School Architecture, Complexity, and Mathematics

Presented at the OAME Conference:
Learning Systems: The Case of Mathematics for Teaching

Dr. Rena Upitis
Queen's University
Kingston, Ontario, Canada

February 2006

This work is supported in part by the Social Sciences and Humanities Research Council of Canada, and by a nested community of colleagues, students, friends, and family: Katharine Smithrim, Ann Patteson, Brent Davis, Gary Rasberry, David Murphy Haglund, Gary Kembel, Zinta Upitis, Hayden Rasberry…


QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.



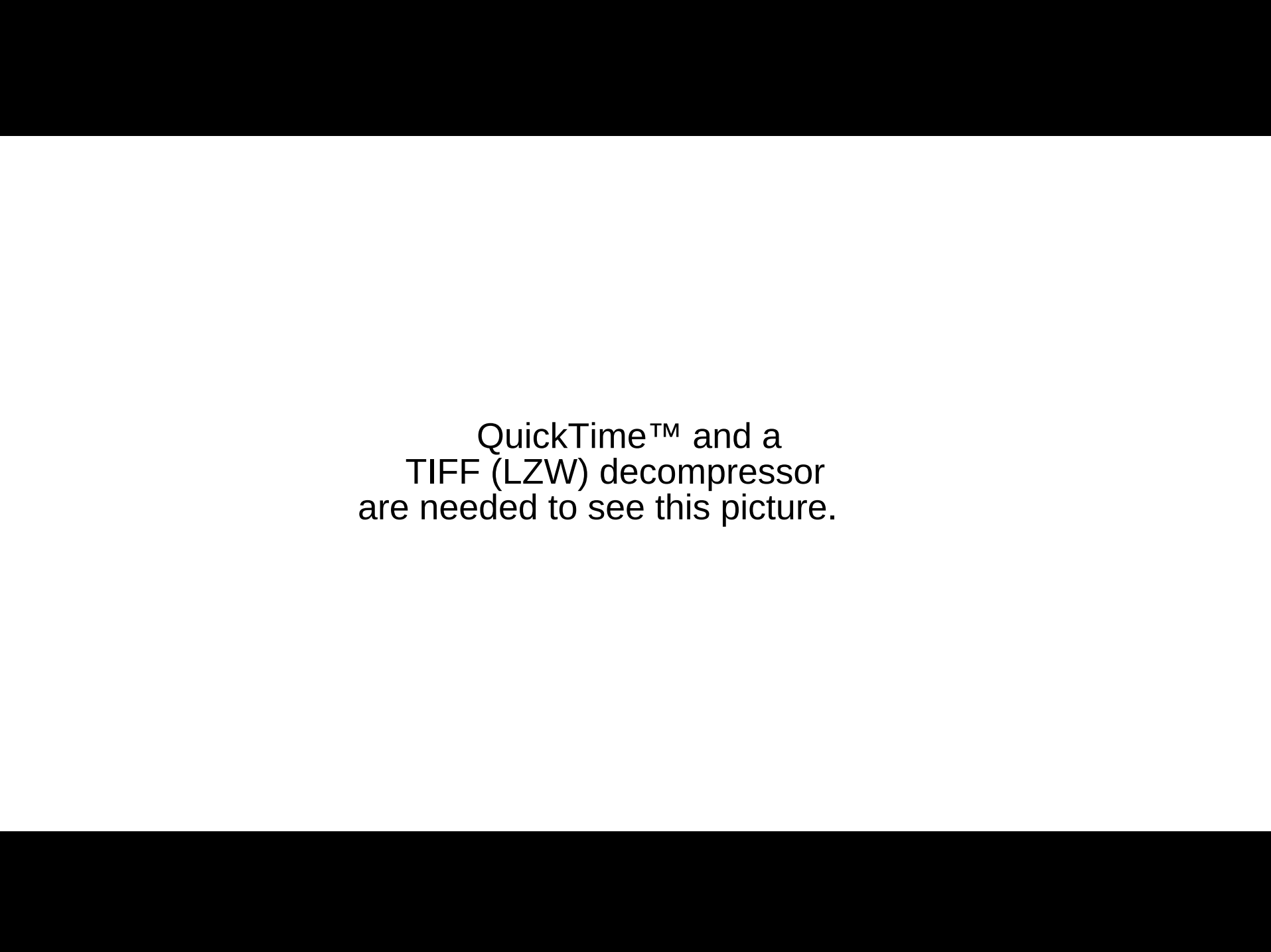
What Do Schools Teach?

