

# Building Arizona's 21<sup>st</sup> Century Schools



Ensuring Innovative School Facilities  
For the Digital Age

In response to Executive Order 2007-06  
Janet Napolitano, Governor of Arizona

Arizona School Facilities Board  
September 2007

# **Building Arizona's 21<sup>st</sup> Century Schools:**

Ensuring Innovative School Facilities for the Digital Age

A Report from the Arizona School Facilities Board  
in response to Executive Order 2007-06  
Janet Napolitano, Governor of Arizona

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**Executive Order 2007-06  
Building 21<sup>st</sup> Century Schools**

**WHEREAS**, to prepare students for the 21<sup>st</sup> Century, Arizona must immediately modernize the delivery of K-12 education and better align its schools with contemporary work and college requirements; and

**WHEREAS**, modern schools with relevant infrastructure for learning and discovery are key to student and teacher achievement; and

**WHEREAS**, individualized instruction enhances learning and the likelihood that students will stay in school; and

**WHEREAS**, school campuses must be appropriate settings for students to learn and grow and should not isolate students from sustained teacher and peer interaction; and

**WHEREAS**, specialized facilities that meet schools' and students' individual program needs will be essential to successfully preparing students for the 21<sup>st</sup> Century economy;

**NOW, THEREFORE**, I, Janet Napolitano, Governor of the State of Arizona, by virtue of the powers vested in me by the Constitution and the laws of this State, hereby order and direct as follows:

1. The School Facilities Board shall, in consultation with Arizona school districts, prepare a report no later than October 1, 2007 containing specific recommendations for how the state can build 21<sup>st</sup> Century schools to best serve Arizona's students. The report shall include specific recommendations on how best to:
  - enhance ability of teachers and students to integrate technology into teaching and learning;
  - create personalized instructional environments that best match teaching programs with individual student needs;
  - foster productive relationship-building between teachers and students;
  - ensure the safety of all students and school personnel;
  - maximize energy and water efficiency; and
2. The report shall also analyze and make recommendations regarding school size and its impact on learning, the impact of class size initiatives on school construction, and the best way to pay for new schools the state needs.
3. Copies of the final report shall be provided to the Governor, the President of the Arizona Senate, and the Speaker of the Arizona House of Representatives.

**IN WITNESS WHEREOF**, I have hereunto set my hand and caused to be affixed the Great Seal of the State of Arizona.



A circular seal of the State of Arizona. The outer ring contains the words "THE GREAT SEAL OF THE STATE OF ARIZONA". Inside the ring, there is a central shield featuring a mountain range, a river, and a sun rising over a desert landscape. Above the shield, it says "DIEAT DEUS DEX". Below the shield, it says "1912".

*J. N. Noyce*  
**GOVERNOR**

**DONE** at the Capitol in Phoenix on this 8<sup>th</sup> day of January in the Year Two Thousand and Seven and of the Independence of the United States of America the Two Hundred and Thirty-First.

**ATTEST:**



*Janice K. Brewer*  
**SECRETARY OF STATE**

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## Preamble

**"We shape our buildings, and afterwards our buildings shape us."** This insight by legendary British Prime Minister and Honorary Citizen of the United States, Winston Churchill explains one of the underlying currents in this report. During the course of fact gathering and research for formulating the recommendations here, the School Facilities Board re-confirmed the fact that the environments within which our students spend their school days do indeed affect the level of their achievement.

Since it is a matter of State interest to see Arizona students achieve and excel, then it is a matter of State responsibility to see that the schools we build for them are places designed to nurture their level of performance, and enrich their educational experience. The schools Arizona will build for the 21<sup>st</sup> Century ought to be expressions of our aspirations for our children and the future they will create.

This next generation of schools for the digital age should reflect the innovation, and motivation for excellence that will be required of this current generation of students, and of those that will follow, if they are to succeed in the interconnected reality of the global economy. This report, in response to Governor Napolitano's Executive Order 2007-06, does not presume to be an exhaustive answer to the issues raised by the Governor, nor to be a definitive crystal ball prediction of what the rest of the 21<sup>st</sup> century holds in store for our schools, our teachers, or our students. Rather, it is intended to help focus public policy discussions about the design and construction of our next generation of school facilities being equal to the nature and demands of a future fueled by emerging technologies.

Innovation and Excellence should be the watchwords for those discussions.

## **DIRECTIVES**

In her Executive Order 2007-06, Governor Janet Napolitano directed the School Facilities Board (SFB) to prepare a report that would recommend how the State can build 21<sup>st</sup> century schools to best serve Arizona's students. Governor Napolitano went on to specify eight areas she required SFB to address. That list of eight specific directives can best be understood if they are organized into three categories 1) Goals, 2) Implications and 3) Requirements. The Goals are based on core values and a shared vision from research groups, town halls, and various policy efforts. Implications focus on the type and size of facilities necessary to address the Goals. Requirements focus on the resources needed to fund those facilities.

### **GOALS**

INTEGRATE technology into Arizona's 21<sup>st</sup> century schools - "enhance ability of teachers and students to integrate technology into teaching and learning;"

ACCOMMODATE the teacher / student connection - "create personalized instructional environments that best match teaching programs with individual student needs and foster productive relationship-building between teachers and students"

ENSURE school safety - "ensure the safety of all students and school personnel"

ADDRESS energy and water consumption - "maximize energy and water efficiency"

### **IMPLICATIONS**

The executive order required recommendations regarding "school size and its impact on learning and the impact of class size initiatives on school construction."

### **REQUIREMENTS**

The executive order required recommendations on "the best way to pay for new schools the State needs."

## **EXECUTIVE SUMMARY**

*To meet the goal of integrating existing & emerging **technology** into Arizona's Schools for the 21<sup>st</sup> Century, The School Facilities Board recommends the following:*

### **Recommendations to the State** (no significant SFB capital outlay required)

1. The State of Arizona should continue its multi-agency effort to complete a statewide survey of broadband capacity and capability in each school district. This is the next step necessary to ensure that all Arizona school districts have high-speed broadband access to the Internet and sufficient broadband capacity and capability to support a digital learning environment.
2. Once the broadband infrastructure gaps restricting Internet connectivity are identified, an action plan should be developed, in concert with the private sector, stating the infrastructure improvements needed, the investment levels required to pay for them, and the time schedule within which they should be made.

### **Recommendations to School Districts** (no significant increases to capital outlay required)

3. Each new school site and building should be equipped with Local Area Network (LAN) capability.
4. Sufficient electrical power receptacles on one 20-amp circuit should be provided on all walls of each classroom primarily for battery charging.
5. Classroom spaces should have infrastructure provisions for sound amplification.
6. Lighting should be controlled for different needs and with adjustable lighting levels.
7. The lighting design issues applicable to educational facilities listed in the American National Standards Institute & Illuminating Engineering Society of North America (ANSI/IESNA) RP-3-00 should be incorporated into the SFB guidelines for new construction.

### **Recommendations requiring Legislative Authorization and /or additional funding**

8. Each new school should be equipped with wireless infrastructure equal to the Institute of Electrical and Electronic Engineers, Inc. (IEEE) 802-11N series equipment standard, the release of which is imminent.
9. Each classroom should be constructed with hard-wire infrastructure consisting of a minimum of six Category 6 data drops.

10. Each classroom should have sufficient bandwidth connectivity to allow for simultaneous wireless Internet connections. This is in addition to the proposed six hard-wired data drops or the current base standard of one hard-wired network modem with Internet access in each classroom.
11. Classrooms for kindergarten through 3<sup>rd</sup> grade should have a ratio of one personal computing device for every three students.
12. Classrooms for grades 4 through 12 should have a ratio of one personal computing device for every student.
13. All classrooms should have computer based presentation system capabilities, at a minimum being a digital projector mounted on the ceiling, preferably with directional flexibility (the ability to project in any direction with wireless connection to the teacher's laptop computer. The emerging technology involves wireless slates ("Airliner™" units) with rear projection interactive white boards ("Smart Board™" units).
14. Presentation (group graphic) wall-boards, in tandem with an Interactive "white board" and a movable projection screen, should be included in all classrooms, in order to allow the most flexible use of the space.
15. The School Facilities Board should continue to evaluate advances in classroom technologies as they become available, for possible integration into new school construction.
16. The State of Arizona should conduct a one-time school design competition for prototypical designs for Arizona's 21st Century Schools in the categories of elementary, middle, and secondary schools. Funding to administer the competition will be sought from private philanthropic sources.
17. The State of Arizona, in cooperation with its three universities, should develop a demonstration and study center to serve as an incubator for innovative application of new technologies in the classroom. In partnership with school component vendors, the incubator would house and showcase cutting edge designs and equipment. Each university could use the center to expose their education students to the latest technologies and designs. Private vendors would use the incubator to showcase their latest innovations. Districts could use the incubator to expose teachers, students, parents and administrators to the latest educational innovations.

*To meet the goal of accommodating & enriching **the teacher / student connection** the School Facilities Board recommends the following:*

**Recommendations to the State** (no significant capital outlay required)

1. The Office of the Governor should institute an annual awards program, administered by the School Facilities Board, to showcase innovative designs incorporated into Arizona school buildings that provide quality personalized learning environments.
2. Post-occupancy evaluations should be done on a pre-determined percentage of the new school facilities constructed each year, after one full year of operation. These post occupancy evaluations would augment the information gathered for the School Facilities Board annual report as specified at A.R.S. §15-2002. sub-section A. paragraph 9.

**Recommendations to School Districts** (no significant increases to capital outlay required)

3. The floor area of each classroom should be sufficient in order to comfortably allow spontaneous re-configuration into group break out segments. This requires a classroom not smaller than 900 sq. ft. (EXCEPTION: this will increase the floor area per pupil formula allocation in K-3 classrooms necessitating additional funding).
4. New school designs should include outdoor areas usable for instructional purposes and informal learning spaces. Each campus should have 3 sq. ft. per pupil designated for outdoor learning spaces to ensure they are incorporated into the design and construction of new schools.
5. In order to ensure the flexibility of the classroom, all furnishings and fixtures in it should be designed to be eminently adaptable, durable, and easily moved.
6. The acoustical performance of the space should be designed to meet ANSI Standards S12.60-2002.
7. Each classroom should have at least one view window to the outdoors. The daylight from this window would augment the minimum required 50 ft. candles of lighting required by the minimum standards.
8. The controls for artificial lighting in each classroom should be capable of providing multiple lighting levels and isolating the areas designated as potential breakout areas, activity zones, or flex spaces.

### **Recommendations requiring Legislative Authorization and /or additional funding**

9. The wireless infrastructure standards recommended in the technology section of this report are critical for 21<sup>st</sup> century classrooms to be truly supportive of personalized instruction and individual learning styles.
10. To ensure that informal learning spaces are included in the design of all Arizona's 21<sup>st</sup> Century Schools an additional 1.5 sq. ft. per pupil should be designated for that space allocation.

*To meet the goal of ensuring the **safety** of students and teachers in Arizona's Schools for the 21<sup>st</sup> Century, the School Facilities Board recommends the following:*

### **Recommendations to School Districts** (no significant increases to capital outlay required)

1. The 911 emergency communication system from each new school should have redundant communication connections to ensure its reliability during any emergency situation or condition.
2. School districts should ensure that the following school safety attributes be thoughtfully and thoroughly considered during the architectural programming phase of each new school project:
  - a. Exterior Security Lighting;
  - b. Administrative Offices location (relative to public entrances);
  - c. Classroom door hardware;
  - d. Student interior restroom configurations;
  - e. Vestibule entry; and
  - f. Sidelights at all interior doors

### **Recommendations requiring Legislative Authorization and /or additional funding**

3. The following four safety and security infrastructure features that are not currently authorized for funding by the School Facilities Board statutes should to be authorized as eligible costs with adequate funding provided.
  - a. Perimeter fencing;
  - b. Security alarms;
  - c. Security cameras; and
  - d. In-classroom telephones

*To meet the goal of ensuring efficiencies in **energy and water consumption** in Arizona's Schools for the 21<sup>st</sup> Century, the School Facilities Board recommends the following:*

**Recommendations to the State** (no significant capital outlay required)

1. The State of Arizona should consider creating a performance based contracting mechanism through which the private sector could propose to provide the installation and operation of the mechanical systems at multiple school sites.

**Recommendations to School Districts** (no significant increases to capital outlay required)

2. In addition to LEED® standards, new school design and construction projects should measure that school's true energy efficiency by the appropriateness of the scale (size) of its mechanical system in proportion to the size of the facility.
3. Opportunities for day lighting of interior spaces, to the maximum benefit of energy efficiency, should be integral to the design of all new school construction.
4. Water conserving plumbing fixtures should be specified throughout all new facilities.
5. All new schools should specify and install water-less urinals.
6. Teachers at these new 21<sup>st</sup> Century Schools should be encouraged to use any of the energy and water conservation measures incorporated into the school facility as "hands-on" teaching opportunities.

**Recommendations requiring Legislative Authorization and /or additional funding**

7. All new Arizona 21<sup>st</sup> Century Schools should meet or exceed the energy measures set out in the Governor's Executive Order 2005-05 relating to renewable energy and energy efficiency.
8. All new Arizona 21<sup>st</sup> Century Schools should have computerized management controls for all energy consuming systems and mechanical systems.
9. Drought tolerant tree canopies along walkways and paths should be designed and installed in order to provide natural shade, to help clean the air of pollution, to add oxygen, and to help cool the microclimate around the school. Drip irrigation systems or sub-surface irrigation should be designed and installed to minimize evaporation losses.
10. Each new school facility project should be sufficiently funded with a specific line item allowance to commission a qualified professional evaluation of the building systems to ensure their maximum energy efficiency and performance levels are attained.

*The School Facilities Board has identified the following implications for the **size of Arizona's 21<sup>st</sup> Century Schools** and the allocation of space within them, inherent in the goals recommended above:*

**Recommendations to School Districts** (no significant increases to capital outlay required)

1. Ideally there should be different sizes of schools in each district, particularly at the secondary level, available for students and their parents from which to choose. The final determination of the size of their new schools should be decided by the local school district, but with an eye to the evidence found in the comparative studies showing better student achievement and teacher attitude at smaller schools. Methods for managing potential cost increases in constructing and operating numerous small schools do exist and need to be studies by school district decision makers.
2. Each new 21<sup>st</sup> century classroom should have sufficient space to accommodate flexibility in teaching styles and learning modalities. Kindergarten through 12<sup>th</sup> grade classrooms should each contain 900 square feet of floor area.
3. High school square foot allocation is recommended to remain at 96 sq. ft. per student. However, the recommended increase in the size of high school classrooms will require adjustments in the space allocation for other uses and room types.

**Recommendations requiring Legislative Authorization and /or additional funding**

4. Kindergarten -- 3<sup>rd</sup> grade school square foot allocation should be increased to 105.5 square feet per student. This represents a 32% increase above the current school allocation of 80 sq. ft. per student.

*The School Facilities Board has identified the following **requirements for funding** of Arizona's 21<sup>st</sup> Century Schools, in order to achieve the desired outcomes listed above:*

**Recommendations to the State** (no significant capital outlay required)

1. The SFB should establish a liaison position to local governments and private developers. The position would help each school district contact potential partners and educate those partners to the advantages of contributing to a school project.
2. The SFB should establish model agreements that districts and local entities can adapt for their own use.

**Recommendations to School Districts** (no significant increases to capital outlay required)

3. School districts should be encouraged to explore the wide range of possible partnerships that can result in shared capital construction costs and innovative school facilities designed to be community learning centers.

**Recommendations requiring Legislative Authorization and /or additional funding**

4. In lieu of General Fund appropriations, Arizona should explore long-term financing to fund new school construction needs. Long-term debt can be issued at the state or the local level.
5. The State should provide a 5 percent match for non-district dollars that are contributed to a school project, over and above the funding amount derived from SFB new construction formulae, as they may be amended.
6. The State should allow a local bonding program targeted to modernizing existing schools.
7. The State should further explore possible dedicated revenue streams to fund or finance school construction.

## OVERVIEW

### Understanding Core Values and A Shared Vision

To be able to appropriately determine how best to build Arizona Schools for the 21<sup>st</sup> Century, the SFB had to first achieve an understanding of the values and vision that will drive the future of Arizona education.

#### LEAD WITH FIVE -- The Rodel Foundation

[http://www.rodefoundationaz.org/initiatives/lead\\_five.shtml](http://www.rodefoundationaz.org/initiatives/lead_five.shtml)

In 2004, the Rodel Charitable Foundation of Arizona published a report entitled "Lead With Five." It was the result of a research and policy analysis project, directed by a steering committee of 26 business, community, and education leaders. They convened to address the questions:

- What would it take to double the achievement of Arizona children?
- What research-based strategies would make a significant difference in improving public education in Arizona?

Their work culminated in the following five investment strategies to improve Arizona public education:

1. Provide full-day kindergarten for all students
2. Prepare and recognize teachers for high performance
3. Create smaller schools
4. Reduce class size
5. Provide one-on-one tutoring and other extra help for struggling students

This report has proven to be the analytical touchstone for Arizona's efforts to provide K through 12 education at the level necessary to make our students competitive in the national and the global marketplace.

#### The 84<sup>th</sup> Arizona Town Hall, Pre-Kindergarten through 12 Education:

Choices for Arizona's Future, June 2004.

<http://www.aztownhall.org/reports/84.asp>

The report of that gathering stated:

- In determining the ideal size for a school district, school or classroom, "one size does not fit all."
- For pre-K through 3<sup>rd</sup> grade, class size must be no greater than 15 students with classes of 15-25 students being appropriate for classes after the 3<sup>rd</sup> grade.
- With regard to school size, students and parents should be able to choose.

