle of the shoulder.
  - The width of the seat is determined by the width of the lower body.

- How might we go about obtaining those measurements?

  These distance measurements are best obtained with a flexible tape measure, though a yardstick would do as well. The angle measurements are more difficult and will require creative approaches. One way to take angle measurements on the body is to have one student place straight rods, such as yardsticks, on another student's body in such a way so as to follow the alignment of the limbs as closely as possible while a third student measures the angle formed by the rods with a protractor.

- What do you think we should do about the fact that the measurements will be different for different people?

  This is of course an issue faced by all designers and especially by designers of ergonomic furniture. The designer must determine what types of people will be using the furniture, and if such people may not be representative of "average" body dimensions (as students are

not), then they must figure out the average dimensions of those for whom the furniture is designed.

- Given that the chair you design is to be used in a classroom setting, what position do you think you should be in as you take these measurements? Should it be your most comfortable position? A position that keeps you awake and alert? Should it be a combination of the two?

  Furniture designed with productivity in mind generally tends to compromise between comfort and the necessity of staying alert. Students may find that their most comfortable position is one in which they are almost supine, though such a position would not likely be conducive to working or learning. On the other hand, the distraction caused by the discomfort of an excessively upright position would not help matter much either. Well-designed ergonomic furniture places the user in a position in which spinal alignment is optimal for long periods of use, which minimizes discomfort and allows the user to focus on the work at hand.

PROCESS YOUR DATA

- Now that you have measured the dimensions of every member of your group as they were seated, how do we use this information? (Remember that the chair you will design should be as comfortable as possible for everyone in your group.) In the case of your group, would it be more helpful to calculate the average of the measurements, find the mean, or develop another method?

  The answer to this question may vary from group to group. If all group members are of a similar size, calculating the average of the measurements would probably be the best approach. If there is one group member who is of a much different size than the others, calculating the average might just result in the dimensions not corresponding well to any one member's size, and taking the mean may work better. Students may also decide that one particular group member is a good representative of the average, and simply use his/her measurements.

DESIGN A CHAIR

- Which of these chairs do you think would be most appropriate as classroom chairs? Which would be more appropriate in a living room? In a dining room? Why?

  Chairs that keep the body relatively upright, have a simple design, and are made from inexpensive materials would make the best classroom chairs. "Stack-ability" is also an issue. Chairs which keep the body relatively supine or relaxed, are made from plush materials or are especially soft, take up a good deal of space, and are made from more expensive materials would be most appropriate for a living room, since they are intended for maximum comfort and are likely to be purchased individually rather than in bulk. Foot rests are a good indication that the chair is made for relaxation rather than productivity. Chairs that keep the

body upright, and are made of wood or other relatively expensive material, and are decorated may be best suited for the dining room, where they serve a particular function (eating) and where the buyer may want to make allowances for aesthetics.

name(s) date

Activity Sheet

Form and Furniture

Is the Chair you are sitting on comfortable?

A GUIDE TO LOOKING AT YOUR SCHOOL CHAIR

Today you and your partners are going to analyze the chairs you sit on in school for the MOJO Company. As you probably know, the same chair is used by both the shortest and the tallest students in the school. These chairs are called **standardized chairs**. Standardized chairs are used all over the world. If you went to visit a school in Texas, Argentina, or Japan, you might see a similarly sized chair.

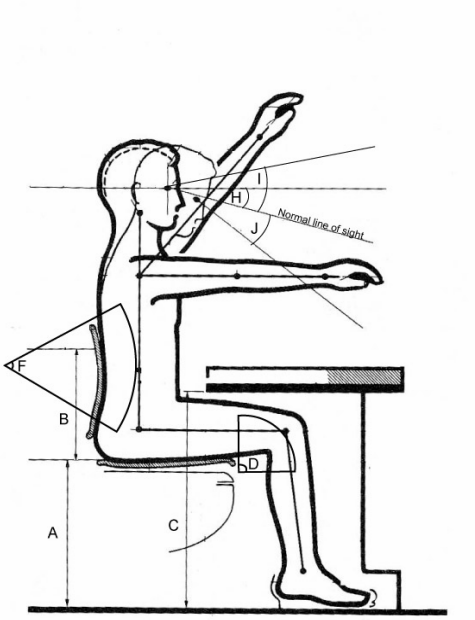
How would you determine if the standard chair is suitable for your class? Try having the tallest and the shortest members of your group sit in the school chair and measure how each fits.

You will need to determine the important chair measurements the company is interested in. Use the diagram below as a guide to figuring out some of the dimensions. Take measurements for both the shortest and tallest members of your group, then average the results to determine standard measurements. Use a separate sheet of paper to do your calculations.

A. The length from the floor to the seat.

B. The length from the seat to upper back where it rests against the chair.

C. The length from the floor to the point where arm rests against the desk (To find the desk height)



Here are some of the curved measurements associated with your body when you are seated:

D. The arc measure of the curve of the knee

E. The arc measure of the curve of the arm as it rests on the desk

F. The arc measure of the curve of the back as it rests against the chair

name(s) date

Activity Sheet

Form and Furniture

There are also distances that relate to your eyes when sitting in the chair.

G. The distance (in degrees) of the arc that your eyes travel (when you only move your eyes and not your head).

H. The “measure” of the angle of elevation when looking at your teacher.

I. The “measure” of the angle of elevation when looking at the top of the blackboard.

J. The “measure” of the angle of depression when looking down at your notebook.

Now create a diagram of a person sitting in the standard chair, labeling all the standard measurements.

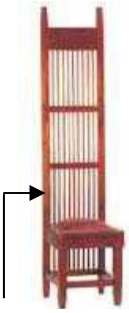
name(s) date

Form and Furniture

Student Guide

This chair was made as a throne for Queen Hetepheres of Ancient Egypt, who ruled during the 4th dynasty (about 2500 B.C.E.)

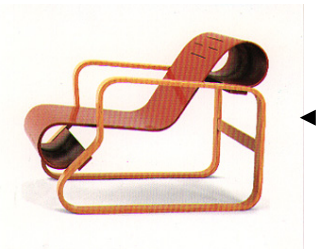
These oak thrones were made in France in 1860.



This chair is from the late Qing dynasty in China (about 1900 C.E.)

This stool is used by royalty in the Ashanti tribe from the West African nation of Ghana.

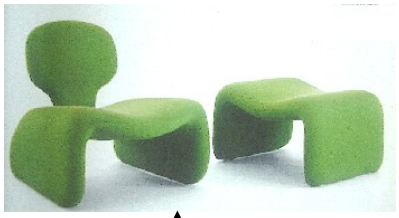
This ergonomic chair was designed by the Swiss architect Le Corbusier in 1928.



This chair is made of laminated pieces of wood and was designed in 1931 by the Finnish architect Alvar Aalto.

American designer Charles Eames designed this chair in 1948 to look like a piece of abstract art.

This chair was built by designer Arne Jacobsen in 1960.



This chair, designed by Olivier Mourgue in 1964, was used in the science fiction movie *2001: A Space Odyssey.*

This chair, designed in 1967 by the Vitra Company, was the first mass-produced chair to be made out of one piece of material, meaning that it requires no assembly.