- Activities that can be completed while sitting down are most highly valued
- To take part in arts activities, it is often necessary to leave the building
- Activities related to the natural world, like gardening, are unimportant
- Learning happens in homogenous groups of about 25 students

What Else Do Schools Teach?

We expect schools to prepare children for living in a democratic society, yet we provide a learning environment that resembles a police state—hard, overly durable architecture, giant chain-link fences, locked gates, guards, and even guard dogs. Such architecture fails to encourage the sense of ownership, participation, or responsibility required for a democracy.

Taylor, 1995.


QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

Learning and Schools

Higher levels of achievement in schools that:

- Meet safety standards
- Are kept clean
- Are well maintained
- Are well lit
- Have appropriate furniture
- Have inviting green areas and play areas

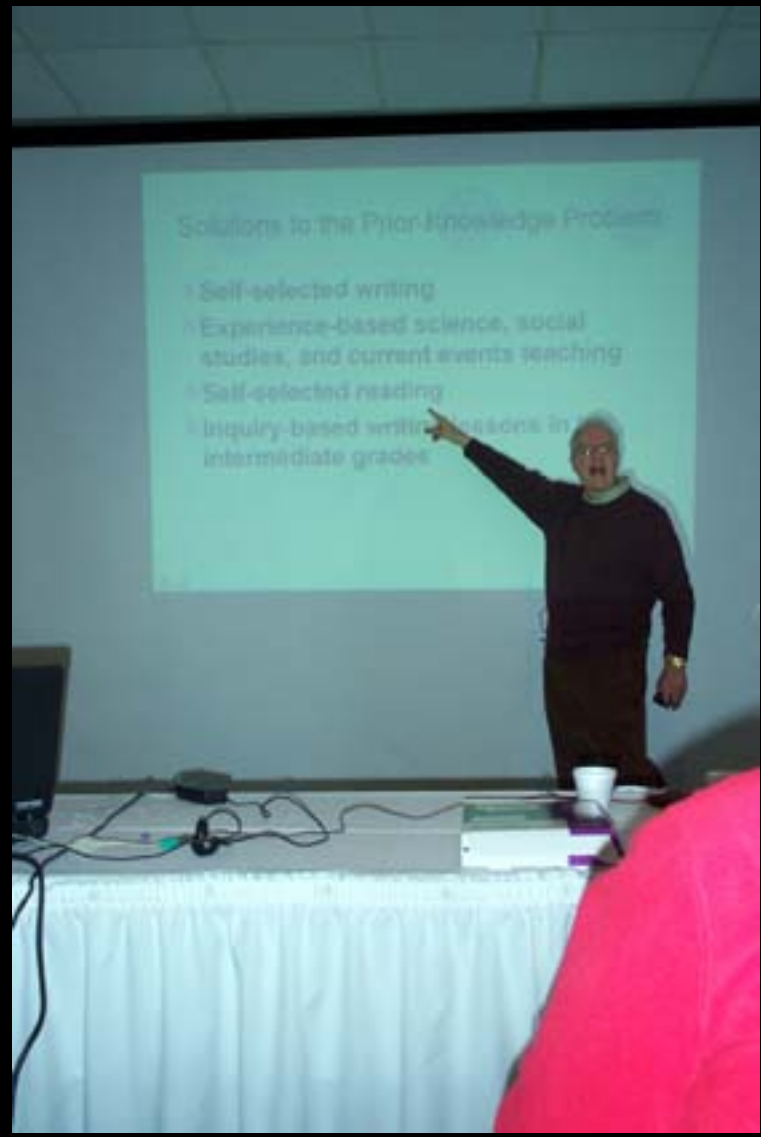
We can do better than keeping our schools clean and making sure that students have appropriate furniture.

Current estimates suggest that in the United States alone, construction begins on two new schools every day. We are in the midst of a surge in school construction and renovation.

Transmission Teaching
Other Possibilities

Transmission Teaching

- Teacher transmits knowledge to students
- Homogeneous groups of students in confined spaces (classrooms)
- Students learn and are tested on a set curriculum
- Students move to the next processing container
- The cycle continues until the students are ready to enter the workplace.



Educational reform cannot happen in most contemporary schools. Architects and educators must come together to determine how the natural and built environments can change in concert with emerging theories about teaching and learning.

