SUGGESTED REFERENCES

- *The Burj Dubai Official Website*
  http://www.burjdubai.com/

  How Stuff Works - How Smart Structures Will Work
  http://www.howstuffworks.com/smart-structure.htm

- *An educational project designed to spread knowledge about the somewhat mysterious and undiscovered field of skyscrapers*
  http://www.allaboutskyscrapers.com/

NATIONAL SCIENCE EDUCATION STANDARDS

Grades K - 4
Physical Science
Properties of objects and materials
Properties of earth materials

Grades 5 - 8
Science in Personal & Social Perspectives
Science & technology in society

Grades K – 4
Science & Technology
Abilities of technological design
Understanding about science and technology

**Source: National Science Education Standards, 1996, National Academy Press*

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Science Screen Report For Kids

VOLUME 19 ISSUE 5

SKYSCRAPER - REACHING THE SKIES

ABET
Accreditation Board for Engineering and Technology
www.abet.org

National Science Foundation
Presidential Awards for Excellence in Mathematics and Science Teaching

JETS
Junior Engineering Technical Society
www.jets.org

SYNOPSIS

Architects and construction engineers are building taller, larger and smarter skyscrapers by inventing new materials that are lightweight, robust and sturdy. The 21st century skyscraper is being tailored to local environments and ecosystems to anticipate weather extremes. This edition centers on the construction of the Burj Dubai - the tallest man-made structure in the world. The building has 162 floors and soars to 818 meters.

Skyscrapers, like temples and palaces, are considered a representation of a city's economic strength. In this new era of architectural ingenuity, there is a hint of showmanship among developers to build the tallest and most spectacular structures.

CURRICULUM UNITS	RUNNING TIME
ENGINEERING	15 minutes
■ ENVIRONMENTAL SCIENCE	

BACKGROUND

In Dubai, one of the seven emirates that make up the United Arab Emirates, one of the worlds tallest buildings reaches up over 800 meters into the clouds. Along a stretch of seven kilometers, 140 skyscrapers are being built, each one taller than 300 meters. The center of attention in this extravagant plan is a skyscraper that supercedes all others – the Burj Dubai.

Surrounding the Burj Dubai is a whole new district with offices, parks, an artificial lake, and 320,000 luxury apartments. There is even an old town quarter embodying traditional Islamic architecture. The goal is to transform Dubai into a service and tourism oriented city.

The crews working on the towering structure are pioneers in the construction industry. A labor force of three thousand from Pakistan, India, and Bangladesh share ten hour work shifts, around the clock. The high temperatures, along with up to 90 percent humidity, make the working conditions very tough even for those used to working in such harsh conditions.

Two thirds of the Burj Dubai is constructed from reinforced concrete. To reinforce the concrete, record amounts of steel have been used for such a small architectural footprint.

In future construction, elevations will not be cast, rolled, or forged - they will be woven. Researchers are developing a material which is lightweight - yet as durable and flexible as steel. Nature is the model for this synthetic plant stalk. Looking for an ingenious combination of strength and flexibility, a weaving machine integrates hundreds of meters of synthetic fibers which will take the place of steel. Every material has its limits, however, this new material has a greater ductility at its breaking point in that it does not suddenly split or tear.

On other projects, architects are designing bioclimatic buildings and focusing on the sustainable, or "green" skyscraper. In an attempt to make skyscraper life more eco-friendly, they use rain water to create falls of fine water mist inside the building. Vertical landscapes comprise several levels of extensive gardens, and for natural cooling, the wind is harnessed to replace conventional air conditioning systems whenever possible. Openings on facade edges allow wind into the buildings where it is directed through atriums, light yards and balconies. Air canals above the dropped ceilings provide a constant supply of fresh air.

Engineers are working on a feature known as an adaptive facade. Climate adaptive facades differ from conventional ones in that they are able to adjust their characteristics to the changing environment, therefore maintaining a comfortable indoor temperature, lighting level and air quality without excess use of energy.

In nature, skin is an example of a multi-tasking organ. It protects against moisture while allowing air to permeate. The design goal is to create a breathing building that can adapt to the environment like a living being. By cladding shape-memory alloys, the facets of the facade can alter their form and flexibility through electro-impulses as needed, to maintain environmental and structural stability.

This adaptibility could help with the fact that skyscrapers have a tendency to sway due to wind forces. An adaptable structural frame may also counterbalance the sway effect on the top floors, if the lower areas are able to actively alter their form.

CRITICAL THINKING EXERCISES

1. Make a list of the largest skyscrapers in the world. What structures and features make each unique?
2. Discuss the different responsibilities architects and engineers who design and build skyscrapers are trained to manage.
3. Are skyscrapers a good way to deal with space constraints in urban areas? What are the advantages and disadvantages?
4. How do engineers make skyscrapers durable enough to withstand earthquakes, high winds, and severe changes in temperature?
5. In this video, scientists used several models from living things as they designed the best way to construct a tall building. Describe plant and animal examples scientists rely on for their unique designs, and for future skyscraper plans.

ADVANCED ORGANIZERS

Prior to viewing this program, students should have some understanding of the following Benchmarks for Science Literacy, Oxford University Press which are excerpted and, in some cases, abbreviated below. Refer to the Benchmarks for more information.

Benchmark 3: The Nature of Technology
Section A. Technology and Science, Grades 3 - 5

- Throughout all of history, people everywhere have invented and used tools. Most tools of today are different from those of the past but many are modifications of very ancient tools.
- Measuring instruments can be used to gather accurate information for making scientific comparisons of objects and events and for designing and constructing things that will work properly.
- Technology extends the ability of people to change the world: to cut, shape, or put together materials; to move things from one place to another; and to reach farther with their hands, voices, senses, and minds. The changes may be for survival needs such as food, shelter, and defense; for communication and transportation; or to gain knowledge and express ideas.

Section C. Issues in Technology, Grades 3 - 5

- Factors such as cost, safety, appearance, environmental impact, and what will happen if the solution fails must be considered in technological design.

**Benchmarks can be found at www.project2061.org/tools/benchol/bolintro.htm*

VOCABULARY

Adaptive facade	"Skin" of a building that is made of materials able to adapt to changing climatic conditions.
Bioclimatic	The study of the effects of climatic conditions on living organisms.
Climatization	To prepare or modify (a building, vehicle, etc.) for use or comfort in a specific climate, especially one that includes extreme cold or extreme heat.
Compressive stress	The stress applied to materials resulting in their compaction (decrease of volume).
Ductility	Able to undergo change of form without breaking.
Newtons	In the meter-kilogram-second system, the unit of force required to accelerate a mass of one kilogram one meter per second per second, equal to one hundred thousand dynes.
Shape-memory alloys	Group of metallic materials that can return to some previously defined shape or size when subjected to the appropriate thermal procedure.

CAREER POSSIBILITIES

- ARCHITECT
- BUILDING CONSTRUCTION
- ELECTRICAL ENGINEER
- GENERAL CONTRACTOR
- MATERIALS SPECIALIST
- STRUCTURAL ENGINEER