## Governor Napolitano's POLICY INITIATIVES for Arizona's Education System

Now in her second term, Governor Napolitano has intensified her focus on the following policy initiatives related to public education in Arizona :

- Early Childhood Education including All-Day-Kindergarten  
<http://azgovernor.gov/sos/2006/010906-SOSVFDK.pdf>
- Support for teachers (<http://azgovernor.gov/tqs/>)
- Science, Technology, Engineering, & Mathematics (STEM) Education  
<http://www.nga.org/Files/pdf/0702INNOVATIONSTEM.PDF>
- Advancement in school design
- Incentives to accelerate innovation  
<http://www.nga.org/portal/site/nga/menuitem.751b186f65e10b568a278110501010a0/?vgnextoid=e34e2bad2b6dd010VgnVCM1000001a01010aRCRD&vgnextchannel=92ebc7df618a2010VgnVCM1000001a01010aRCRD>
- The Governor's P-20 Council: "From Education to Work: Is Arizona Prepared?"  
<http://www.governor.state.az.us/P20/>

## **Understanding Teaching and Learning Methods**

Across the nation, and indeed around the globe, educators are implementing thoughtfully creative new ways of teaching, based on this current generation's immersion in digital technologies and their sense of interconnectedness with the world through the World Wide Web. Emerging digital technologies inextricably influence any view of the future. The reoccurring themes in discussions about the future of education include:

- New ways kids learn
- Technology savvy "Millennials"
- Updated teaching methods
- Emerging technologies for teaching
- Project focused curricula
- Collaborative learning

Margaret Haughey, Professor in Educational Policy Studies at the University of Alberta (<http://www.ualberta.ca/>) addressed the following three questions at a recent meeting sponsored by Educause: 1.) What do we know about learning and cognition that should be applied to the online environment?; 2.) How can existing technologies be used in the design of effective teaching and learning experiences? ; and 3.) What are the next challenges education will face in moving from the transfer model of learning to the design of rich, Web-based learning environments? The following are excerpts of her in-depth answers:

- ❑ Learning itself cannot be *designed*. It can only be *designed for* through the (thoughtful) design of learning environments...
- ❑ Research tells us that learning occurs best in an environment that is resource rich.
- ❑ Learners must also be encouraged to go beyond the information itself.
- ❑ ...if technologies were simply for providing and structuring information, they wouldn't be all that learner centered.
- ❑ Technologies enable us to choose authentic issues and problems.
- ❑ This is why we bother with technologies: they have the potential to expand choices about how we teach and learn.
- ❑ Now that we know that learning is socially constructed, we can begin to see the importance of interaction between teachers and learners and between learners and their peers.
- ❑ Networked environments inspire community, which is the context for social learning.

See Professor Haughey's complete presentation "Principle-Based Technology and Learning Environment Design" at: [www.educause.edu](http://www.educause.edu).

## **Understanding Alternative Visions of 21<sup>st</sup> Century Schools**

Crystal ball gazing is often proven inaccurate with the passage of time. Nonetheless there is always the brave soul who will venture a prognostication of what life will be like several decades out. One such intrepid futurist is high school teacher Karl Fisch from Arapahoe County, Colorado. He created a blog, called "The FischBowl" that he explains as "A staff development blog for Arapahoe High School teachers exploring constructivism and 21<sup>st</sup> century learning skills." As part of that blog, he produced a video clip entitled "2020 Vision." This was his prediction of the world students will experience upon their graduation in the year 2020. The following is the hyperlink to that video clip. <http://thefischbowl.blogspot.com/2006/11/2020-vision.html>

Other prognostications about what our schools will look like by 2020 run the gambit from "not much different from the schools of the last part of the 20<sup>th</sup> Century" to "Schools will look more like the places where their students will be working."

Picking up on that theme, examples abound of innovative workspaces that are not limited to small entrepreneurial companies or creative endeavors like advertising and graphic arts, or digital imaging studios. They include some of the largest but more innovative corporations like Toyota, where project based group effort has made that company very productive and profitable; or Apple Computers where innovation is their strong suit; or Intel where pushing the limits of technology requires a collaborative drive to build a better microprocessor. In these and other examples like them, the key physical attributes are flexibility of the work environment to optimize productivity or to maximize group interaction to solve a problem. A challenge for Arizona is to look at our school facilities, particularly at the high school level, in much the same way successful companies look at their workplaces. They are not afraid to adapt or to re-configure

their workspaces to keep their companies "in the game" and ahead of their competition.

Some of the most dramatic examples of these types of spaces shaped by the collaborative, project based, teaching method are found in classrooms purposefully designed to emulate the work spaces high school students will be encountering when they enter the workforce. During her presentation to the "Building 21<sup>st</sup> Century Schools" Symposium, Dr. Susan Wolff of Oregon showcased several examples. While some were in Community Colleges, notably the Center for Teaching and Learning at Estrella Mountain Community College in Avondale, there were examples at the high school level, including the East Valley Institute of Technology in Mesa. Showing slides of some of the instructional spaces there, Dr. Wolff expressed her admiration for the fact that the lead faculty in the various disciplines at the school were integral to the design, lay-out, and equipping of the classrooms. Those disciplines run the gambit from culinary arts to the fire science program.

Another example mentioned by Dr. Wolff is a learning facility in Greensboro, North Carolina shared by the local high school and Guilford Community Technical College. The two institutions purchased an old warehouse and have turned it into a manufacturing prototyping center, where both high school and college level students are introduced to the concept of testing prototypes and about system design processes. They then learn by building a prototype as a group project. Dr. Wolff was impressed by the fact that when the facility is not in use by the students at either institution, the space and equipment is rented out, on an hourly basis, to local small business owners who cannot afford the outright purchase of similar equipment. She explained this arrangement allows for the purchase and updating of equipment with minimal impact to a general fund budget. The facility is located in downtown Greensboro looking like a manufacturing company, with all its high tech equipment, but with instructional spaces, meeting rooms, and support spaces.

## **Facilities Programming**

While the SFB's role is limited to the construction of schools, it can only do that job well if it understands the nature of the functions those facilities are being built to house. Any good new facilities project begins with, as William Peña, FAIA, founder of CRSS, Inc. of Houston called it, "... an organized method of inquiry... a five step process... to determine the requirements of a proposed building..." and the constraints within which it is to be constructed. This "organized method" has been known as architectural or facilities programming. Peña went on to say that "Good buildings don't just happen. They are planned to look good and perform well, and come about when good architects and good clients join in thoughtful, cooperative effort." Peña defined Programming as analysis and Design as synthesis.

Part of that thoughtful, analytical method of inquiry is understanding and defining the functional activities that the proposed new facility is to house. The range of current and emerging teaching and learning methods that Arizona's new schools should enhance and not hinder run the gambit from the traditional pedantic pedagogy to fresher

methods like collaborative, project based methods. During Dr. Kenneth Tanner's presentation to the "Building 21<sup>st</sup> Century Schools" Symposium sponsored by the School Facilities Board and the Arizona Association of School Business Officials on May 30, 2007, he emphasized the necessity of our next generation of school facilities to be that flexible. The examples from his professional research at the University of Georgia on the subject of student achievement in relationship to the physical facilities in which they are taught and learn underpinned his conclusions. These newer techniques are similar to the business models of new companies that look to collaborative problem solving as their central modes of operation.

Another example shown by Dr. Wolff was the Canby High School Advanced Technology Center in Canby, Oregon. It has a bio-agriculture space with state-of-the-art bio-tissue culture lab equipment that was donated. An impressive freestanding greenhouse is immediately adjacent, housing a floral design instructional space and a biology lab.

A key component in the world the kindergarteners of 2007 will inherit, as they graduate from high school in 2020, will be innovation. Some of the key attributes of an innovative society are collaborative effort, a problem-solving mind-set, learning by doing, and an entrepreneurial spirit. These attributes ought to be reflected in the schools we build.

These are not the types of attributes that can be dictated by formula. However, they can be nurtured by the thoughtful, methodical collaboration between the school district as client and the design team during the pre-construction phase of a project in which they answer the following questions:

- ❑ What are the goals the client wants to achieve and why?
- ❑ What are the needs relating to budget, space, and quality?
- ❑ What are the facts about this building project?
- ❑ How does the client want to achieve the goals?
- ❑ What are the general design directions the design of the building should take and the principle attributes it should manifest?

## **ANALYSIS & RECOMMENDATIONS**

### **Integrating existing & emerging technology into Arizona's 21<sup>st</sup> century schools**

The digital age is characterized by ever increasing rates of change in technological applications and by the ever-widening range of available information. In a future where technology and information are linchpins of the global economy, our students deserve to have their educational experience match the times. While this report cannot offer a precise prediction about the future of digital technologies in our classrooms, it can help frame the principles that will be necessary for our next generation of school facilities to enable -- and not hinder --the integration of digital technologies into the learning experience those schools will house.

The results of a national poll conducted by Zogby International, titled "Education Attitudes 2007," were released on July 26, 2007. The results showed that of the 7,000 Americans who participated 59% agreed that "information technology is a vital tool that can help educate our students by providing access to video and other dynamic content" and that more should be done to incorporate technology into the learning process. The poll also suggests that 69% of Americans believe that science and math courses should be made mandatory for grades 7 through 12. Cisco Systems sponsored a panel discussion at the National Press Club in conjunction with the survey's release. On that panel was Don Knezek, CEO of the International Society for Technology in Education who expressed the opinion that schools need to look beyond rote practices and look forward to innovative learning by encouraging collaborative work and project-based work in team environments. All of the panelists agreed that educational technology should be uniformly integrated across all school districts, and that more funding is needed to achieve that goal. Participating in that same forum, Bill Fowler, executive director of Cisco's 21<sup>st</sup> Century Schools Initiative observed, "How to best educate students so that they have the skills needed to succeed in the 21<sup>st</sup> century workforce is a critical issue facing every nation. This survey highlights that there is a common understanding and appreciation that technology will play a key role in improving the way teachers teach and students learn, so that they are prepared to take advantage of all the opportunities a global society and networked communities provide."

#### High-Speed Internet Access

One prediction that is certain is that the ability of any school to take full advantage of the World Wide Web is totally dependent on its connection to the Internet. Without reliable "connectivity," a school is relegated to use computers to connect to its internal local network only. All Arizona's schools, particularly the next generation of new school facilities, must have high-speed broadband access to the Internet. A critical first step in making sure all Arizona schools are connected to the Internet is a statewide survey to determine the availability of broadband capacity and capability for the geographic area of each school district. The conclusion that such a survey was necessary resulted from a joint effort involving the Department of Education, the Government Information

Technology Agency (GITA), the Department of Commerce, and the e-Learning Task Force. The Department of Education, the Government Information Technology Agency, the Department of Commerce, and the School Facilities Board should cooperatively undertake a statewide survey of broadband capacity and capability in each school district.

Earlier this year, the Arizona Telecommunications and Information Council (ATIC) and the Communications Infrastructure Advisory Committee of the Governor's Council on Innovation & Technology sponsored the [Arizona Telecom Summit – 2007](#). That meeting brought together 200 government and industry leaders to explore options and reach consensus on policies and strategies to improve statewide access to high-speed connection to the Internet.

The primary focus of the Summit was on "the Middle Mile." There are two primary telecom services required to deploy broadband into a community – Last Mile and Middle Mile. The Last Mile is the Internet connection between the Internet service provider (I.S.P.) and businesses, homes, schools, etc. The middle mile is the high capacity trunk lines and associated infrastructure to connect communities to the Internet backbone *points-of-presence* located in major metropolitan areas such as Phoenix and Tucson. If a common middle mile infrastructure is not available, at reasonable rates, communities or last mile providers must construct their own middle mile infrastructure. This may prohibit deployment of broadband service or significantly increase the last mile costs and end users monthly rates.

The Summit recommended several policy initiatives including:

- Creation of a statewide Broadband Authority;
- Clarification of the use of state, tribal, and county owned rights-of-way for broadband infrastructure; and
- Planning the use of those rights-of-way that will minimize associated costs.

The Broadband Authority, suggested by the Summit, could be the coordinating mechanism for an action plan that includes overcoming broadband infrastructure gaps restricting Internet connectivity within some school districts. It is recommended that the Arizona Telecommunications and Information Council (ATIC), and the Government Information Technology Agency (GITA) – in consultation with the Department of Education – prepare a coordinated action plan, cooperatively developed with the private sector.

### **High-Speed Internet Access Recommendations**

- The State of Arizona should continue its multi-agency effort to complete a statewide survey of broadband capacity and capability in each school district. This is the next step necessary to ensure that all Arizona school districts have high-speed broadband access to the Internet and sufficient broadband capacity and capability to support a digital learning environment.

- Once the broadband infrastructure gaps restricting Internet connectivity are identified, an action plan should be developed, in concert with the private sector, stating the infrastructure improvements needed, the investment levels required to pay for them, and the time schedule within which they should be made.
- Each new school site and building shall be equipped with Local Area Network (LAN) capability designed to meet or exceed the connection demands and bandwidth of 80% of the designed student cohort with wireless laptops in simultaneous use.
- Each new school shall be equipped with wireless infrastructure equal to the Institute of Electrical and Electronic Engineers, Inc. (IEEE) 802-11N series equipment standard, the release of which is imminent. (*This standard is capable of correcting most signal interference problems caused by masonry and concrete structural systems.*)

## Applied Technologies in the Classroom

We found it helpful to categorize the possible applications of digital technology in our schools thus:

### INFORMATION

- Information and data for the teacher to use
- Research information & inspiration for the student

### PRESENTATION

- Digital presentation options for the student as well as for the teacher

### WORK PRODUCT & EVALUATION

- Digital mechanism for student work and for review and grading by the teacher
- Mechanism for real-time access to achievement levels to determine effectiveness of teaching methods as well as individual student performance

### TEACHER / PARENT COMMUNICATION

- Communication between teacher & parent

Because the last two of these categories are specific to instructional programs in the schools and do not rely on the physical attributes of their school facilities, they are not included in the following discussion that is focused on the physical attributes of Arizona's 21<sup>st</sup> Century Schools. However, when the full range of opportunities that digital technology presents for our 21<sup>st</sup> century schools and the students in them is clearly understood, it becomes clear that successful application of the technology hinges on the commitment of the schools faculty and administrators to fully integrate I.T. into the educational process at their school.

For purposes of this report, we have not explored the areas of digital technology applications relating to school administration. Digital technology applications relative to facility management are discussed in the water & energy conservation section of this

report. Communication technology applications central to school safety and security are discussed in the school safety section of this report.

On July 5, 2006, cosponsors Discovery Education and Pearson Education published a report entitled "America's Digital Schools 2006." That publication released the results of a national survey of the top 2,500 U.S. school districts that predicted by the year 2011 more than half of all student computing devices in their schools will be mobile rather than desktop units. It also predicted that, in the same five-year period, online learning will grow at a compound annual rate of 26% in their schools. The school districts participating in the survey reported rapid growth in "1:1 computing." That phrase means each student and each teacher has one internet-connected wireless computing device for use both in the classroom and at home. For more information about the study, visit [www.ADS2006.org](http://www.ADS2006.org). The key findings of that study included the fact that over 87% of schools offering 1:1 computing reported substantial academic improvement where results were tracked. It also revealed that district superintendents ranked low total cost of ownership as the single most important factor for implementing 1:1 computing. On the downside, the study revealed that many districts were unaware of a looming bandwidth problem that could be caused by the growing number of student computers and applications at each of their schools. The report also cautioned that merely providing laptop computers, or alternative personal computing devices, was not the answer. It said, "Professional development (of faculty and staff) is perhaps the single largest factor in the success or failure of the digital school. ... The focus needs to shift to a rigorous process of curriculum integration, data-driven decision making, and capacity building." The study quoted Calvin Baker, Superintendent of the Vail School District in Tucson, "Planning is crucial. Teachers need to be part of the decisions and not have the solution dumped on them." Baker began professional development for the faculty at Vail's Empire High School, where each student has a laptop and access to digital textbooks, a full year before the school opened. He employed a train-the-trainer model for the professional development program there.

A follow-up report, "America's Digital Schools 2007," scheduled for publication in November 2007 will focus on the following six topics that were identified from discussions with school districts, legislators and business partners:

- ❑ Implementation Success Factors in 1:1 Computing
- ❑ Learning Management Systems
- ❑ Online Assessment
- ❑ Student Devices
- ❑ Interactive Whiteboards
- ❑ Internet Bandwidth

For more information about the report, and the K-12 education technology survey that will have produced it, visit [www.ADS2007.org](http://www.ADS2007.org).

On this topic of technology in our schools, the "Lead With Five" report said this:

*" Recent research has concluded that 'embedding' technology in instructional programs has a significant effect on test scores. According to some research reviews, the effect of embedded technology rivals that of class-size reduction in the lower elementary grades.*

*" Arizona has developed a substantial technology infrastructure over the years; most, if not all, schools are linked to the Internet and to district offices and/or a state network. At school sites, however, investments in computer hardware and software are too often conceived as one-time capital expenditures. In fact, most computer related-technologies need to be maintained, fixed, upgraded and replaced over time.*

*" Cost studies of technology suggest that schools require about \$250 annually per student, ..., for purchase, upgrade and maintenance of hardware and software. ... These resources will be used effectively only if teachers and administrators use the(ir) professional development efforts ...to learn how to embed technology into the instructional and management programs of each school."*

For more information about the report, visit

[http://www.rodelfoundationaz.org/initiatives/lead\\_five.shtml](http://www.rodelfoundationaz.org/initiatives/lead_five.shtml).

At the "Building 21<sup>st</sup> Century Schools" Seminar held on May 30, 2007, the focus group devoted to the topic of Technology highlighted 1.) Technology design must be addressed with a systems approach, and 2.) The central driver will be the digital curriculum adopted by the faculty. Virtually all of the recommendations raised in that focus group are included in this report. For a complete report of the Technology focus group report from the Symposium, along with the reports of the other three focus groups, refer to Exhibit "A" of this report.

From the perspective of the teacher, utilizing digital technology includes researching materials and writing lesson plans for customized class texts in collaboration with faculty colleagues for approval by the school administration. The teacher also has a broad field of teaching tools available over the wide world web to help make the learning experience relevant and engaging for his/her students.

From the viewpoint of the student, digital technology is the only relevant way to learn in this day and age. Students in our classrooms today were, for all intents and purposes, weaned on computer-based technologies. It is second nature to them. If Arizona is to catch up to the curve, let alone get ahead of it, we must engage our students using the digital language they grasp better than may of us who are from another generation.

Personal computing devices also become tools for collaboration in the classroom when project based teaching methods are employed. They give students the ability to share data, information, and concepts with their group cohorts with very effective learning results. Collaborative learning is one of the new teaching techniques that mirrors the collaborative problem solving methodologies in many 21<sup>st</sup> century work environments. Each classroom, therefore, should have sufficient bandwidth connectivity to allow for

simultaneous wireless Internet connections in order for these rooms to be truly supportive of personalized instruction and individual learning styles. This is in addition to the base standard of one hard-wired network modem with Internet access in each classroom.

Therefore, it is recommended that our next generation of school facilities include the following physical attributes:

- ❑ From the perspective of the teacher, being able to use computer based group displays for instructional purposes enhances her/his ability to effectively communicate ideas and concepts to the entire class. Internet based research opportunities offer the teacher the ability to bring in definitive primary source information at the exact time a class presentation or discussion warrants it. Doing so helps the teacher ingrain in the students the value of the World Wide Web as a learning tool beyond the classroom as well.
- ❑ From the viewpoint of the student, computer based presentation materials are an exciting way to learn that engage both sides of the brain. It also brings into the learning environment the digital means and methods to which this generation of students is accustomed. Not to do so will result in class presentations that they would consider "lame" in their jargon. The basic touchstone for the design of these learning environments is the student's right to see easily, to hear clearly, and to be comfortable.
- ❑ Interactive "white boards" are the standard today, but advances in presentation wall boards are evolving rapidly, with multi-touch surface computing screens being on the not too distant horizon.