Other Possibilities

When No One is Watching: Authentic Learning

- Think of something you love to do, something you consider a hobby or a passion…
- How many of you thought of something that is related to the arts, the body, or the natural world?
- Did you learn about your passion at school?
- Would the architecture of the school have enabled you to learn about your passion?

Dewey’s Utopian School

Dewey began his discussion of the Utopian school with *physical space,* emphasizing the importance of:

Large grounds, gardens, greenhouses

“Open-air” interiors

Variety of workspaces

Easy access to books

Feeling of a well-furnished home

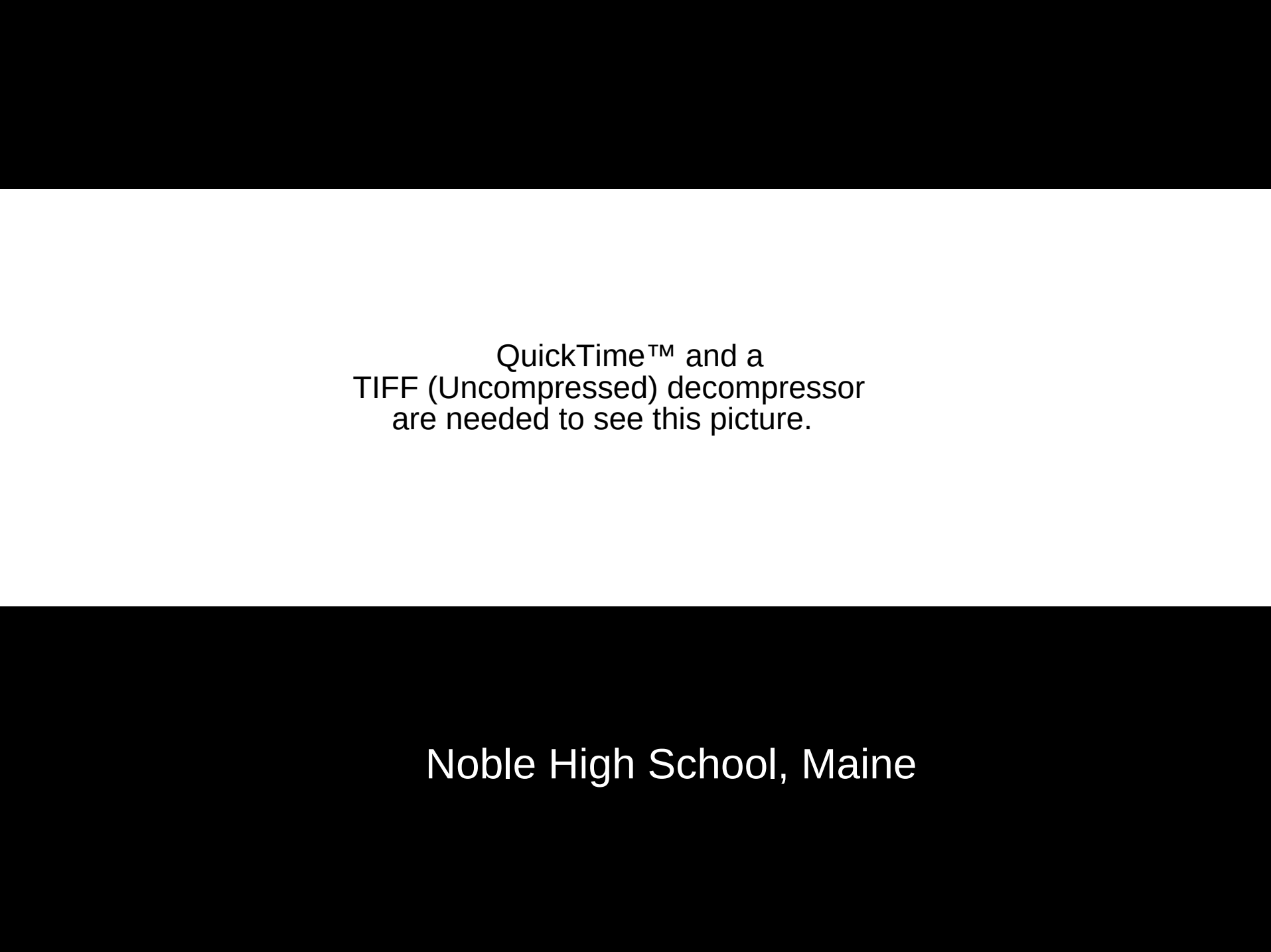
Beauty, comfort, excitement

What if architecture *was* regarded as part of the nested system of curriculum, classrooms, disciplines, and communities?