### **Applied Technologies in the Classroom Recommendations**

- ❑ Each classroom shall be constructed with hard-wire infrastructure consisting of a minimum of six category 6 data drops. (Note: some districts, Yuma for example, have already set that count per classroom at twelve.)
- ❑ Classrooms for kindergarten through 3<sup>rd</sup> grade should have a ratio of one laptop, or comparable personal computing device, for every 3 students. (1:3 ratio.)
- ❑ In classrooms for Grades 4 through 12 the ratio should be 1:1.
- ❑ Sufficient electrical power receptacles on one 20-amp circuit should be provided on all walls of each classroom primarily for battery charging.
- ❑ Classroom spaces will require computer based presentation system capabilities, at a minimum being a projector mounted on the ceiling, preferably with directional flexibility (the ability to project on any wall) with wireless connection to the teacher's laptop computer. The emerging technology involves wireless slates ("Airliner™" units) with rear projection interactive white boards ("Smart Board™" units). The application of these devices in the classroom holds extraordinary possibilities for inter-active teaching and learning experiences. 21<sup>st</sup> century classrooms in Arizona should be equipped to accommodate them.

- Presentation (group graphic) wallboards, in tandem with an Interactive "white board" and a movable projection screen, should be included in all classrooms, in order to allow the most flexible use of the space.
- Every four to five years, SFB should evaluate then current advances in available technology for possible integration into new school construction.
- Classroom spaces should have infrastructure provisions for sound amplification.
- Lighting should be controlled for different needs with multiple switching levels. (Refer to the Maricopa Community College Learning Space Design Guidelines 1.8.1 for General Learning Area Illumination Levels and Controls as an example reference.)
- The lighting design issues listed in the American National Standards Institute & Illuminating Engineering Society of North America (ANSI/IESNA) Recommended Practice RP-3-00, applicable to educational facilities, should be considered.
- The SFB should continue to evaluate advances in classroom technologies as they become available, for possible integration into new school construction.

### Inspiring Innovation & Collaboration

We have seen technological breakthroughs occur with ever increasing rapidity, over the past three decades. We can expect that pace to continue. The innovations yet to come can't be predicted or mandated. They will come and our schools ought to epitomize incubators of innovation. Our students should be inspired to think about the future and to learn the value of their imaginations. The schools we build ought to stimulate their imaginations and inspire them to strive for their personal best.

This report recommends that the State of Arizona play a catalytic role in stimulating innovation and imagination on the part of the client school districts and their design teams. It can do this by mounting a one-time architectural design competition for prototypical designs for Arizona's 21<sup>st</sup> Century Schools in the categories of Elementary, Middle, and Secondary Schools. The SFB will prepare the prototypical architectural program and space allocations, which the competing designs will have to accommodate in each of the three school types for their respective hypothetical sites. There would be a juried selection process administered by the School Facilities Board, with the jury comprised of nationally recognized school design architects, school administrators, teachers, and education policy officials. The jury selections would be given widespread public exposure and a booklet published that could stimulate additional ideas and innovations on the part of school boards and other decision makers involved in the design and construction of Arizona's 21<sup>st</sup> Century Schools.

Such a professional design competition ought to be structured as the Governor's Challenge to the Arizona architectural and engineering community to let their design talents soar in designing prototypical schools that embody the innovation and excellence that reflect the opportunities of the digital age as well as the level of high achievement we as a State want to see from our students. The decentralized range of ideas and concepts that such a competition could generate would set the new standard for school design in Arizona. It has the potential to provide the stimulus for

future new school design and construction projects that embody the qualities of innovation and excellence.

Recognizing that technologies are changing at ever-increasing rates, but wanting to grab hold of some effective way to showcase emerging technological advances and their benefits to the learning environments in Arizona's 21<sup>st</sup> century schools, the SFB recommends creation of a demonstration and study center, affiliated with the three state universities, to serve as an **Incubator for Innovation** demonstrating the practical application of new technologies in the classroom. In partnership with school component vendors, this incubator would house and showcase cutting edge designs and equipment. Each university could use the incubator to expose their education students to the latest technologies and design ideas. Private sector vendors would use the incubator to showcase their latest innovations in classroom applications. School districts could use the center to expose teachers, students, parents, and administrators to the latest educational innovations.

The incubator would be a facility where everything from classroom configurations to the latest in surface computing could be tried out and demonstrated. The latest in visual presentation hardware could be installed by the private sector to demonstrate its benefits to our next wave of new schools and Arizona's teachers. Similar arrangements with building systems manufacturers could be negotiated, allowing for the demonstration and practical testing of these new systems for the benefit of school district personnel and teachers from across the state.

The spaces in this center could also double as professional development instructional spaces specifically for training in the use of technology and methods for integrating technology into the educational process at the various grade levels. In affiliation with each of the three state universities, it could also function as a statewide resource for video conferencing and closed circuit broadcasts of classes on the proper use of hardware and software in the classroom. Part of the reason there hasn't been more acceptance of integrating technology in classrooms has been inadequate training of school teachers and staff. With this center employing the latest broadcast capabilities to bring state-of-the-art professional in-service training to every teacher in the State, the effective integration of technology into the educational experience in Arizona's schools will be the rule rather than the exception.

The enlightened self-interests of Arizona's IT companies would be served by stimulating a higher level of competency in our teaching corps, and by stimulating the imagination and engagement of our students in the use of technologies that will help them learn and that they will need in their future workplaces. IT companies benefit directly from a well-educated and technologically savvy workforce. It is in the State's interest to see to it that its students have the best educational grounding to compete in the global economy. It is in the State's interest to see to it that our graduating students provide the highest quality labor pool necessary to keep our Arizona companies strong and innovative. It is in the State's interest to see our students, in whose talent we invest, stay to work in Arizona.

## **Engendering Innovation and Inspired Collaboration Recommendations**

- The State of Arizona should conduct a one-time design competition for prototypical designs for Arizona's 21st Century Schools in the categories of Elementary, Middle, and Secondary Schools.
- The State of Arizona, in cooperation with its three Universities, should develop a demonstration and study center to serve as an incubator for innovative application of new technologies in the classroom. In partnership with school component vendors, the incubator would house and showcase cutting edge designs and equipment. Each university could use the center to expose their education students to the latest technologies and designs. Private vendors would use the incubator to showcase their latest innovations. Districts could use the incubator to expose teachers, students, parents and administrators to the latest educational innovations.

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## Accommodating the teacher/student connection

Over the next 20 years, Arizona faces the prospect of needing to build over 800 new schools. The physical learning spaces we build in our next generation of schools should enhance – not hinder -- the emerging teaching methods and learning styles of the 21<sup>st</sup> century.

SFB agrees with the three fundamental rights for students in their learning environments proposed by the authors of **The Classroom Design Manual**:

- Students should be able to see anything that is presented visually
- Students should be able to hear anything that is presented audibly, free from noise and distortion
- Students should be comfortable in their learning environment, including air flow, room temperature, and proper furniture.

These requirements are primary and need to be met before any other attributes should be considered.

As part of Arizona's shared vision for our next generation of schools, Governor Napolitano has identified two interrelated goals:

- To create personalized instructional environments that best match teaching programs with individual student needs; and
- To foster productive relationship-building between teachers and students.

In order to meet these goals, we must understand the emerging teaching methods and learning styles of the 21<sup>st</sup> century.

- Teachers throughout Arizona and across the country are keeping abreast of the digital age. Today's teachers recognize that this generation of students seems to have been born technologically savvy. Today's students are connected to family and friends by cell phones. They are connected to their world via the Internet. They rely on the World Wide Web for their news, as their phone book, and as their reference source. They don't go to the library, they "log-on" wherever they might be.
- Medical research is tracking actual physiological changes in the neurological pathways of the brains of "Millennials" when compared to those of their parents. Those researchers are of the opinion that this is the result of their exposure to digital technology in their very early years.
- Teachers recognize the new possibilities of applying digital technologies to their lesson plans. New educational software and Internet based resources are growing exponentially. These new tools are expanding the methods available to teachers for reaching students individually.

- ❑ A growing body of evidence shows that this digital generation learns best in small collaborative groups. This fact also bodes well for more individualized possibilities of teacher / student interaction.

Throughout this report are references to the need to accommodate the range of teaching methodologies and learning environments. One of the most direct comparisons between "Traditional Learning Environments" and "New Learning Environments" is contained in the **National Educational Technology Standards for Students: Connecting Curriculum and Technology**, published in 2005 by the International Society for Technology in Education. The following table is an excerpt from that document:

<b>TRADITIONAL</b> Learning Environments	<b>NEW</b> Learning Environments
Teacher-centered instruction	Student-centered learning
Single sense stimulation	Multi-sensory stimulation
Single path progression	Multi-path progression
Single media	Multimedia
Isolated work	Collaborative work
Information delivery	Information exchange
Passive learning	Active/exploratory/inquiry-based learning
Factual, knowledge-based	Critical thinking and informed decision-making
Reactive response	Proactive/planned action
Isolated, artificial context	Authentic, real-world context

### The Classroom

The resulting implications for the classroom in 21<sup>st</sup> century schools is that it must be flexible in its ability to accommodate this new mix of:

- ❑ teacher instruction to the entire class;
- ❑ collaborative learning in small groups with a project focus;
- ❑ individual student laptops with wireless connections to the school network;
- ❑ interactive visual and video display panels; and
- ❑ connectivity to the World Wide Web.

The one physical factor that will best achieve "flexibility" is adequate space, augmented by movable/adjustable furnishings and equipment.

### **Accommodating the Teacher/Student Connection In the Classroom Recommendations**

- ❑ The wireless infrastructure standards recommended in the technology section of this report are critical for 21<sup>st</sup> Century classrooms to be truly supportive of personalized instruction methods and individual learning needs.

- The floor area of each classroom needs to be sufficient to comfortably allow spontaneous re-configuration into group break-out segments. This requires a classroom not smaller than 900 sq. ft.
- In order to ensure the flexibility of the classroom, all furnishings and fixtures in it must be eminently adaptable, durable but attractive, and easily moved.
- The acoustical performance of the space should be designed to meet ANSI Standard S12.60-2002.
- Each classroom should have at least one view window to the outdoors. The daylight from this window shall augment the minimum required 55 ft. candles of lighting, required by the base standards.
- The controls for artificial lighting in each classroom shall be capable of providing multiple lighting levels and of isolating the areas designated as potential breakout areas, activity zones, or flex spaces.

### Informal Learning Spaces

The classroom is not the only learning environment Arizona's 21<sup>st</sup> century schools will have to house. New exemplar schools have all allocated space for informal learning environments. These less formal, non-traditional, spaces have proven to be well-used resources for individual instruction and for collaborative learning at all grade levels. Recently built, well-designed high schools provide good examples of open spaces, adaptable for multidisciplinary instruction and learning.

Even though it is written for application in the design of college facilities, the Maricopa Community College Learning Space Design Guidelines give a very good description of the nature and purpose of these novel learning environments in new schools. The following is an excerpt from those Guidelines:

"Instruction and learning no longer stops at the walls of our classrooms, it continues at nearly all other times and locations that students or faculty may gather. In the *Social Life of Information*, John Seely Brown and Paul Duguid claim: 'As much learning happens outside the classroom as inside.' ... Both indoor and outdoor spaces can be developed, but must be planned. We try to provide a variety of spaces, uses, and furnishings to fit the wide variety of social and learning styles of our students. These spaces are social, interactive and flexible, multi-purpose, reconfigurable and open."

"Seating and informal social areas are desirable in circulation areas of learning settings where code allows, and in other areas outside of learning areas. Seating creates an atmosphere of unhurried scholarship, social interaction and informal teaching situations outside the classroom. Students are able to linger in public areas, hallways before and after classes. Have impromptu discussions, and are not shuttled in or out once classes end. What were once just hallways become waiting and social areas before class or meetings. Corridors and connectors become learning streets, with activities on and between destinations, not just paths to their final location."

"The following are items and ideas that often are found with and contribute to successful informal spaces:

- Flexibility
- A variety of seating arrangements, from picnic tables to four person round tables with loose chairs, from upholstered chairs and couches for social settings, to tables for group meetings and learning. Be sure to take into account seating and accessibility for physically challenged and wheelchairs.
- Food and drink nearby
- Technology connections, hard wire but most recently, wireless
- A variety of lighting arrangements to complement the setting
- Proximity to main pedestrian paths and entities to buildings
- The ability to 'see and be seen' from the seating
- Typically, a 'more active' environment, including music, but also some quieter, retreat or study spaces for older students used to a more placid study setting
- Seasonal shade for outdoor areas but allowing sun or filtered sun in the spring, winter and fall.
- Association with a water feature, providing background sound and cooling effect in the summer
- Larger, more active spaces generally located away from classroom areas to contain noise and trash, although some limited seating, quiet study and waiting areas directly outside classrooms is useful
- Separated areas for smokers away from buildings and other seating areas, but set up similar to other seating."

Properly located secure outdoor areas have proven to be very good informal learning spaces, and even excellent alternative venues in which to hold structured classes. The advent of student laptops has made this possibility even more appealing and effective. The critical attributes for these outdoor areas are shade, wireless connectivity, and reasonable security.

The old formal Library & Study Hall has long since evolved into the "Media Center." Now, the construct of the Media Center has been evolving of late, often a mix between a research library with an array of computer workstations to a library with very few books but more audio and video recordings available with work areas for students to work on their personal laptops. The more innovative schools across the country, albeit at the secondary and community college levels, have taken that evolution to another level. They have transformed these Media Centers into social as well as informal learning hubs. These "Information Commons" have taken on the attributes of a student lounge or a coffee shop, "Info Bistro" if you will. Informal collaboration or solo study takes place, but in a relaxed, contemporary atmosphere. The concept of students continuing to learn over refreshments or a snack helps reinforce the lessons being taught in the classroom at the same time reinforcing the notion that in this day and age students can continue the learning process wherever they are and whatever they are doing. It has the potential of nurturing their awareness that there are many

ways to learn a lesson. A great school facility will reinforce the realization that a student's personal quest for knowledge and wisdom can be, and should be life-long.

In any good management construct, post-occupancy evaluations of recently constructed facilities are done to learn how well novel design elements are actually performing. Those that are ought to be showcased and replicated. This report recommends that a dedicated appropriation be enacted by the legislature to fund post occupancy evaluations overseen by the School Facilities Board. These evaluations shall be done on a pre-determined percentage of the new school facilities constructed each year, after one full year of operation, and should focus on imaginative design solutions providing personalized instructional environments. These post occupancy evaluations would augment the information gathered for the annual report as specified by A.R.S. §15-2002. sub-section A. paragraph 9.

The more creative informal learning spaces schools provide, the better they will be. This is true at all grade levels. Creativity is not achieved by dictating a template. The State should not develop a template for these innovative learning spaces. Innovation is not something that can be mandated, but it can be nurtured and rewarded at the State level. To that end, the School Facilities Board recommends that the Office of the Governor institute an annual awards program, administered by the Board, to showcase innovative designs incorporated into Arizona school buildings, whether funded by the SFB or not, that provide quality personalized learning environments.

Key to this recognition should be evidence that these spaces have contributed to productive relationship building between teachers and students. Another measure of the success of these innovative learning spaces, worthy of gubernatorial recognition, shall be evidence of improved academic achievement and increased student engagement in their own learning process. These innovative achievements shall also have been accomplished within a reasonable budget.

### **Accommodating the Teacher/Student Connection in Informal Learning Spaces Recommendations**

- ❑ To ensure that informal learning spaces are included in the design of all Arizona's 21<sup>st</sup> Century Schools an additional 1.5 sq. ft. per pupil should be designated for that space allocation.
- ❑ New school designs should include outdoor areas usable for instructional purposes and informal learning spaces. Each campus should have an additional 3 sq. ft. per pupil designated for outdoor learning spaces to ensure they are incorporated into the design and construction of new schools.
- ❑ Post-occupancy evaluations should be done on a pre-determined percentage of the new school facilities constructed each year, after one full year of operation, and should focus on imaginative design solutions providing personalized instructional environments.

- The Office of the Governor should institute an annual awards program, administered by the School Facilities Board, to showcase innovative designs incorporated into Arizona school buildings that provide quality personalized learning environments.

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## **Ensuring the safety of students and teachers**

### Arizona Safe Schools

Schools in Arizona should be safe and secure places in which our children and young adults can focus on learning. Their teachers ought not be preoccupied with their own personal safety and that of their students. There are numerous design attributes and facility characteristics that can enhance a school's safety and security performance. These attributes were highlighted in a report prepared earlier this year by the School Facilities Board entitled "Arizona Safe Schools." The report was officially adopted and issued by the Board on August 2, 2007.

<http://www.azsfb.gov/sfb/21st%20Century%20Schools/School%20Safety%20Recommendations.pdf>

That report highlighted the CPTED (Crime Prevention Through Environmental Design) program of the National Crime Prevention Institute. The four strategies that define CPTED are:

- Natural Surveillance
- Territorial Reinforcement
- Natural Access Control
- Target Hardening

That report recommended the following ten safety features be included in all new school facilities. They are incorporated into the recommendations of this report:

1. Exterior Security Lighting
2. Administrative Offices Location (relative to public entrances)
3. Classroom Door Hardware
4. Student Interior Restroom Configuration
5. Vestibule Entry
6. Sidelights (at all interior doors)
7. Perimeter Fencing
8. Security Alarms
9. Security Cameras
10. In-Classroom Telephones

### 911

One of the most critical physical attributes necessary in an emergency situation is a reliable communication system. The "911" emergency telephone system is the cornerstone of a school's emergency connection to first responders. Redundancy in that system from every school facility should be part of the design review for all new schools.

In the event of any and all emergency incidents, a district or individual school requires reliable communication with first responder agencies. Part of an effective school safety

strategy is to ensure that communication and information systems in Arizona's schools are reliable and sufficiently redundant to provide back-up to failure in the primary system.

### Other Operational Safety Considerations

Having established familiarity and cooperation with the first responder agencies in their locales, school districts, and their individual schools, will have a leg up on efficient and effective communication at the time of an emergency safety or security incident. SFB is cognizant of the fact that these are operational issues and not facilities or fixed asset issues. However, we would be remiss if this observation was not stated in the context of our response to the Governor's executive order.

The Arizona Department of Homeland Security instituted the AZ-211 Online Emergency Information System in June 2005. It is available at [www.az211.gov](http://www.az211.gov). That web site provides a reliable statewide source for real-time updates during an emergency or disaster situation. It also provides reliable information on available resources in times of disaster or emergency. It is the quickest source for State and local emergency bulletins and alerts in a crisis. School faculty and district personnel should know about that resource and plan for its use in times of emergency, to the best advantage of the schools, their students, and their parents.

The Preparedness Section of the Division of Emergency Management within the Arizona Department of Emergency and Military Affairs, in collaboration with the Arizona Department of Education, is currently conducting a survey of Arizona's School Districts to identify any shortcomings in Arizona's school emergency response capabilities. Once there is sufficient statewide data accumulated by this instrument, the two participating agencies will make recommendations to the Governor for corrective or supplemental actions necessary to ensure the safety of our students and teachers and the security of our school facilities. The results of that analysis will alert the SFB of physical security features beyond those that are recommended here for inclusion in all new school construction projects.

The Division of Emergency Management also provides training and simulated exercises to school district personnel to help them better prepare for emergency scenarios requiring quick response and decisive action including the protocols for contacting the most appropriate first responders in a variety of emergency situations. School District personnel can avail themselves of that training support by going to the Division of Emergency Management website at: [www.dem.state.az.us](http://www.dem.state.az.us) and looking for the Preparedness category link at the left hand side of the Home Page of that website, or use this direct URL link:

<http://www.dem.state.az.us/preparedness/training2004/training.htm#>

School District officials should also avail themselves of technical assistance and advice available from the Arizona Division of Emergency Management [www.dem.state.az.us](http://www.dem.state.az.us) Louis Trammell, Director.

SFB also suggests that school districts avail themselves of the technical assistance from national organizations such as the School Safety Assessment Services available from the National School Safety Center [www.nscc1.org](http://www.nscc1.org) in Westlake Village, California or the National Crime Prevention Council [www.yar.org](http://www.yar.org) in Washington, DC. Also, the Federal Emergency Management Agency (FEMA) within the Department of Homeland Security, in association with the Department of Education, offers on-line training courses in emergency management planning and implementation specifically for schools.

The Department of Education, in January 2007, published a handbook entitled "Practical Information on Crisis Planning: A Guide for Schools and Communities." It can be found on-line at the following hyperlink:

<http://www.ed.gov/admins/lead/safety/emergencyplan/crisisplanning.pdf>

### **Arizona Safe Schools Recommendations**

- School districts should ensure that the following safety attributes be thoughtfully and thoroughly considered during the architectural programming phase of each new school project:
  - a. Exterior Security Lighting;
  - b. Administrative Offices location (relative to public entrances);
  - c. Classroom door hardware;
  - d. Student interior restroom configurations;
  - e. Vestibule entry;
  - f. Sidelights at all interior doors;
  - g. Perimeter fencing;
  - h. Security alarms;
  - i. Security cameras; and
  - j. In-classroom telephones

### **911 Recommendations**

- This report recommends that the 911 emergency communication system from each new school have redundant communication connections to ensure its reliability during any emergency situation or condition.

## **Addressing efficiencies in energy and water consumption**

### Energy

The average elementary school consumes power equivalent to 1,275,000 KWh per year. The average high school consumes 2,880,000 KWh per year. These are not insignificant numbers. With the current projection of 800 new schools Arizona will need to build within the next twenty years, the total energy consumption levels represented by these new schools will be on the order of 1,180,500 MWh per year. Any efficiency that can be instituted in the energy use of these new schools, over and above the current efficiencies required by SFB, will be significant.

Arizona Revised Statutes set out the requirement for energy conservation standards for public buildings at ARS §34-451. That law includes school facilities. It sets the Arizona standard consistent with the energy conservation standards of the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) and the International Energy Conservation Code.

Another industry standard is LEED®. The Leadership in Energy and Environmental Design (LEED®) Green Building Rating System™ is the nationally accepted benchmark for the design, construction, and operation of highly efficient buildings. LEED® provides the quantifiable references needed to measure a buildings' performance and efficiency. The LEED® for Schools Rating System recognizes the unique nature of the design and construction of K-12 schools. Based on LEED® for New Construction, issues such as classroom acoustics, master planning, and mold prevention are addressed.

ENERGY STAR is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy. ENERGY STAR is a national energy performance rating system to help citizens save money and protect the environment through the use of energy efficient products and practices. In calendar year 2006, Americans engaged in ENERGY STAR, saved enough energy to avoid greenhouse gas emissions equivalent to those from 25 million cars — all while saving \$14 billion on their utility bills. Part of the ENERGY STAR program, the Office of Building Technology, State and Community Programs in the Department of Energy promotes a program called Energy Smart Schools. For more information, visit: [www.energysmartschools.gov](http://www.energysmartschools.gov).

By issuing Executive Order 2005-05, Governor Napolitano set the bar for all new state buildings to: (1.) derive a minimum of 10% of their energy from a renewable source; (2.) meet energy efficiency standards consistent with Arizona Revised Statutes § 34-451; and (3.) meet at least the "Silver" LEED® standard in their design and construction. (see Executive Order 2005-05 at Appendix "B".) The School Facilities Board can apply these measurements to all new schools, however to achieve them will require increased allocations to do so. The LEED® standards consist of the following six certification categories: 1.) Sustainable Sites; 2.) Water Efficiency; 3.) Energy & Atmosphere; 4.) Materials & Resources; 5.) Indoor Environmental Quality; and 6.) Innovation & Design. SFB is already ensuring that new construction projects incorporate those LEED®

standards that are low-cost or no-cost. These required measures can account for 16 to 18 points toward LEED® certification for a new school project.

*For the complete LEED School Project Check List, go to the LEED® website: <http://www.usgbc.org>*

In order for a new school project to attain LEED® Silver Certification it must achieve 37 points out of a possible 79 points in the listed Schools Rating System categories. An example of a recently constructed school in Arizona that achieved LEED® Silver Certification is Desert Edge High School, in the Agua Fria School District in Goodyear.

*(There are two other school facilities in Arizona that have achieved LEED® Certification. They are Davidson Elementary School (Tucson Unified School District) in Tucson and First Mesa Elementary School (Cedar Unified School District) in Keams Canyon.)*

The LEED® standard for mechanical system efficiency, however, is limited to the efficiency ratings of the equipment components themselves but does not include an analysis of the efficiency of the complete system. Therefore, the SFB recommends including, as a measure of a school's true energy efficiency, the size of its mechanical system being efficiently proportional to the size of the facility (the usual industry standard is square feet per ton of air conditioning). The baseline measure of a building's systemic performance should be expressed as energy consumed, in KWh per square foot per year.

If our new schools are to be 21<sup>st</sup> century vintage, Arizona ought to move to include computerized management controls for all energy consuming systems and mechanical equipment. Currently, SFB funding does not cover such computer-based controls.

Additional energy consumption levels can be reduced by the careful integration of daylight into the school. A consistent result of research shows the positive correlation of student achievement, and teacher performance, to classrooms lit by exterior windows with views to the outdoors. This is an equally important reason to insist that the classrooms, and other spaces for learning, in our new schools have windows to the outdoors.

In the near-term, the existing technology of solar panels for heating water could account for supplemental energy savings in the operation of our new schools. With as much consistent sun light as we have in Arizona, it is an opportunity for Arizona schools to teach other sectors of energy users the wisdom of harnessing this renewable and abundant Arizona resource. The current technology for this application is simple and cost effective with a pay back period averaging about 5 years, depending on the complexity of the system. The less complex and less expensive the system the shorter the pay back period will be.

*For more detailed data, go to: <http://www.solarroofs.com/economics/index.html>*

There are examples of school facilities in Arizona that have incorporated solar power systems. The leader in the application of solar power systems in new school construction has been the Tucson Solar Schools Project, involving three school districts in partnership with Tucson Electric Power Company. The energy savings estimates for the individual schools that are part of this project are:

#### Tucson Unified District

1. Davidson Elementary School – 14,400 KWh per year;
2. Doolen Middle School – 9,600 KWh per year;
3. Project MORE – 24,000 KWh per year;
4. Hohokam Middle School – 7,200 KWh per year;
5. Tucson Unified School District Facilities Office – 3,000 KWh per year;
6. Palo Verde Magnet High School – 7,200 KWh per year.

#### Vail School District

7. Civano School – 4,800 KWh per year;
8. Empire High School – 12,000 KWh per year; and

#### Safford Unified District

9. Safford Middle School -- 9,600 KWh per year.

While these installations are modest in scale, they do represent a responsible effort to lead the way in application of solar technology. Moreover, because of their location at school facilities, they provide a “real world / hands-on” opportunity to see how solar power can be harnessed today. They can stimulate students to think about the possibilities for solar power in the future.

Current photovoltaic technology carries a higher burden of initial capital cost, per KW produced. However, the prospects of that capital cost decreasing over the coming years are very good. In the meantime, distributed electrical energy from renewable sources, including solar arrays, is increasing. The Arizona Corporation Commission has recently issued a decision that the power companies it regulates must produce 15% of the electricity they distribute from renewable energy by the year 2025. For uses other than to heat water, the focus of advancing energy generation from renewable sources is best placed on the power companies rather than on individual schools.

Once photovoltaic technology breakthroughs occur making their initial capital cost more reasonable, the possible requirement to have all new schools incorporate solar power systems in their design and construction should be re-visited.

School Districts are encouraged to take advantage of the information and technical assistance available through the Energy Office within the Arizona Department of Commerce and from local utility companies. The Energy Office provides information on energy efficiency, renewable energy usage, and policy advice. See [www.azcommerce.com/Energy/](http://www.azcommerce.com/Energy/).

### **Energy Efficiency Recommendations**

- All new Arizona 21<sup>st</sup> Century Schools should meet or exceed the energy measures set out in the Governor’s Executive Order 2005-05 relating to renewable energy and energy efficiency.

- ❑ In addition to LEED® standards, new school design and construction projects should measure the school's true energy efficiency by the appropriateness of the scale (size) of its mechanical system in proportion to the size of the facility.
- ❑ All new Arizona 21<sup>st</sup> Century Schools should have computerized management controls for all energy consuming systems and mechanical systems.
- ❑ Opportunities for day lighting of interior spaces, to the maximum benefit of energy efficiency, should be integral to the design of all new school construction.
- ❑ Life-cycle cost analysis of all building systems should be conducted every five years by the SFB, based on then current best available operating data compiled from around the State, and compared against the best available national industry data. This will give some empirical data on the most cost effective systems that can inform the periodic updating of SFB standards for these systems in the new schools constructed during each successive five-year period.
- ❑ Teachers at these new 21<sup>st</sup> Century Schools should be encouraged to use any of the energy conservation measures incorporated into the school facility as "hands-on" teaching opportunities.

## Water

WATER SENSE is a voluntary partnership program offered by the U.S. Environmental Protection Agency. Similar to the ENERGY STAR program, WATER SENSE provides performance ratings on products that use water. The web-link is [www.epa.gov/watersense](http://www.epa.gov/watersense). This program provides information on water efficiency for products and equipment that may soon be available for use in our schools. Examples of these are:

- ❑ "high efficiency toilets" that are a grade above the "low flow toilets" currently mandated by National and State Plumbing Codes,
- ❑ weather sensor control technologies for sporting fields irrigation.

There are many water efficient technologies available to the food service industry that could benefit our school cafeterias. Currently the Arizona Department of Water Resources (ADWR) is promoting a water efficient pre-rinse spray valve through a new program called "Arizona Rinse Smart". These new, and very efficient, valves save both water and energy. This program is focused on replacing high water use spray valves with low water use spray valves in commercial kitchens. The new spray valves use less water and have higher water pressure.

Pre-rinse spray valves are used in commercial dishwashers at food service establishments, primarily to remove food particles before plates and trays. Typically, the food service industry is a hard sector to convince to use water efficient technologies. Two-thirds of water used by restaurants is used for dishwashing. That same rate of water usage undoubtedly applies to school cafeterias. These new valves are rated at 1.6 gallons per minutes at 60-psi (pounds per square inch) pressure. The newer, more

efficient spray valves use half as much water and clean more effectively than standard valves.

Food steamers used in preparing vegetables that do not bear the ENERGY STAR or WATER SENSE label are typically utilizing a boiler to heat the water. Boiler models typically waste 40 gallons of water per hour by releasing water into the sewer drains. Another opportunity for savings is through the replacement of water-cooled ice machines with air-cooled machines. Replacement of a water-cooled machine with an air-cooled model can save 85-95%. Another way to use less water in school cafeterias is to make flaked ice instead of cubed ice. There are ice machines that use no more than 20 gallons of water to make 100 pounds of ice.

Washing of outdoor surfaces (parking lots, sport courts, concrete, etc.) is best done with water brooms. Water brooms use a combination of water pressure and air to clean surfaces. Other water efficiency technologies are listed on the ADWR website: [www.azwater.gov](http://www.azwater.gov).

Arizona Revised Statutes (ARS §45-313.01) requires every effort be made to install water free urinals in all State buildings constructed after January 1, 2005. The SFB currently encourages the use of water-less urinals in all new school construction projects. Currently, requirements for the installation of water saving plumbing fixtures and fittings in new construction projects are being enforced during project review.

Case study data from the Socorro, Texas School District shows that the annual cost savings in water and sewer bills is at least \$100 to \$200 per urinal, according to Joe Covarrubias, that school district's Maintenance Coordinator. Their water savings at elementary schools where water-free urinals have been installed is between 15 & 20%.

Refer to: <http://waterless.com/savings.php>

The water saved from one water-less urinal in a school over the course of one year can be as high as 45,000 gallons.

An obvious area for water conservation is in the type of landscaping material palette selected for new schools. Those materials need to be draught tolerant varieties with a minimum of turf for ground cover.

School Districts are encouraged to take advantage of the consolidated source of research information and analytical support available through the Arizona Water Institute, a consortium of Arizona's three universities, the Arizona Department of Water Resources, the Arizona Department of Environmental Quality, and the Arizona Department of Commerce. See [www.azwaterinstitute.org](http://www.azwaterinstitute.org).

## **Water Efficiency Recommendations**

- Water conserving plumbing fixtures should be specified throughout all new facilities.
- All new schools should specify and install water-less urinals.
- Drought tolerant tree canopies along walkways and paths should be designed and installed to provide natural shade, to help clean the air of pollution, to add oxygen, and to help cool the microclimate around the school. Drip irrigation systems or sub-surface irrigation should be designed and installed to minimize evaporation losses.

## Commissioning of Mechanical, Water, and Waste-water Systems

Another initiative that will result in significant life cycle cost savings for school facilities is the implementation of a "commissioning process" to evaluate the functional performance of the environmental systems in each of Arizona's new schools. A licensed professional mechanical engineer who has achieved certification by the Building Commissioning Certification Board, and whose credentials as a Certified Commissioning Professional have been accepted by the SFB, can serve as a "commissioning agent" for a new school construction project. {Visit the Building Commissioning Association at: [www.bcx.org](http://www.bcx.org) for more information.} In that capacity, the commissioning agent is directly contracted by the district to conduct this analytical exercise on behalf of the district, and to report directly to the district as owner of the facility. The qualified commissioning agent is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management. The commissioning agent may assist with problem-solving or resolving nonconformance or deficiencies, but responsibility resides with the general contractor and design professionals. { Excerpted from the First Public Review Draft: ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.) Standard 189, Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings. }

Such commissioned evaluations of these building systems will help ensure that the sizes and types of system components are the best matched for the facility and when installed will provide the most energy efficient and cost effective systems for this particular new school application. That qualified agent can also evaluate the actual in-place performance levels achieved by the systems, and can make recommendations for adjustments to the system that will maximize its efficiency of operation.

## Performance Contracts for Mechanical & Utility Systems

There is reason to believe those multi-school operations, possibly in more than one school district, can be competently run with significant capital and operating cost savings to the participating school districts. Those cost savings could then be diverted into an equipment replacement fund. Economies of scale could be maximized if multiple school districts participated.

Similar performance based contracts for waste water treatment could also be entertained, if the geographic clustering of new schools in a given area, at the time of construction, warranted such an alternative to stand-alone systems for each of those new schools.

An example of such a contractual public/private sector partnership was recently announced by the San José (California) Unified School District. The district hailed it as an innovative partnership that is the largest solar power and energy efficiency program in K-12 education in the United States. The contractual partnership involves the school district, Chevron Energy Solutions, and Bank of America. It provides for the installation of five megawatts of solar power at the district's schools. The projected energy cost savings over the life of the solar power system is more than \$25,000,000. The project is being constructed without any district capital investment required. The partners announced that the new system will effectively reduce carbon dioxide emissions by 37,500 tons, which they equate to planting 400 acres of trees.

At the July 25, 2007 announcement, Jorge González, president of the district board of education said: "This program is the result of years of research and commitment on the part of San José Unified's Board and is living proof that schools can improve their facilities and help the environment without tapping their capital budgets. It's also an educational opportunity – it can help teach our school communities about energy efficiency and renewable power."

Chevron will design, build, operate, and maintain the photovoltaic arrays on the school sites. They will also measure, verify, and guarantee the solar energy system's performance. Bank of America will own the equipment and, through its Energy Services Financing Solutions team, will sell power to the district under a service contract at rates significantly below market utility rates. The first phase of the project is expected to be completed by early 2008. The School District's web-link is: [www.sjusd.org](http://www.sjusd.org).

### **Commissioning and Performance Contracts Recommendations**

- Each new school facility should commission a qualified professional evaluation of its environmental building systems to ensure their maximum energy efficiency and performance levels are attained as installed.
- The State of Arizona should create a performance based contracting mechanism through which the private sector would propose to install and operate the mechanical systems at, or provide utility service to, multiple school sites under a request for proposal basis.

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## Implications for facility size and classroom dimensions

**Lead With Five**, the Rodel Foundation report, and others like it across the country, concluded that smaller class size, particularly in the lower grades, is crucial for achievement throughout a student's academic career. That Rodel report also reviewed national research that confirms the benefits of small schools. See the table below for its recommendations concerning school and class size.

Rodel Recommendations

SCHOOL TYPE	GRADES	SCHOOL SIZE (# of Students)	CLASS SIZE
Elementary	K -- 3	500	15
	4 -- 5		25 (average)
	6 -- 8	500	25 (average)
Secondary	9 -- 12	500 – 1,000	25 (average)

There is consensus that the class size recommendations by the Rodel Foundation are consistent with the other class reduction initiatives across the nation. This conclusion is based upon interest group discussions, teacher interviews, discussions with educators and administrators, and focus group discussions at The 21<sup>st</sup> Century Schools Symposium co-sponsored by the Arizona School Facilities Board and the Arizona Association of School Business Officials on May 30, 2007, in Casa Grande, Arizona.