How would some of the features of complexity translate into architectural impulses?

Diversity

- Schools that serve diverse community needs support complexity.
- Environments which support multi-age groupings introduce diversity into the learning environment.
- A variety of indoor spaces such as project rooms, atriums, laboratories, workshops, libraries, and ateliers create diversity and support complexity.
- Outdoor learning environments also support complexity.



Noble High School, Maine

Neighbour Interactions

Informal areas to congregate
Technology and books throughout
Presentation spaces
Getaway spaces and niches
Display spaces
Teacher workrooms
Promenades
Paths with goals

Note the relationships between these types of recommendations, made by architects, philosophers, and teachers from various settings, and Alexander's *Pattern Language* used in the intensive 3-hour workshops















60,000 hectares of rainforests destroyed

140 species of living beings eliminated

27,000 children dead from hunger

Education for sustainability must connect the knowledge of subjects with knowledge of the hands and heart.

– David Orr (1992, 1999)

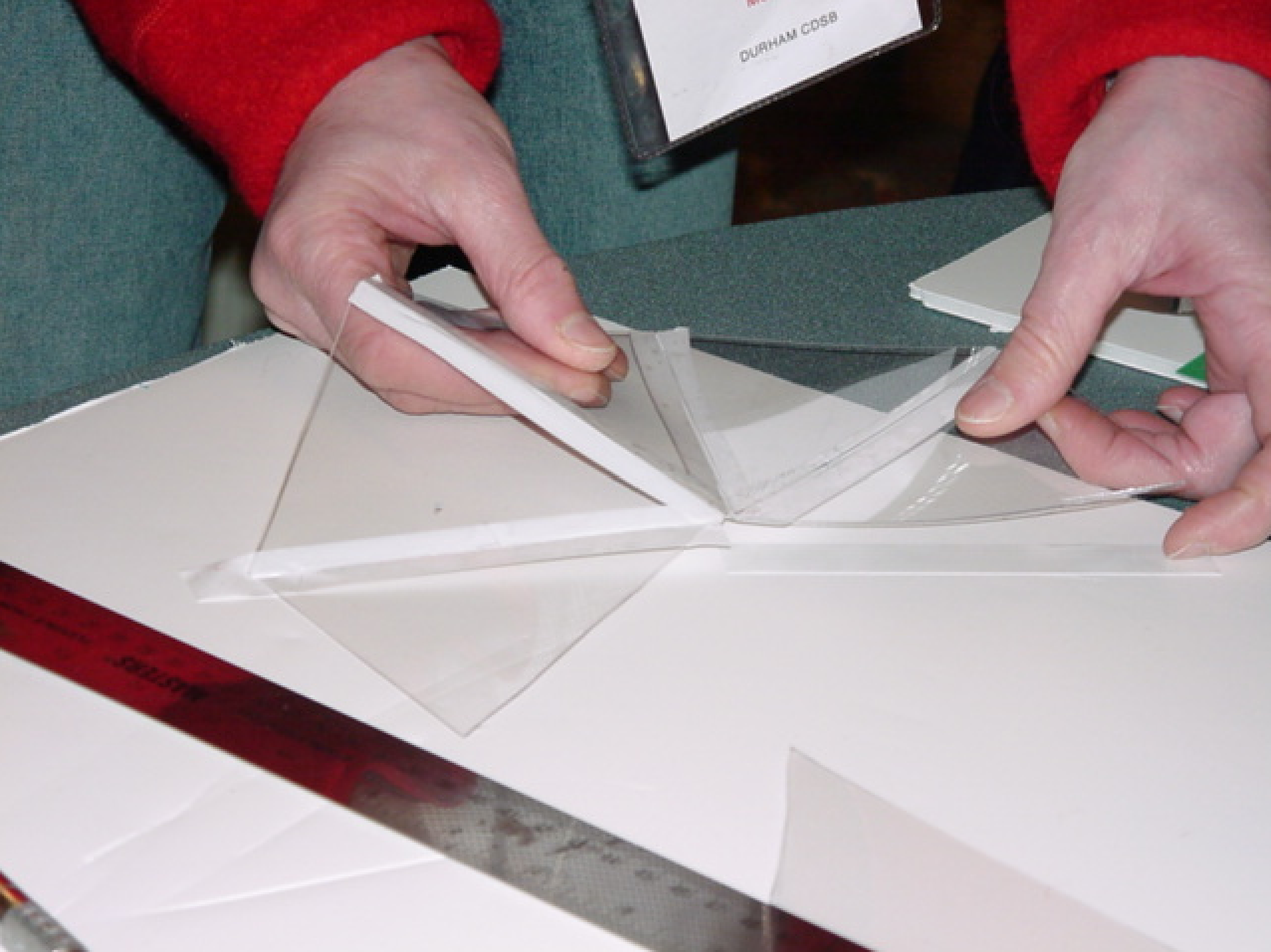
Place has little importance in contemporary education because…