### School Size

On the point of optimal school size, "Lead With Five" said:

*"Creating smaller schools might seem like an expensive proposition. But if the idea is implemented correctly, it can be just as cost-effective as large-school alternatives. ...it is possible to create smaller school units without building smaller school buildings."*

It went on to describe the concept of creating groups of smaller school units on the same campus with shared support facilities, athletic programs, and administrative structure. It elaborated on its recommendation to create smaller schools this way:

*"The recommendation is not that all schools in Arizona be converted to smaller schools. Rather, consistent with the 'choice' philosophy that operates in Arizona, the suggestion is that parents and their children be given a wide range of schools so they may attend large comprehensive high schools, or 'schools within schools,' or some small schools built with state funds, or charter schools."*

## Comparison of School Size Recommendations & Requirements

School Type	Rodel Recommended School Size (in # of students)	Florida (recent Statutory limits for new schools)	Florida Existing SMART Schools (averages)	No. Carolina Dept. of Edu.	Lawrence, et al. 2002*	Stevenson, Kenneth R.: Edu Trends Shaping School(s) **	# of SFB Currently Approved School Projects	SFB Currently Approved Schools (average size)
Elementary	500	500	820	300 -400	500	200	35	937
Middle	500	700	1,139	300 - 600	750	400 - 500	9	908
Secondary	500 -- 1,000	900	2,180	400 - 800	1,000	500 - 750	16	1,413

\* Lawrence, Barbara Kent, et alia. "Dollars & Sense: The Cost Effectiveness of Small Schools." 2002. Knowledge Works Foundation. See also Howley, Craig B. and Howley, Aimee. "School Size and the Influence of Socioeconomic Status on Student Achievement: Confronting the Threat of Size Bias in National Data Sets." 2004. Educational Policy Analysis Archives.

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In June of 2004, the topic of the 84<sup>th</sup> Arizona Town Hall was Pre-Kindergarten through 12 Education: Choices for Arizona's Future. The report of that gathering stated:

*"In determining the ideal size for a school district, school, or classroom, 'one size does not fit all.' Size is most important at the school and classroom level and should be determined at the local level....*

*"The ideal size for a classroom will depend upon the age and needs of the students and the subject matter being taught. All agreed that small class sizes are better because they contribute to greater student-teacher interaction and create an effective learning environment. For pre-k through third grade, class size must be no greater than 15 students with classes of 15-25 students being appropriate for classes after the third grade.*

*"With regard to school size, students and parents should be able to choose whether a small school with a more individualized environment or a larger school with a greater variety of programs and diversity within the district is appropriate for the individual student. With regard to class and school size, the basic needs of the students should be kept in mind."*

That conclusion was reinforced by the discourse among the 199 individuals attending the Building 21<sup>st</sup> Century Schools Symposium sponsored by the School Facilities Board and the Arizona Association of School Business Officials on May 30, 2007, at Casa Grande Union High School. The purpose of that Symposium was specifically to solicit ideas and discuss concepts addressing the eight specific topic areas directed by Executive Order 2007-06 relating to the attributes needed in our next generation of new schools.

In the national arena, the SFB found research and other reports that corroborated that recommendation. The Knowledge Works Foundation, with the support of Concordia, LLC and The Rural School and Community Trust, published two reports, the first entitled "Dollars & Sense: The Cost Effectiveness of Small Schools" © 2002, and the second entitled "Dollars & Sense II: Lessons Learned from Good, Cost-Effective Small Schools" © 2005. The first of these professed:

*"Conventional wisdom contends that small schools are substantially more expensive to build than large schools, but the evidence ... challenges that belief. ... Analysis of this database (from 145 'reasonably sized schools') shows that the smaller of the reasonably sized schools are less expensive to build than the larger schools, whether we look at cost per square foot or cost per student. ... creating facilities for small schools can be done cost effectively ..."*

That report also pointed out:

*"Adding up the costs and weighing them against the benefits shows that small schools not only are better places in which to educate children, but that large schools themselves actually create significant diseconomies. ... Students drop out of large schools at significantly greater rates than do out of small schools. The costs to society for students who drop out of high school before graduating are enormous.... It takes more paid professionals per student to deal with the negative effects of alienation in a large school than in a small one, where people know each other better."*

In its publication Guidelines on Facilities Planning, the North Carolina Department of Education states:

*"American school leadership continues to build large public schools in pursuit of cost effectiveness and curriculum diversity, but may be sacrificing positive school culture and meaningful education reform in the process (Conway, 1994). ... Researchers on school size indicate ideal school sizes for improved safety and violence reduction to be: Elementary: 300-400; Middle: 300-600; High: 400-800."*  
(North Carolina Department of Public Instruction, 2000, p. 4, 40)

In his paper entitled; "Educational Trends Shaping School Planning and Design: 2007", Kenneth R. Stevenson, of the Department of Educational Leadership and Policies, College of Education, University of South Carolina, wrote:

*"In the next 25 years it may not be unusual to see elementary schools housing an average of 200 students, middle schools with no more than 400 to 500 students, and high schools with 500 to 750 students....*

*"Supporters of the trend argue that small schools are particularly good at improving the academic achievement for students who have not done well in traditional settings, and that small schools have higher graduation rates, promote greater student involvement in co-curricular activities, and experience improved student behavior (Wasley, 2002; et. Al.) Supporters also believe that since children are better known to teachers and administrators in small schools, they are safer and receive more individualized instruction.... If small schools demonstrably produce higher graduation rates, in the long run they cost communities less than do large schools."*

Calvin Baker, Superintendent of Vail School District 20 in Pima County, has conducted a recent survey that sheds some light on the comparative perceptions of students from high schools in three size categories. (See Exhibit "C") Although the study focused primarily on attitudinal and comportment observations, the results are telling. The students at the largest school felt much less positive about their school than students at the smaller schools. The following problem areas were perceived to be appreciably worse in the large school by students enrolled there, than they were by the students in the two smaller schools: Bullying, Fighting, Drugs, Harassment, Disruptive Students, Verbal or Physical Abuse, Truancy, Vandalism, and Theft.

In reflecting on the results of the survey, Mr. Baker observed:

*"...it is difficult to explain why students at the large school perceive the school so much worse than students at the smaller schools.... It is difficult to look at the data without concluding that school size must be at least partially responsible for the difference in how students perceive their school's environment."*

### Sizes of Current SFB Approved School Projects

A review of the current list of new construction projects approved by the School Facilities Board reveals that in the elementary school and middle school categories, where the Rodel Report recommended new schools be limited in size to a student enrollment of 500, SFB has approved a total of 44 projects with an average designed enrollment of 931.<sup>1</sup> This represents an average school size that is 86.2% in excess of the Rodel recommendation.

The same data for secondary schools where the Rodel report recommends new schools sized for student enrollments between 500 and 1,000 shows 16 SFB approved projects whose average designed capacity to be 1,413 students. This represents an average school size that is between 41.3% (as compared to the 1,000 student size recommendation) and 82.6% (as compared to the 500 student size recommendation) in excess of the Rodel recommendations for secondary schools.

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<sup>1</sup> SFB approved (as of February, 2007) new construction projects scheduled for completion between 2008 and 2010.

School Type	Grade Level	Rodel Recommended School Size	Current SFB Approved School Projects			
			# of Projects	Average School Size (Designed Capacity in number of students)	Average floor area	Average Unit Allocation per student
Elementary		500	35	937 (average)	75,176 s.f.	80.23 sf
	K -- 5		7	860		
	K -- 6		5	765		
	K -- 8		23	999		
Middle		500	9	908 (average)	73,125 s.f.	80.53 sf
	6 -- 8		7	824		
	7 -- 8		2	1,204		
Secondary		500 -- 1,000	16	1,413 (average)	144,076 s.f.	101.96 sf
	7 -- 12		1	661		
	9 -- 12		14	1,552		
	10 -- 12		1	223		

Analyzing the current list of SFB approved new school projects that are not yet completed, we find the following per student space allocations:

35 Elementary Schools whose average size is 75,176 sq. ft. with an average designed capacity of 937 students = 80.23 sq. ft. / student.

9 Middle Schools whose average size is 73,125 sq. ft. with an average designed capacity of 908 students = 80.53 sq. ft. / student.

16 High Schools whose average size is 144,076 sq. ft. with an average designed capacity of 1,413 students = 101.96 sq. ft. / student.

There does appear to be consensus within the Arizona educational community that the State should not mandate the size of schools at the various grade levels. The prevailing sentiment is for the question of the appropriate sizes of schools a district builds to be left to the local school boards. The previous table, on page 43, illustrates that the sizes of new elementary, middle, and high schools recommended by the Rodel study are comparable to those sizes recommended in other states across the country.

After careful consideration of these comparative studies, review of these reports, and opinions expressed in the various discussions with groups of educators, school administrators, interest groups, and focus groups, the State of Arizona should support the finding of the Rodel Foundation that ideally there should be different sizes of schools in each district available for students and their parents to choose from. Moreover, the final determination of the size of their new schools should be decided by the local

school district, but with an eye to the evidence showing student behavior, teacher attitude, and improved student achievement.

While the ideal would be for each school district to have a range of school sizes available from which students and parents could choose which is best for them, not all Arizona school districts have the numbers of students or resources sufficient to make that ideal real. Therefore, this report suggests that when adjoining districts find it difficult to provide such school size choices individually, they consider working collaboratively to decide how together they might be in a position to create different school size choices.

### School Size Recommendations

- Ideally there should be different sizes of schools in each district, particularly at the secondary level, available for students and their parents from which to choose. Moreover, the final determination of the size of their new schools should be decided by the local school district, but with an eye to the evidence found in the comparative studies showing better student and teacher attitude and perception, as well as proven achievement, from those at smaller schools.

### Class Size

On the issue of optimal class sizes, there has been a virtually unanimous conclusion that children who are taught in smaller classes in the early grades perform better than those who are in classes with 20 or more pupils. The longer-term achievement levels of those students who had the benefit of smaller classes during Kindergarten through third grade are also higher. Numerous studies that have proven this fact were cited in the Rodel Foundation report, **Lead With Five**.

Florida was so convinced of the benefits of smaller class size, in November 2002 it voted to limit classes for:

- pre-kindergarten through the 3<sup>rd</sup> grade to a maximum of 18 students;
- grades 4 through 8 to a maximum of 22 students; and
- grades 9 through 12 to a maximum of 25 students.

Comparison of Class Size Initiatives  
number of students in each class

Grade Levels	Rodel Recom-mended Class Sizes	84th AZ Town Hall	California Initiative to Reduce Class Size	Florida State Law	Georgia State Board Rule	Indiana Prime Time	Tennessee Project STAR	Tennessee Education Improvement Act	Federal Dept. of Education
K					18				
K -- 3	15	15 < 20		18		18	13 - 17	20 - 25	18 or <
1 -- 3					21		13 - 17		
4 -- 5	25	15 - 25		22	28				15 - 20
4 -- 6								25 - 30	15 - 20
6 -- 8	25	25		22	28				15 - 20
.7 -- 12								30 - 35	
9 -- 12	25	25		25	24 - 35				

Resulting Classroom Floor Area

One might initially assume that the initiatives to reduce class sizes would result in smaller classrooms. There is a logic to that, but at the same time, educators are pushing for more "kinetic teaching and dynamic learning" environments. This requires more space per student in the classroom, not less. The current SFB unit allocation for new schools is 80 sq. ft. per student. The classroom allocation is figured at 45% of that 80 sq. ft. This results in a classroom allocation of 36 sq. ft. per student.

## Comparative Analysis of Class Sizes & Classroom Floor Area

<b>Classroom by Grade Levels</b>	<b>Kinder garten</b>	<b>1 -- 3</b>	<b>4 -- 6</b>	<b>7 -- 8</b>	<b>9 -- 12</b>
SFB sq. ft. Allocations per student	18	36	36	36	33
Rodel Recommended Class size (# of students)	15	15	25	25	25
Resulting Classroom Space Allocation (in sq. ft.)	270	540	900	900	825

**Median Classroom Sizes in SFB Approved & Funded Schools \* (in sq. ft.)**  
applying Rodel Class Size (# of students) Recommendations

<b>Classroom Size by Grade Levels</b>	<b>Kinder garten</b>	<b>1 -- 3</b>	<b>4 -- 6</b>	<b>7 -- 8</b>	<b>9 -- 12</b>
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Elementary School Classroom Sizes	707	921	919		
space per student in sq. ft.	47.13	61.40	36.76		based on Rodel Class Size Recommendations

Middle School Classroom Sizes				902	
space per student in sq. ft.				36.08	based on Rodel Class Size Recommendations

Secondary School Classroom Sizes					898
space per student in sq. ft.					35.92 based on Rodel Class Size Recommendations

\* SFB Approved New School Construction Projects as of February 2007 with scheduled completion dates from 2008 to 2010.

Community College "Learning Studio" Sizes			
Estrella Mountain Community College	750 sf renovated classrooms	955 sf	1,000 - 1,200 sf recommended
Designed Student Occupancy	24	32	32
Unit Allocation in Sq. Ft. per student	31.25	29.84	31.25 to 37.5

### Kindergarten – 3<sup>rd</sup> Grade Classrooms

Each kindergarten classroom does not result in sufficient space to accommodate such flexibility. For the recommended K – 3<sup>rd</sup> grade class size of 15 students, using the current 36 sq. ft. per student, a classroom is limited to 540 sq. ft. Additionally, Arizona's current practice of only recognizing ½ of each kindergarten student, for facility purposes, dictates a kindergarten classroom of 270 sq. ft. for a class of 15 students. These room sizes will not permit the alternative layouts demonstrated to be so beneficial to early childhood educational experience. A 900 sq. ft. classroom would require SFB's unit allocation per student to be increased to 60 sq. ft. To quote the late Walt Disney: "Crowded classrooms and half-day sessions are a tragic waste of our greatest national resources – the minds of our children." In light of Arizona's commitment to all day kindergarten, and the evidence of the lifetime benefits of effective early childhood education, the SFB allocation for K-3 classroom space should be increased to 60 sq. ft. per student.

### 4<sup>th</sup> – 6<sup>th</sup> and 7<sup>th</sup> & 8<sup>th</sup> Grade Classrooms

The Rodel Foundation study recommended that class sizes at grades 4 through 8 be limited to 25 students. SFB's current allocation for 4<sup>th</sup> – 6<sup>th</sup> grade classrooms is 36 sq. ft. / student. This would result in a 900 sq. ft. classroom. That floor area is sufficient to allow for multiple small group project-focused teaching modes.

SFB's current allocation for 7<sup>th</sup> & 8<sup>th</sup> grade classrooms is 36 sq. ft. per student. That results in a 900 sq. ft. classroom, which is sufficient to allow for multiple small group project-focused teaching modes.

### 9<sup>th</sup> – 12<sup>th</sup> Classrooms

The Rodel Foundation study recommended that Arizona adopt a class size in secondary school classrooms of 25 students. SFB's current unit allocation per student at these grade levels is 33 sq. ft. This would result in classrooms in our high schools being limited to 825 sq. ft, which is minimally sufficient to allow for multiple small group project focused teaching modes. Assuming a set classroom size of 900 sq. ft. would require SFB's unit allocation per student to be increased to 36 sq. ft.

Although an increase in the space allocation for secondary school classrooms is recommended, the total net size of new high schools should be held to the current per student allocation of 96 square feet per student. This will mean the reduction or elimination of some space in other use categories in the architectural programs for new high schools. Other options may be discovered with creative design solutions.

### Per Student Space Allocation Comparisons

1-3 Current		K-3 Recommended		
Standard - 25 students per classroom		Standard - 15 students per classroom		
	sq. ft. allocation	% of total floor area	sq. ft. allocation	
Classroom	36.0	45%	60	57%
Cafeteria	4.0	5%	4	4%
Admin	9.7	12%	9.7	9%
Transitional Spaces	12.4	16%	12.4	12%
Bathrooms	3.5	4%	3.5	3%
Media	2.9	4%	2.9	3%
Gym	5.6	7%	5.6	5%
Walls	5.8	7%	5.8	6%
Total School per student sq. ft.	80	100%	105	100%

4-8 Current		4-8 Recommended		
Standard - 25 students per classroom		Standard - 25 students per classroom		
	sq. ft. allocation	% of total floor area	sq. ft. allocation	
Classroom	36	45%	36	45%
Cafeteria	4	5%	4	5%
Admin	9.7	12%	9.7	12%
Transitional	12.4	16%	12.4	15%
Bathrooms	3.6	5%	3.6	4%
Media	2.9	4%	2.9	4%
Gym	5.6	7%	5.6	7%
Walls	5.8	7%	5.8	7%
Total School per student sq. ft.	80	100%	81.5	100%

9 -- 12 Current		9-12 Recommended		
Standard - 25 students per classroom		Standard - 25 students per classroom		
	sq. ft. allocation	% of total floor area	sq. ft. allocation	
Classroom	33	35%	36.0	38%
Cafeteria	7	7%	5.9	6%
Admin	18	15%	15.3	16%
Transitional	13	14%	11.0	11%
Bathrooms	3	4%	2.5	3%
Media	4	4%	3.5	4%
Gym	15	15%	12.7	13%
Walls	9	7%	7.6	8%
Total School per student sq. ft.	96	100%	96	100%

## **Classroom Space Allocation Recommendations**

- Each new 21<sup>st</sup> century classroom should have sufficient space to accommodate flexibility in teaching styles and learning modalities.
- The space allocation for Kindergarten through 3<sup>rd</sup> grade classrooms should be increased to result in 900 square feet of floor area for each classroom. This would require a new category, K – 3, distinct from grades 4 – 6.
- 4<sup>th</sup> through 6<sup>th</sup> grade classrooms should be maintained at a 900 square foot floor area allocation.
- 7<sup>th</sup> & 8<sup>th</sup> grade classrooms should be maintained at a 900 square foot floor area allocation.
- The space allocation for 9<sup>th</sup> through 12<sup>th</sup> grade classrooms should be increased to result in 900 square feet of floor area for each classroom.

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## Requirements for Construction Funding

Over the next 20 years, the SFB anticipates the need to expend approximately \$18 billion on new school construction. The current system for financing new schools relies on the State allocating these funds from State General Funds.

This system is problematic for the following reasons:

- ❑ It fails to take advantage of the benefits of long term financing. Under certain economic conditions long term financing can provide the needed capital at little to no cost. Further, long-term financing allows the state to spread costs over the useful life of the facility.
- ❑ It places capital investment needs in direct competition with annual school operational needs. In nearly every instance of this type of competition, facility capital construction needs lose out.
- ❑ It places immediate long-term capital investment needs in competition with annual maintenance needs. Generally, the demands for additional space preclude needed investments in maintaining current spaces.
- ❑ The demand for new space (volume) limits the resources available to improve the types of spaces the State funds (quality).

However, in addition to these policy questions, two key fiscal questions must be addressed:

- ❑ If the State were to decide to use a Lease to Own method of debt financing to construct new schools, will the annual debt service (lease) payment exceed the annual cash outlay costs of the school construction program?
- ❑ How does the total cost of using debt compare to the cost of pay as you go?

As outlined in the following scenarios the answer to these questions depends upon the assumptions employed for three key variables that determine the effective cost of annual debt payments vs. the effective cost of the annual cash outlay. These three key variables: 1) population growth rate; 2) inflation rates; and 3) cost of debt are discussed below.

### Population Growth

While everyone agrees that Arizona will continue to grow, there is much dispute over how fast and for how long. Population projections are impacted by multiple variables including the context of projections for the overall economy of the state, the ability of the state to continue to be a preferred destination of domestic and international migration, and the state's willingness to provide required infrastructure. Below, two different population growth scenarios are provided to show the range of potential outcomes.

## Inflation Rate

Projecting inflation over the next thirty-years is more difficult than projecting population. However, since July of 2000, the JLBC has adopted an official rate of inflation for Arizona school construction. These adoptions reflect inflation from July 1, 1999 to July 1, 2006. During this period, Arizona has experienced both a recession and an economic boom. Therefore, the average of these adopted rates should be a good reflection of inflation going forward. The average rate is 4.92 percent.

## Cost of Debt

The average rate for thirty-year debt for the last 10 years is 5.37 percent. Current rates are under 5 percent. While no one can project where rates will be over the next 30 years, in order to present a relatively conservative analysis a 5.5 percent rate, slightly higher than the 10-year average is used below.

## Scenarios

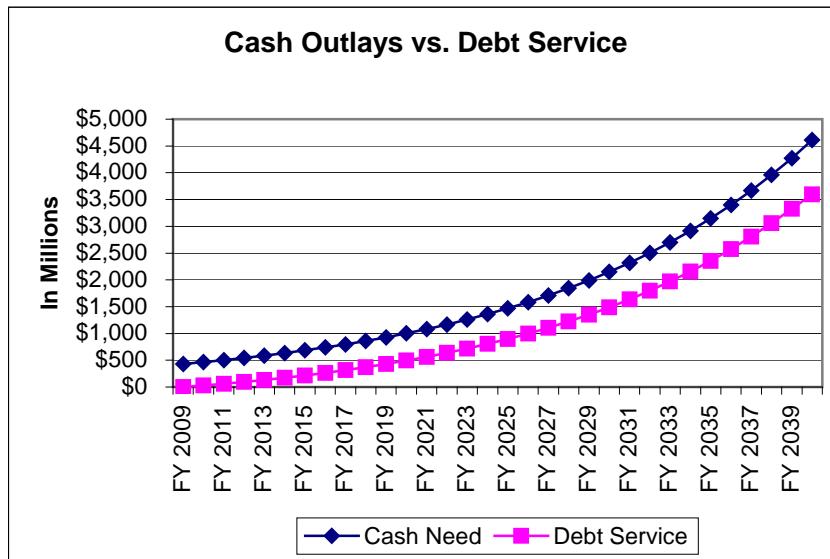
Below are two scenarios that show different population assumptions coupled with the assumed inflation rate and cost of debt. Scenario I assumes a constant rate of growth of 2.87 percent. This rate is based on work done at the University of Arizona. Scenario II is based on the Department of Economic Security (DES) published projections. DES assumes that the rate of growth will decline over time. They reflect this by reducing growth rates from 2.86 percent in 2009 to 1.07 percent in 2040.

### Scenario I

Growth Rate – University of Arizona 2.87%

Inflation Rate – 4.92%

Cost of Debt – 5.5%



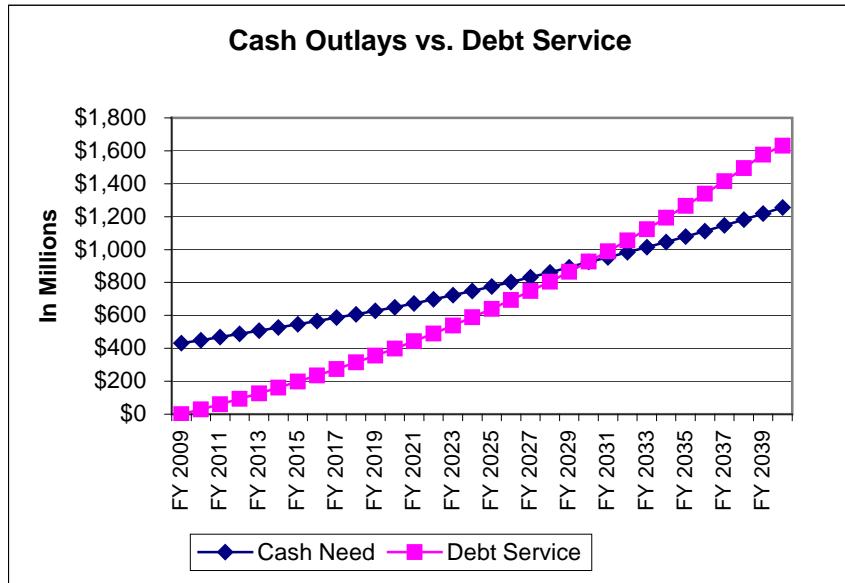
The result of the assumptions for Scenario I is that the annual cost of debt service will not cross the cash cost of the program within the next 30 years. Over this period, using debt will save the State \$19.6 billion.

#### Scenario II

Growth Rate – DES 2.86% declining to 1.07%

Inflation Rate – 4.92%

Cost of Debt – 5.5%



The result of the assumptions in Scenario II is that the annual cost of debt service will exceed the cost of the program in 2030 or 21 years from next fiscal year. Over that 21 year period, the cost of debt will be \$5.4 billion less than that of the cash program. Over the entire period shown, the cost of debt will be \$3.3 billion less than the cost of the cash program.

DES deliberately excluded the impact of Arizona's expanding economy in their population projection model. Therefore, this scenario likely underestimates future population growth and thus the required cost of new schools. However, even in this overly conservative scenario, the cost of debt service will not exceed the necessary cash outlay until 2030. The \$5.4 billion in savings will be generated during Arizona's high rate expansion period and will be available to invest in other critical areas. Additionally, in the other scenario, because of the greater population loads, the total cost of the cash program is significantly higher than in the DES scenario leading to substantially more savings during the critical growth years. Again, these savings would be available to invest in other areas strained by the explosive growth.

### Total Cost of Debt vs. Cost of Cash

As shown above, over the next 30 years using debt will likely cost the State General fund less than using cash. However, that does not address the total cost of the debt vs. the cost of cash. To review this question, only a single average transaction will be shown. If debt is the chosen mechanism, the cost comparison for an average transaction will be the same for debt over time.

If the state issues \$400 million in debt for 30 years at the assumed 5.5 percent rate, the cash flows would be as follows:

#### Cash vs. Debt – Nominal Dollars

		Outflows
Year 1	\$400 million	
Years 2-31		\$27.5 million per year
Total	\$400 million	\$825 million

Based on the above table, the total cost of debt is over twice that of the cost of paying cash.

However, since the debt service payments will be made in future years, to make an accurate comparison against the current year expenditure of \$400 million, the payments must be discounted for inflation. Since the payments are General Fund dollars and not necessarily construction funds, a discount rate based on construction would be inappropriate. A generally accepted discount rate is the Gross Domestic Product Implicit Price Deflator (GDP deflator). The 20-year GDP deflator average is 2.51 percent. However, since Arizona is projected to be in a strong growth economy for the next thirty years, this analysis will use a slightly higher rate of 3.5 percent.

With the debt service payments discounted for inflation, the cash flows are as follows:

#### Cash vs. Debt – Real Dollars

	Inflows	Outflows
Year 1	\$400 million	
Years 2-31		Amount varies by year.
Total	\$400 million	\$507 million

Taking into account inflation, the cost of debt is now only \$107 million higher than cash. That cost is spread over a 30-year period for an average annual cost of \$3.6 million.

## Investment Income

In addition to discounting the payment streams for inflation, the analysis must also consider the value of saving \$400 million in the first year. As noted above, those dollars will become available to address other needs generated by growth. Whether these investments are operational in nature (salary increases, insurance premiums) or additional infrastructure (road construction, university or medical facilities) they will enter the state's economy and produce a return. In addition to the return on the \$400 million saved, we must also consider the loss of the potential investment of the debt service payments. While the state gains the investment income from the \$400 million saved, it loses the potential investment income from the \$27.5 million it must now pay in debt service for the next 30 years.

While no argument will be presented on an assumed rate of return, in order to completely offset the full cost of debt, approximately 9 percent would have to be earned on an annual basis. While such a return is unlikely, even a return of 4 percent would drop the cost of debt to less than \$60 million over 30 years or less than \$2 million per year.

## Should the State Use Debt?

As shown above, the average debt issue over the next 30 years will probably cost slightly more than paying cash. However, as noted there are several policy benefits to financing long-term capital with long-term debt. The most important of these is freeing State funds to address needs presented by the anticipated explosive growth and taking school construction out of direct fiscal competition with these other needs.

Most other states in the country have recognized the shortcomings of relying on state general funds and have found alternative ways to invest in education infrastructure (See the following table). Of the 17 states where a significant amount of the total funds for new construction are state funds, only two (Arizona and Arkansas) rely heavily on General Fund monies while 13 states rely mainly on some type of long-term financing. The other two states (Florida and Wyoming) have specific revenue sources to fund the capital programs. Arizona could benefit from an analysis of the experience of these two states for possible adaptation to our plan for funding school construction.

The following comparative table lists those 17 states.

## State School Construction Financing Programs

<b>State</b>	<b>Main Financing Source</b>
Arizona	General Fund
Arkansas	General Fund
California	Long-Term Debt
Connecticut	Long-Term Debt
Delaware	Long-Term Debt
Florida	Dedicated Revenue Source
Georgia	Long-Term Debt
Illinois	Long-Term Debt
Maryland	Long-Term Debt
Massachusetts	Long-Term Debt
New Jersey	Long-Term Debt
New Mexico	Long-Term Debt
New York	Long-Term Debt
Ohio	Long-Term Debt
Washington	Long-Term Debt
Wyoming	Dedicated Revenue Source
Hawaii	Long-Term Debt

Source: [State Roles in Financing Public School Facilities](#); Texas Legislative Council; December 2006. States were selected based on type of funding and percentage of total funding.

### Local Level Debt

Arizona's constitution provides that districts may issue long-term debt in value up to 15 percent of the value of the district's property. When Students' FIRST was adopted, the law further limited this ability to 5 percent of the district's property value. The intent of Students' FIRST was to allow districts to use this remaining bonding ability to enhance the state standards.

The State could use the remaining 10 percent of constitutional bonding authority to fund the Students' FIRST program. Further, the State could limit the debt to only use new value added after 2007. This would limit the impact of the bonds on existing property tax payers, and require new growth to fund the bonds.

Example: If district "A" had a net assessed value in 2007 of \$2 billion and is adding new value at 6 percent per year, under current statute, the district could issue \$100 million in bonds (5 percent) and the constitution would allow debt up to \$300 million. Under the proposal above, the state would take advantage of the 10 percent of available constitutional bonding on the new growth. The following table shows the available bonding capacity by year under this scenario.

Fiscal Year	New Value (From 2007 Base)	Bonding Capacity
2008	\$120 million	\$12 million
2009	\$247.2 million	\$24.7 million
2010	\$382 million	\$38.2 million
2011	\$524.9 million	\$52.5 million

If the State limited the local bonds to just new value, the program would have to be supplemented with other revenues. The program would provide significant resources to offset costs in high growth districts. This program would require a constitutional change to fully implement.

### State Level Debt

As noted above, most states issue general obligation bonds to finance the costs of school infrastructure. Arizona currently does not have the constitutional authority to issue these types of bonds. In lieu of general obligation bonds, the state can finance by either lease purchase or special revenue bonds.

### Upgrading Existing Schools

In addition to improving new schools, it is critical to find ways to address needed upgrades in our existing schools. This is especially true for energy/water conservation and safety issues. One possible way to finance these upgrades is through local bonds. As noted above, current statute only allows districts to tap 1/3 of their constitutional bonding capacity. The statute could be changed to allow districts to tap an additional 1/3 of their constitutional bonding capacity for very specific modernization projects. For example, the bonds could be limited for energy conservation and school safety projects.

These bonds would be subject to local voter authorization and thus would allow the school community to prioritize local facility issues. One risk of relying on local funds is that it may encourage facility disparities between low property wealth and higher property wealth districts. However, by keeping the purpose of these bonds very narrow that gap will be limited. Additionally, the state may have to continue to target some state monies to compensate districts if disparities do arise.

### Sharing the Costs

The State should take every step possible to reduce or share the costs of schools. While public education is the key beneficiary of public schools, several other entities could or do benefit from school infrastructure. These beneficiaries are generally public sector entities that can take advantage of school infrastructure to meet the needs of their own constituencies. Some examples of these entities include:

- City performing arts programs
- City sport leagues
- City or County health clinics
- Continuing education programs
- Community College programs
- County flood control
- City or County parks

In addition to identifying sustainable revenue streams, the state needs to take specific steps to maximize the level of non-district value and ensure that those entities benefiting from the school facility are contributing to the cost of that facility.

### Private Sector Participation

There are numerous examples of housing developers who understand the added value of good schools in, or adjacent to, their new subdivision developments and who have acted upon that enlightened self-interest. Such a company is Kennecott Land of Utah. Their recent 4,100-acre master-planned development, Daybreak, is southwest of Salt Lake City. It was planned and designed to align with the core values and principles of the regional planning framework established by a civic lead planning effort called "Envision Utah" completed in the late 1990's. With a build out time frame of more than 50 years, Daybreak anticipates construction of 87 schools to serve the estimated 150,000 households that will comprise the development. In cooperation with the local school district, Kennecott participated in the land set-aside and construction costs for the Daybreak Elementary School and Community Center. As the name implies, the school shares spaces (like the gymnasium, sports fields, and library) in the same building complex with other community agencies and groups. These spaces are scheduled for use by the school during school-calendar weekdays. They are scheduled for use by the community-at-large on weekends and during evening hours.

*Source: Urban Land, April 2006, "Salt Lake City: Humans / Nature" by Sam Newberg. Pages 56 – 62.*

The Denver School of Science and Technology (DSST) accepted its first students in the fall of 2004. It is part of the Stapleton redevelopment project in Denver, Colorado on the land once occupied by Stapleton International Airport. Forest City Development undertook the redevelopment of 2,935 acres on the old Stapleton site. It donated 10 acres of land to the school as part of its strategy to use great schools as a means of attracting families to the neighborhood and encouraging new businesses to locate in this large in-fill project. David Ethan Greenberg, of New Schools Development Corporation in Denver, founded DSST. The curriculum is based on the STEM (Science Technology, Engineering, & Math) model. Greenberg received a charter for the school from the Denver Public Schools Board along with an investment from the Board of \$5,000,000. He also secured start-up funding from the Gates Foundation and raised \$15,000,000 from philanthropic and corporate sources for construction and operating costs. The construction costs of the school were comparable to that of the average

local high school in metropolitan Denver. The school has a student body that is 60% black or Hispanic and about 44% are from low-income families. Yet, in its first year of operation, the DSST 9<sup>th</sup> grade was the highest performing class in math scores in Denver and was second in reading and writing to a much less diverse school. [www.newschoolsdevelopmentcorp.com](http://www.newschoolsdevelopmentcorp.com).

Source: *Schools Designed for Learning* (2006) American Architectural Foundation. 25 pages.

A new 12,900-acre land development within the city limits of Albuquerque, New Mexico, called Mesa del Sol, considers itself a true public / private partnership, from its funding and design to its actual construction with participation from Forest City Covington, NM, LLC, the University of New Mexico, the State Land Office, the State of New Mexico, Bernalillo County, Albuquerque Public Schools, and the City of Albuquerque. It has planned for as many as 15 elementary schools, 5 middle schools, and 3 high schools. These numbers were derived from Albuquerque Public Schools (APS) planning guidelines for school sizes. The following is an excerpt from the marketing materials for Mesa del Sol:

*"Public schools will be important centers of community life at Mesa del Sol. The schools needed to serve Mesa del Sol's population will be sited prominently and designed as civic landmarks. It is proposed that portions of school buildings available for community use, such as auditoriums and meeting rooms, will be designed to form a "front door" to the school in a highly visible and accessible location.*

*"Most school sites will be adjacent to joint use park sites with multi-purpose fields. Elementary schools will help to anchor neighborhood centers, along with swimming pools, plazas, and opportunities for neighborhood-scale retail shops. To the extent that phasing considerations allow, middle schools at Mesa del Sol will typically be co-located with either an elementary school or a high school in order to create opportunities for shared athletic and other facilities. High schools and combined middle/high schools will typically be located near mixed-use centers. Nearly all schools will be located adjacent to open space corridors, providing opportunities for environmental education as well as convenient and pleasant off-street pedestrian and bicycle access routes to schools.... Forest City Covington NM, LLC will work with APS, as well as interested private school providers, to ensure that school sites are located and designed as community focal points."*

Source: <http://www.mesadelsolnm.com/>

Here in Arizona, development companies like DMB and Del Webb have participated in the construction of new schools to serve their new subdivision communities by contributing the land for school sites. Del Webb also participated in the funding of the new high school to serve Anthem on the north edge of Phoenix. Several school districts have worked in partnership with developers in securing school sites, if not by outright contribution, at least at a discounted price. However, the opportunity to build schools as community learning centers has not been fully embraced. Discussions with possible partnering public and private entities at the early planning stages of new school design and construction projects need to be encouraged and facilitated to maximize the potential for shared funding, and subsequent shared use, of our new schools.

Reading the discussions about classroom sizes, one understands the need to provide generous accommodation for more flexibility in the way classes can be conducted within their walls. At the same time, the discussion above shows a trend in public policy and informed opinion that endorses smaller school sizes. It would appear that the size for Arizona's 21<sup>st</sup> Century Schools needs to be smaller than we have been constructing, but that the new kindergarten through 3<sup>rd</sup> grade classrooms for this digital age need to be larger than allowed by the current SFB formula. With Arizona's population ever expanding and the current best wisdom dictating that schools ought to be smaller, Arizona faces the prospect of needing to build more schools in proportion to the number of students requiring accommodation than has been the case in our recent history. Coupled with increasing construction costs and revenue streams that will not keep pace with the demand for new facilities, Arizona will need to design a strategy that recognizes these seemingly irreconcilable pressures.

While the allocation of space for Kindergarten through 3<sup>rd</sup> grade classrooms is increased substantially by the recommendation above, this report recommends the total net size of our future schools be held to the current per student allocations at the various grade levels. This will mean the elimination of some space in other use categories in the architectural programs for our schools.

Some of the more dynamic new schools being built with evidence of higher student achievement are accomplishing this by eliminating traditional media commons and/or library spaces. They have placed their emphasis on internet-based resources and created ample opportunities for their students to connect to the web. Others have engaged in partnerships with their local municipalities or new community developers to allow shared use of these and other multi-purpose spaces on their campuses. Some of these jointly or alternatively funded spaces include: multi-purpose assembly / cafeterias; gymnasiums; sports fields and passive use parks; swimming facilities; and the like.

#### **Requirements for Construction Financing Recommendations**

- ❑ In lieu of General Fund appropriations, Arizona should explore long-term financing to fund new school construction needs over the next 20 years. Long-term debt can either be issued at the state or the local level.
- ❑ The state should allow a local bonding program targeted to modernizing existing schools.