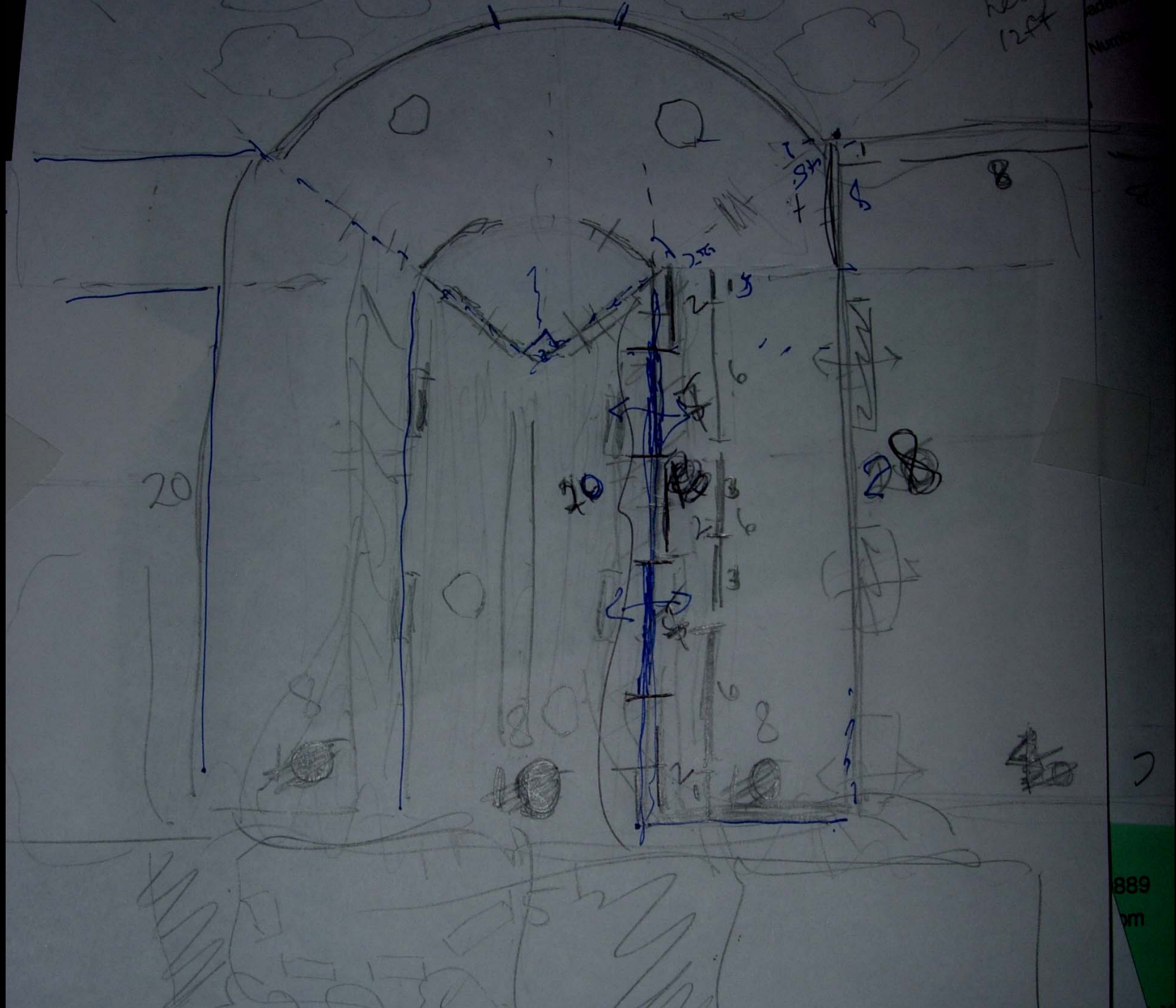
- Schools are immediate and mundane
- Construction set in motion to renovate or repair
- Opposition to “innovative” designs
- Test scores drive decisions
- Public does not think about how natural and built environments affect learning