- The SFB sees an opportunity for school districts to explore the wide range of possible partnerships that can result in shared capital construction costs and innovative school facilities designed to be community learning centers. This could ensure the provision of adequate communal and assembly space categories that could be short-changed with the recommended increase in space allocations devoted to classroom uses.
- The SFB should establish a liaison position to local governments and private developers. The position would help each school district contact potential partners and educate those partners to the advantages of contributing to a school project.
- The SFB should establish model agreements that districts and local entities can adapt for their own use.
- The state should provide a 5 percent match for non-district dollars that are contributed to a school project, over and above the funding amount derived from SFB new construction formulae, as they may be amended.
- The State should further explore possible dedicated revenue streams to fund or finance school construction.

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**Schools Designed for Living: The Denver School of Science and Technology**, Denver, Colorado. (2007). Great Schools by Design, An initiative of the American Architectural Foundation with the cooperation of KnowledgeWorks Foundation. Washington, DC: The American Architectural Foundation. DVD, including 17 minute documentary film, and print guide. <http://www.archfoundation.org/aaf/gsbd/Video.Denver.Intro.htm>

## **EXHIBITS**

- A. Report from the May 30, 2007 Symposium:  
"Building Arizona's 21<sup>st</sup> Century Schools".
- B. Governor Napolitano's Executive Order 2005-05: Implementing Renewable Energy and Energy Efficiency in New State Buildings.
- C. Survey Data Related to School Size, Vail School District. June 2007.
- D. Feedback and Comments received during the Public Review period September 6 – 22, 2007.
- E. Acknowledgements.

## **Exhibit A.**

Report from the May 30, 2007 Symposium:  
"Building Arizona's 21<sup>st</sup> Century Schools".

# Building 21st Century Schools Symposium

## Presented by the School Facilities Board and AASBO

**Wednesday, May 30, 2007**

### CASA GRANDE UNION HIGH SCHOOL

2730 North Trekkel Road  
Casa Grande, AZ 85222

(From I-10, take the McCartney Rd. exit and travel west approximately 2 miles)

#### Schedule

**8:30am-** Registration and  
Continental Breakfast

**9:00am-** Dr. Susan Wolff

**9:50am-** Break

**10:00am-**Dr. Kenneth Tanner

**10:50am-**Break

**11:10am-**Focus Groups

- (a) Technology
- (b) Personalized Learning Environments
- (c) Water and Energy Efficiency
- (d) Class and School Size

**12:10-**Lunch

**1:00-**Discussion Group

**2:30-**Tour of School

For event information  
contact Kristen Landry at  
602-542-6144 or  
[klandry@azsfb.gov](mailto:klandry@azsfb.gov)

For registration information  
contact AASBO at  
602-253-5576 or  
[hgambay@aasbo.org](mailto:hgambay@aasbo.org)

The School Facilities Board (SFB) and the Arizona Association of School Business Officials (AASBO) invite you to participate in the Building 21st Century Schools Symposium.

This Symposium is to solicit ideas to present to Governor Napolitano as part of her Executive Order which asked the SFB to identify attributes of 21<sup>st</sup> century schools allowing Arizona to modernize its schools with relevant infrastructure, specialized facilities and opportunities for individualized instruction.

#### **Who should attend?**

We invite all administrators, business managers, principals, teachers, board members, architects, and anyone who would like to share their opinion on school facility design. The SFB needs your suggestions.

#### **About the Event**

Guest Speakers include Dr. Susan Wolff and Dr. Kenneth Tanner. Dr. Wolff will discuss how Arizona schools are preparing students for the 21<sup>st</sup> century workforce and what physical design features of schools best support collaborative, project-based learning and enhance the transition for students to college learning environments. Dr. Tanner will discuss research that shows how school building design influences student attitude, learning and behavior. He will address what the implications are for design of 21<sup>st</sup> century learning environments for K-12 students.

Symposium participants will break into focus groups to discuss the physical design features that support 21st century learning environments for technology, personalized learning environments, energy and water efficiency, and class and school size.

Following lunch, participants will return to a general session to discuss the comments from the breakout sessions.

**Cost to Attend:** The registration fee is \$25 per person if received by May 23, 2007. Late registration is \$40 per person if registration is received after this date. Registration includes event materials, refreshments, and lunch.

**How to Register:** You may submit your registration online by logging on to the AASBO Web site- [www.aasbo.org](http://www.aasbo.org). Online registration is available to members and non-members.

**Members:** log in to the members side of the site. You will be prompted for your username and password. If you do not know these, click on the "I forgot my password" link and the information will be emailed to you. Once you have logged in, click on the calendar of events. Select the "Building 21st Century Schools Symposium" and register. After you have completed your registration, an invoice will be generated. Print the invoice and send it in with your payment. **Non-members:** Locate the Symposium under "Upcoming Events". Please submit a separate online registration for each attendee. Online registration is only available until May 23, 2007. After that time, you will need to call the AASBO Office at 602-253-5576 to check on availability. **Cancellation Policy:** A full refund will be given if a person cancels at least 5 working days prior to the date of the conference by calling AASBO at 602-253-5576 and then confirming via fax to 602-253-5764. "No Shows" and cancellations made after this time will not be refunded. AASBO reserves the right to cancel due to insufficient enrollment or any other reason by giving at least three days notice.

## Presenters

### **Dr. Susan Wolff**

**Director-** Wolff Designs

#### **Chief Academic Officer-**

Columbia Gorge  
Community College,  
Oregon

#### **Education**

Oregon State University  
M.Ed. Adult Education and  
Training in Industry  
Ed. D. Community College  
Leadership

Montana State University  
B.S. Home Economics  
Education



Dr. Susan Wolff is the Director of Wolff Designs and focuses primarily on educational and facilities planning. Her current areas of research and consulting include designing and planning physical learning environments and master facilities plans at Pre-K to higher education levels in formal and informal learning settings; career and technical education; collaborative, project-based learning; developing learning/academic plans; technical assistance with accreditation planning; and report writing.

Her most recent experience was as Project Coordinator for the New Designs for Career and Technical Education at the Secondary and Postsecondary Levels project for the School of Education, Oregon State University and funded through the National Research Center for Career and Technical Education and the U. S. Department of Education. Other areas of responsibility have included site and program administration, workforce development, distance learning, continuing and extended education, training and economic development, faculty development, and coalition building among education, business, and industry leaders.

She is Chief Academic Officer at Columbia Gorge Community College in Oregon, where she has been since 2004. Prior to that time, Susan had experience as the Associate Dean of Instruction at Clark College and Associate Dean of Extended Learning at Linn-Benton Community College. She has also worked at Oregon State University on three occasions as the Assistant Director of Continuing Education, Coordinator of the New Designs for Career and Technical Education national research project, and as Acting Director of the Oregon Professional Development System. Dr. Wolff also serves as a consultant to architects and educators across the country and internationally in educational and facilities planning.

### **Dr. Kenneth Tanner**

**Professor of Educational Leadership**-College of Education, University of Georgia

#### **Education**

University of Virginia  
Post Doctoral  
School Design

Stanford University  
Post Doctoral  
Danforth-Johnson Scholar  
National Institute in  
Problem-Based Learning  
For Educational Administration

Florida State University  
Ed. D. Educational Administration  
M.S. Educational Administration

Troy State University  
B.S. Mathematics

## About the Presenters



Dr. Kenneth Tanner has been a professor of Educational Leadership at the College of Education, University of Georgia for the past 22 years. Prior to joining the faculty at the University of Georgia, Dr. Tanner was professor of Educational Administration and Supervision at the University of Tennessee, Knoxville. He received his Doctor of Education at the Florida State University in 1968.

He continued his post doctoral studies as a Danforth-Johnson Scholar at Stanford University in 1993; in school design at the University of Virginia in 1998; and in leadership at Harvard University in 2004. He also has been on the Engineering Faculty at the University of Georgia since 2002.

Some of his most recent scholarly articles have focused on the topics of: "Links Between the School's Physical Environment and Student Achievement"; "Classroom Size and Number of Students Per Classroom"; "School Design Factors that Influence Student Learning"; "The Influence of School Architecture on Academic Achievement"; and an array of others. He has presented papers to numerous learned groups such as: the Council of Educational Facility Planners, International; International Society of Educational Planning; the National Commission on Excellence in Education; the American Education Research Association; and others. He has served on Federal Advisory Panels for the National Clearing House of Educational Facilities and for the National Academy of Building Sciences.

Arizona School Facilities Board & Arizona Association of School Business Officials  
**Building 21<sup>st</sup> Century Schools Symposium – May 30, 2007**

**TECHNOLOGY: Focus Group Comments**

WHAT SHOULD BE THE RATIO OF PERSONALIZED LEARNING DEVICES (like lap-tops) IN A CLASSROOM?

DOES THAT RATIO VARY BY GRADE LEVEL?

AT WHAT GRADE LEVEL SHOULD DIGITAL CURRICULUM BE IMPLEMENTED?

ARE SCHOOL DISTRICTS READY TO ACCEPT THE DIGITAL CURRICULUM CONCEPT, AND IF NOT WHAT ARE THE REASONS THEY ARE NOT?

WHAT ARE THE CHARACTERISTICS OF OUR EXISTING SCHOOLS THAT WE NEED TO CHANGE IN OUR NEW SCHOOLS THAT WILL MAKE THEM MORE ADAPTABLE TO USE DIGITAL TECHNOLOGY TO ITS BEST POTENTIAL?

- Technology design must be addressed with a systems approach
- The central driver will be the digital curriculum adopted by the faculty
- Only part of the technology system is within the responsibility of the SFB. They must be confident that other policy and operating organizations will step up to and deliver to their 21st Century School design in a collaborative basis.
- School Technology Required from SFB:
  - 1:2 to 1:3 computer interface devices per student grades K-3
  - 1:1 grades 4-12
  - Repair, replacement and upgrades of computers, laptop batteries, and peripherals.
  - Both wired and wireless into the foreseeable future
  - Presentation system: Projector now, then airliner,
  - interactive white boards;
  - wired for sound with speakers and teacher microphone, infrastructure.
  - Wired data drops (Category 6) in each classroom (minimum number @ 6 12 recommended)
  - Differential and adjustable lighting by thoughtful switching design
  - Provide 20 amps of power on each wall
- District Technology Required:
  - Voice over IP (Internet Protocol) for telephone service
  - Alarm wiring, 911
  - WiFi (+ next generation), wireless, cellular

- Design to minimize wireless signal impediment caused by masonry walls & concrete structural elements
  - Data capacity – servers
  - State Technology Required
    - Cost effective broadband internet access into every district statewide to match the growth of capacity needs as current population of internet computers grow from 1:8 to 1:1 (120,000 to 1.6 million in 20 years)
    - Keep pace with internet based rich content usage increases (maybe by a factor of 10).
  - Soft Stuff That Is Not Controlled by SFB Policy:
    - eLearning savvy teacher population (which is a function of: the funding and delivery of state wide system of educational curriculum in Arizona Colleges; professional development and teacher preparation programs; and after hour use at home)
    - Community support and connectivity
    - Technical Support
    - Data Systems
    - Instructional technology standards
  - Special Requests:
    - School by school annual quantitative survey of all school districts on the state of their current technology.
    - Consider the effects of long range 21st Century school technology adoption scenarios with financial modeling of the entire cost of educating a student.
    - A typical scenario would assume 1:1 eLearning is adopted, the students learn 30% faster, a very modest percentage of the learning moves into the home and community,
    - M & O funding from the state is changed from 100 day seat time to completing one academic year on the students personal learning plan,
- 

### **PERSONALIZED LEARNING ENVIRONMENTS: Focus Group Comments**

DO CURRENT SCHOOLS LACK THE NECESSARY SPACES TO ACCOMMODATE PERSONALIZED LEARNING?

- Defining Personalized Learning Environment
  - Optimal learning surroundings
  - Encourage, induce, and nurture collaboration
  - Community Spaces
- Unlimited square footage outdoors goes under utilized or not utilized at all
- Varied styles of learning need to be accommodated
- Appropriate / flexible furniture is a must
- Community involvement

- Flexible Spaces
- Utilization of all spaces
- Student Personalized Space

**ARE THERE SPACES IN CURRENT SCHOOL DESIGN THAT CAN BE REDUCED OR ELIMINATED,  
i.e. MEDIA CENTERS?**

- Outdoor space is not utilized to best advantage
  - Active use of outdoor areas should be considered
  - Security and access issues are inherent
- Increased widths of transitional spaces main hallways, etc. Vary widths also
- Use mobile furniture and fixtures within labs & specialty classrooms – maximum flexibility
- Multi-use facilities
- Partnerships / Community
- Eliminate Computer Labs
- Balance State & Local participation / Clarify who pays for what / get local community participation & \$
- Eliminate "built-in" fixtures
- Media Center should evolve into the "Hub" of the School -- The Info Bistro
  - Information Resource Center
  - Social Center
  - Snack & Refreshment Center

**WHAT IS THE RELATIONSHIP BETWEEN PERSONALIZED LEARNING SPACES AND TEACHER CLASSROOM ASSIGNMENTS?**

- Individual teacher expression / domain is important
  - Teacher's "Carts" diminish that personalization
  - Equate Personalized Learning Environment with the Classroom
  - Realistic Situations
- 

**SCHOOL SIZE & CLASSROOM SIZE: Focus Group Comments**

**SHOULD THERE BE A MIX OF SCHOOL SIZES AT EACH SCHOOL LEVEL IN EACH DISTRICT?**

**ARE THE RODEL SCHOOL SIZE RECOMMENDATIONS REASONABLE AND REALISTIC?**

**Sizing of lunchroom / cafeteria spaces –**

- current standard of 1/3 student population is insufficient
- particularly in high schools
- larger elementary schools built to that standard require 4 lunch shifts
- 1<sup>st</sup> graders are having to take lunch at 10:30am
- consider size of school and functionality of resulting floor area when standards are applied to room sizes

**Vail School District High School experience**

- District has no attendance boundaries, giving students choice of size of school

- Small – Vail High School – 160 students
- Medium – Empire High School – 650 students (*the all lap-top school*)
- Large – Cienega High School – 1,750 students
- District conducted survey study of student attitudes at each as part of school safety program grant
  - Student perceptions about their school varied consistently based on comparative size of the school they attended.
    - Adults at school care about the students
    - Problems of Bullying, Fighting, Drug Use, Harassment, Disruptive Students, Verbal or Physical Abuse, Cutting Class or Truancy, Vandalism, & Theft.
- Pressure of athletics and other programs seem to drive constituency for larger high schools
  - High performers gravitate to range of programs offered at large schools
  - Perception is “bigger is better”
  - Athletic league standards for participation in AA or AAA categories determines size of school more often than comparative measurements of academic achievement
  - Efficiency of scale is presumed
- Maintenance & Operations budgets are a concern that argues against smaller size schools
  - Vail School District bases their funding on a lump sum, per student, basis. The smaller schools then have to decide on what programs to cut – like marching band, or inter-mural athletics
- Vail currently has a waiting list for enrollment at both smaller high schools
- Vail District planning new high school, size has not been determined, but most constituencies are steering toward larger size
- Charter Schools are providing Choices of school and class sizes that public schools are missing
- The current square foot per student standard is a problem for adequately funding smaller schools. Should a different standard be developed for small schools?
- Evolution of older classrooms designed for 50 students into classrooms that house only 18 does not compute according to current space allocation formulas
- What is the breakeven point between today’s needs and standards and those we anticipate in 10 years or more?
- Let each district make their own CHOICE as to school & classroom sizes. THEY know what works best for them (*and presumably their own students*)
- Categories of schools (Elementary, Middle, and High) are not all alike.
  - Recognize different grade level groupings in future schools
  - Funding and standards ought to accommodate these different grade level groupings K-12, vs. K-6, or K-3, etc.

- TECHS & TEDS have been proven to be successful alternative educational choices for many students
  - yet SFB cannot provide funding for these schools
  - alternative ways to fund these types of technical schools should be explored
  - 0.05% secondary tax funding
- Linear foot standard creates problems
  - Harder for rural schools to configure best use of space
  - Not recognizing rise of construction costs
  - Create the "factory model" school that inhibits innovative teaching and learning environments
- Quality of design and aesthetics influence performance of students and teachers and instills pride and allegiance in the place
- Band Rooms, Drama Classrooms, Music Rooms are not receiving sufficient funding

#### Summary Comments on School Size

- Leave Choices of School Size to Districts
- Help answer the concerns about the feared extra O&M cost burden of smaller schools
- Funding formulas for new schools needs to be more realistic, especially for the specific requirements and constraints affecting rural schools

#### What is the Threshold Size Between "Too Small" & "Too Big" for Classrooms?

- TUSD adopted small class sizes
  - Difficult to retro-fit older school buildings if they need to house the same number of students over all but in smaller class sizes
  - Override (elections) are difficult
- Funding is biggest hurdle, especially for rural districts
  - Current formulas do not allow for facilities issues specific to rural areas, especially in colder climates
  - Possible geographic based funding premiums
- MAGs need to be fixed
  - Take steps to go further
  - Sq. ft. per student & \$ per sq. ft. formulas need adjustment
- Accommodating innovative curriculum and anticipating future possibilities requires classrooms to be "Flexible"
  - Able to be used by multiple small (break-out) groups at the same time
  - Circulation and movement in the classroom must not be constricted, but rather free flowing and without functional conflict

- Space configuration and appointments should allow for use by different classes and for different subjects
- Class sizes recommended by the Rodel Report, "Lead With Five", are about right
  - 30 1<sup>st</sup> Graders are too many to teach effectively
  - Packing kids into small spaces creates behavioral problems like bullying
- The same space planning process used for designing meal service areas needs to be applied to classrooms
  - The current standard of 32 sq. ft. per K-3 student needs to be understood as the personal comfort zone
  - Functionality requires additional space allocation for ease of circulation and alternative desk configurations in the classroom
  - 2006 Int'l. Building Code sets space allocation at 50 sq. ft. per student for life safety purposes

Should personalized learning areas be within the classroom for elementary grades? What does that mean for classroom sizes?