A Pattern Language


DURHAM COSB





Schools are teachers, and as such, should provide students with a deep understanding of how their choices affect the earth

Four cases illustrate how the study of place can foster links* between thinking and doing, between community members, between people and land

* mathematical, physical, social, emotional, cognitive …


Shearwater Steiner School, Mullumbimby
http://www.shearwater.nsw.edu.au
Photographs by the author

Founded in 1993 with 37 students; in 2005 there were over 550 students, K-12

Town of Mullumbimby has a pop of 6,000; many small neighboring towns and villages with “wired” populations of parents



Master plan developed with Sydney architects Mark Baxter and David Jacobson

Natural setting paramount to the design

- serves as a symbolic and driving force in the school
- administration and arts buildings surrounding a white fig tree
- grey water treatment by means of reed bed






X
Y
Z



Seabird Island Community School

Agassiz, British Columbia, Canada

Exterior photographs by James Dow, courtesy of Patkau Architects, Vancouver, BC http://www.patkau.ca

Interior classroom photograph by the author

Seabird Island is the traditional home for the Sto:ló Nation: People of the River. Aboriginal values gave direction to the process, the construction, and the final product.

Participatory design process resulted in a school:

- positioned at the head of the village serving as a year-round community centre
- built by members of the community with traditional post-and-beam construction
- mimicking the mountains and evocative of the racks still used to dry salmon
- reflecting the notion that there is life in inanimate objects





Joseph Adam Lewis
Environmental Center

Oberlin College, Ohio



Photographs from:

http://www.eere.energy.gov/solar/images/photo_10855.jpg
http://www.coolshadow.com/ConsultingProj/oberlinimages/t1.gif
http://www.loe.org/thisweek/021213oberlin.jpg

See also William McDonough & Partners

http://www.mcdonoughpartners.com/projects/oberlin/default.asp?projID=oberlin

Design forum with 25 students and a cadre of over a dozen architects, engineers, landscape architects, scientists, and other professionals

Set of criteria developed:

- generating more electricity than required
- no waste water
- no carcinogenic materials
- sustainable materials
- landscaping for diversity
- full-cost accounting
- promoting ecological competence





Classes offered in:

- Conservation biology
- Sustainable architecture
- Ecological design
- Environmental education
- Solar energy

Practical and political work of students resulted in a learning environment embodying sustainable building principles of the highest order.



Edible Schoolyard

Martin Luther King Jr. Middle School
Berkeley, California

- One-acre organic garden planted on an abandoned asphalt parking lot
- Alice Waters and Neil Smith spearheaded the planning in 1995, with the first crops being harvested in 1997
- Crops now include an amazing array of seasonal produce, herbs, vines, berries, flowers and fruit trees. Chickens are also kept in the yard

- Close to 1000 students participate in the “seed to table” program as they:
  - Prepare garden beds (compost)
  - Plant seeds
  - Tend crops
  - Harvest produce
  - Cook meals
  - Eat with the school community
  - Collective clean-up and compost

- In addition to working in the garden and preparing food in the kitchen, classroom lessons support understanding of:
  - Food origins
  - Principles of ecoliteracy

    Diversity, networks, interdependence, complexity, nested systems, cycles, energy, resources, succession, co-evolution, self-organization, flexibility, stability
  - Cultural food practices
  - Respect for living systems



Food Preparation





Diversity



Networks,
Interdependence



Respect for Living Systems

- Learning environments that focus on place foster links between, thinking and doing, between all members of the community, between people and the earth

- Learning is intellectual, physical, social, and emotional and may involve political thought and action

- We will build more structures in the first half of the 21st century than in all of recorded human history (Orr, 1999).
- Students have a strongly developed moral sense of suicide, homicide, and genocide. But they have virtually no moral sense of biocide or geocide (Berry, 1996).


It behooves us to shape schools to
develop these moral senses as well.

First we shape our schools, then our schools shape us