- can't do break-outs for small project centered learning without aides in the classroom, limiting lower class levels to the "Teacher Centered" model

#### Summary Comments on Classroom Size

- Leave Decision about Classroom size to the Districts
- Classroom sizes needs to be left to the districts as they go through the pre-design facilities planning & architectural programming phase of each project
- CHOICE drives the success of Charter Schools in Arizona, primarily because of the smaller class sizes they offer and the resulting personalized learning experience their students benefit

#### Concluding Thoughts

- "If the State of Arizona is going to encourage growth and development then it also must find ways to properly fund the schools it needs as a result of that growth." Kathryn Hollenback, Voc Ed Teacher
  - Future funding for new construction needs to reflect escalating construction costs
  - SFB formulas for funding must move away from sq. ft. per student standards
- 

#### WATER & ENERGY EFFICIENCY: Focus Group Comments

##### WHAT ARE APPROPRIATE PAYBACK MEASURES?

- Lighting retrofits
  - Payback period = 2 ½ to 5 years
  - 51% reduction in energy consumption for lighting

- lowers the cooling load
- Energy Management Systems
- High Efficiency A/C systems
- Solar: Photo Voltaic
  - Payback period = 7 years
- Thermal Storage
- Cool Roofing
  - Different Materials = Differing Payback Periods
- Commissioning
  - Mechanical Systems
    - Reviewed to meet current code
    - Operate as designed
    - Training of facilities staff
- Variable Frequency Drives
- High Efficiency Motors
- Construction
  - Structural System Design
  - Building Envelope
  - Insulation
- Waterless Urinals
- Landscape Design
  - Xeriscape *i.e.* Low Water Use / Drought-Tolerant Plant Palette
- Design to LEED Standards
  - Incorporate several energy items
- Displacement Ventilation
- Energy Star Appliances

#### WHAT IS THE SFB's ROLE IN WATER & ENERGY EFFICIENCY?

- Education & Training for Faculty & Staff about energy and water conservation
- Establish performance requirement / metric / to establish baselines for energy cost per sq. ft. so school can measure building performance against a set standard
- Incentive vs. disincentive for energy savings
- Fund commissioning and re-commissioning of systems
  - Economies-of-Scale could be maximized if multiple districts participated
- Build pilot school as a model to evaluate energy efficiencies of their systems
- Allow SFB funding for energy efficiency systems in new construction projects
  - Not currently funded with state money
  - Life Cycle Cost should be part of minimum guidelines
- Assess systems one at a time
  - Proven systems should be standard and funded
  - Use industry recognized standards (outside/independent proof is an additional cost) *e.g.* Chillers, Energy Management Systems, Reflective Roofing Materials, High Efficiency A/C, etc.
- 8-Year Payback has returns other than monetary
  - diminished absenteeism

- better health
- Schools as energy producers rather than energy consumers
- Policy Makers need to define quality standard and decide to fund or not fund
  - e.g. 13 SEER vs. 15 – 18 SEER A/C
- Encourage partnerships with federal agencies
- Put links on SFB website to resources

#### SHOULD SCHOOLS GENERATE POWER?

- Tax Credit to private companies
  - U of A / ASU will be allowed to sell unused power back to grid if current legislation becomes law

#### WHAT SYSTEMS CAN BE PRIVATIZED?

- Central Plants
- Organic Waste
- Performance Contracting
  - Divert savings to re-invest in systems

---

#### Symposium Wrap-Up Discussion: Comments

- Where does Arizona spend above the national average based on population?
- Districts need State support for counselors
- Districts need State support for plant & operations
- What is Arizona's per pupil spending rank nationally: 48<sup>th</sup> or 50<sup>th</sup>?
  - We can & ought to be doing better
  - Let's do it and not just talk about it again and again!

## **Exhibit B.**

Governor Napolitano's Executive Order 2005-05:  
Implementing Renewable Energy and Energy Efficiency  
in New State Buildings.

**Executive Order 2005-05**

**IMPLEMENTING RENEWABLE ENERGY AND ENERGY  
EFFICIENCY IN NEW STATE BUILDINGS**

**WHEREAS**, development of renewable energy and promotion of energy efficiency can significantly improve Arizona's energy reliability and security, economic development, and environment; and

**WHEREAS**, as a state with abundant sunshine, Arizona has the opportunity to achieve national and global leadership in research, design, construction, manufacturing and development of renewable energy; and

**WHEREAS**, Arizona's dense forests pose both a fire hazard and an economic opportunity to develop thermal energy using forest biomass; and

**WHEREAS**, developing thermal energy using forest biomass also creates economic incentives for responsible and necessary commercial thinning of our forests; and

**WHEREAS**, supporting responsible use of Arizona's naturally renewable energy resources and increasing energy efficiency is important to the State, and the national economy;

**NOW, THEREFORE**, I, Janet Napolitano, Governor of Arizona, by virtue of the authority vested in me by the Constitution and laws of this State, hereby order as follows:

1. All Executive Branch agencies shall implement to the extent practicable the following standards in all new state-funded facilities:

**A. Renewable Energy** – All new state funded-buildings constructed after the date of this Executive Order shall be designed and constructed to derive at least 10 percent (10%) of their energy from a renewable resource. A renewable resource may include: solar, wind, or the use of thermal energy from biomass fuels for heating and or cooling. This goal may also be met through the purchase of renewable energy credits (as defined by the Department of Commerce Energy Office) from an energy producer.

**B. Energy Efficiency** – The design for all state-funded buildings constructed after the date of this Executive Order shall include energy efficiency standards consistent with Arizona Revised Statutes § 34-451 and Executive Order 2003-14.

- C. LEED Standard** – All state-funded buildings constructed after the date of this Executive Order shall meet at least the “silver” Leadership in Energy & Environmental Design (LEED) standard.
2. The Arizona Department of Administration, Arizona Department of Transportation and Arizona School Facilities Board, shall submit a report to me (as well as to the Director of the Department of Administration) in writing via electronic submission, by August 1, 2005, and annually thereafter, summarizing: a) actions taken to achieve the renewable and energy efficiency goals of this Order; b) the extent to which the goal has been achieved; and c) if the goal was not achieved, an explanation why it was not achieved and an assessment of what can be done to achieve the goal.
  3. All other branches of state government are also encouraged to review and comply with the design standards set forth in this Executive Order.

**IN WITNESS WHEREOF**, I have hereunto set my hand and caused to be affixed the Great Seal of the State of Arizona.



GOVERNOR

Signed at the Capitol in Phoenix this 11<sup>th</sup> day of February Two Thousand Five and of the Independence of the United States of America the Two Hundred and Twenty-Ninth.

ATTEST:



Janice K. Brewer  
SECRETARY OF STATE



### **Exhibit C.**

Survey Data Related to School Size.  
Vail School District. June 2007.

## **Survey Data Related to School Size**

Vail School District

06/07

Does school size make a difference in how students experience and/or perceive their school?

In the fall of 2006, the Vail School District administered a survey to all high school students. The survey was designed and administered with help from the University of Arizona as part of a federally funded program on school safety.

A school-by-school review of the data reveals only minor differences regarding the characteristics of students. (Note the first two pages of the attached data.)

The same review reveals some stark differences in the way students perceive the environment of their schools. (Note data on the remaining pages.) In general, the larger the school, the worse it is perceived by students.

The Vail School District has a large, medium and small high school. They are described below:

Cienega High is a somewhat typical, large comprehensive school, with about 1750 students. It is designed with three separate "houses" to make the school "feel" smaller.

Empire High is a medium-size comprehensive high school, with approximately 550 students.

Vail High is a small comprehensive high school of approximately 160 students. It is located within the University of Arizona's Science and Technology Park.

Other relevant facts:

- The District has no attendance boundaries. Parents choose where to send their students. There are few geographic trends to the choices. Each school has a broad range of students from across the district.
- The administrators at the schools are of similar quality, all hired by the same people with a similar process. The only prior administrative experience of the principals at the smaller schools was as assistant principals at the larger (Cienega) school.
- The teachers at the three schools are of similar quality — hired by similar people with a similar process. Many of the teachers have taught at one of other schools in the District.
- The large school is well-respected. Many of its athletic teams are successful. It is rated as an "Excelling School" and the principal was honored as Arizona's "High School Principal of the Year" the year before the survey was taken.

In brief, it is difficult to explain why students at the large school perceive the school so much worse than students at the smaller schools.

While some differences in the survey data were expected, I was totally surprised by some of the dramatic differences. I was especially surprised because I personally supervised the conceptualization, building, staffing and development of all three schools.

Obviously there are a host of uncontrolled factors and any of those factors could contribute to the differences. Even so, it is difficult to look at the data without concluding that school size must be at least partially responsible for the differences in how students perceive their school's environment.

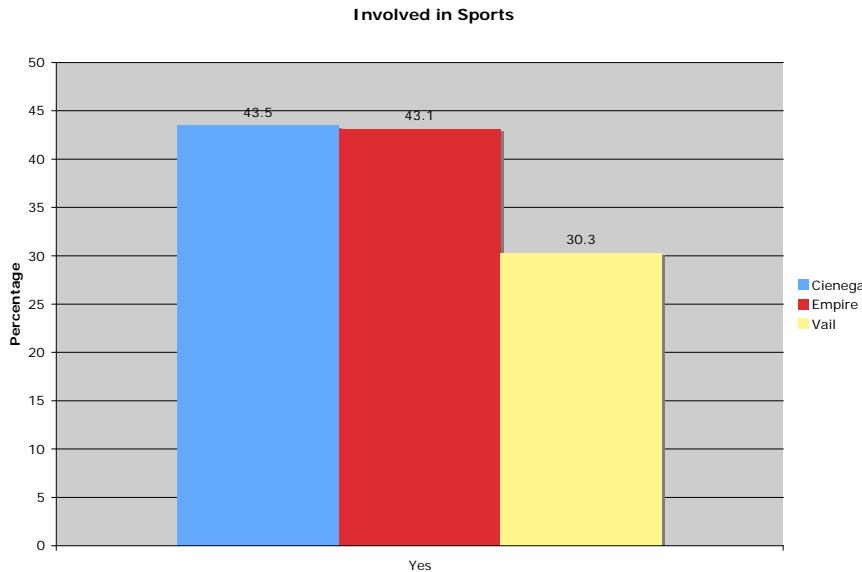
Calvin Baker  
Superintendent  
Vail School District

## Vail CARES Student Survey Analysis

### Similarity of Students

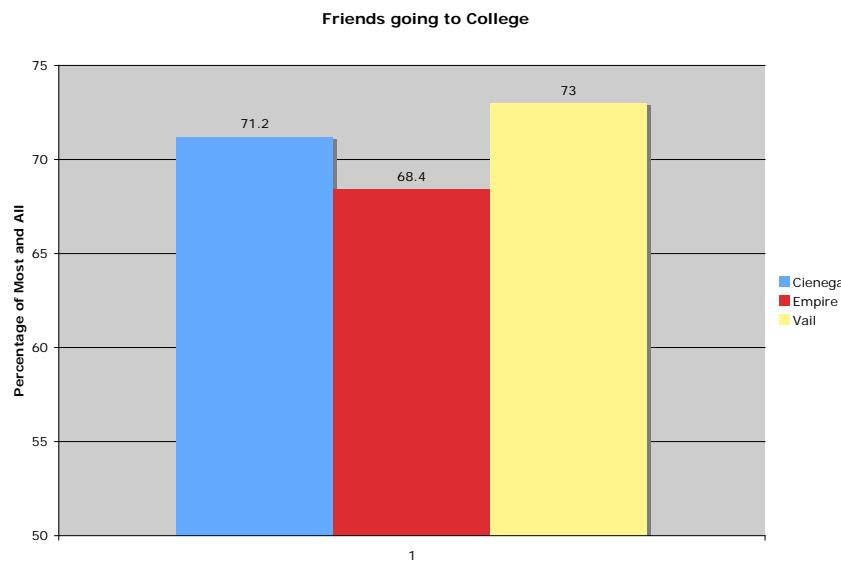
What activities are you involved in – sports?

	Yes
Cienega	43.5%
Empire	43.1%
Vail	30.3%



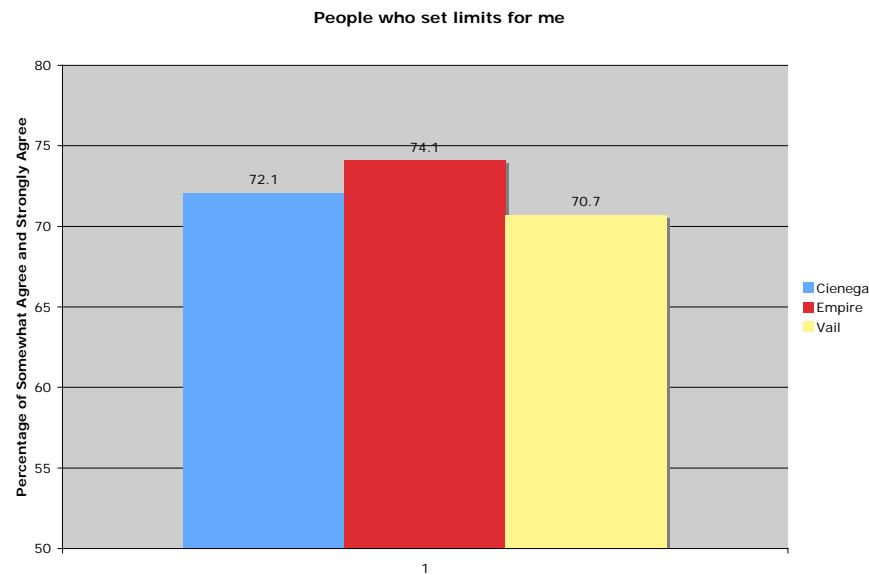
How many of your friends plan to go to college?

	Most and All
Cienega	71.2%
Empire	68.4%
Vail	73%



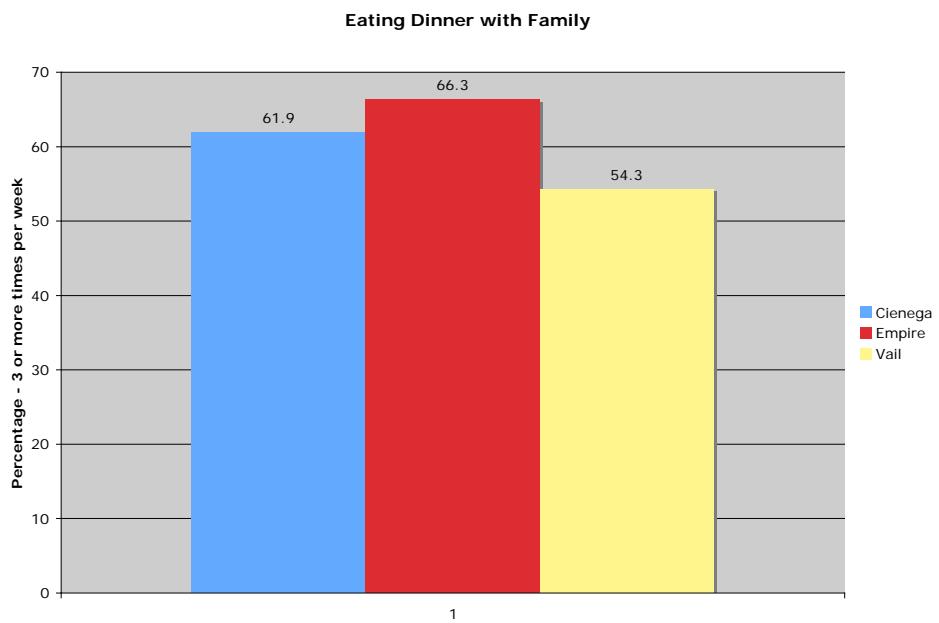
I have people who set limits for me so I know when to stop before there is danger or trouble.

	Somewhat Agree and Strongly Agree
Cienega	72.1
Empire	74.1
Vail	70.7



During a typical week, how many times do any or most of your family living in your home eat dinner together?

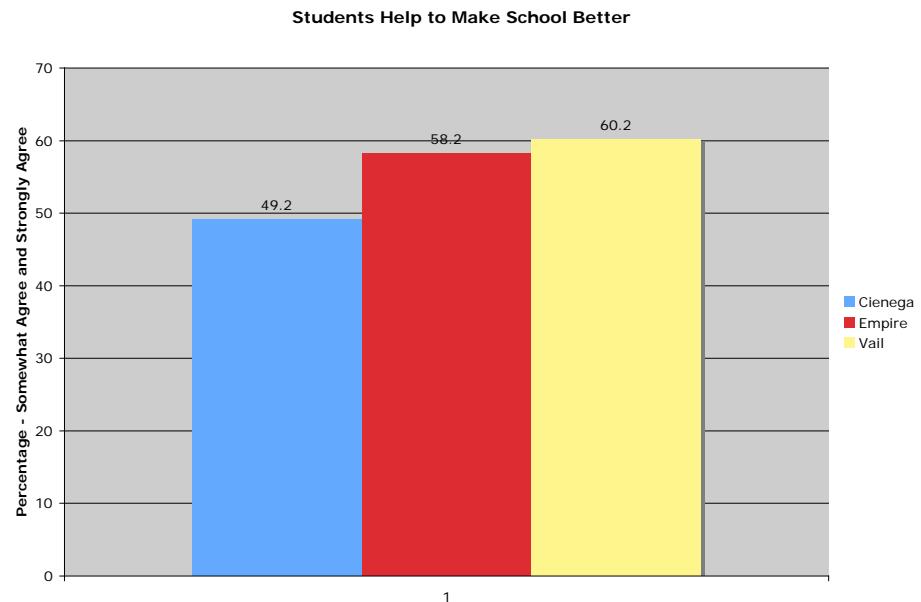
	3 or More times
Cienega	61.9
Empire	66.3
Vail	54.3



## Differences between Schools

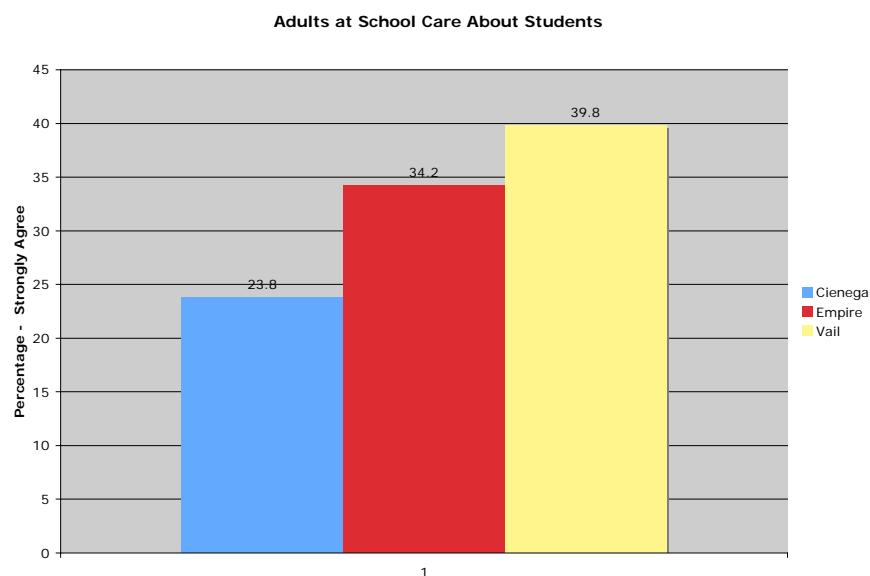
Students at my school do things to help the school be a better place.

	Somewhat Agree and Strongly Agree
Cienega	49.2
Empire	58.2
Vail	60.2



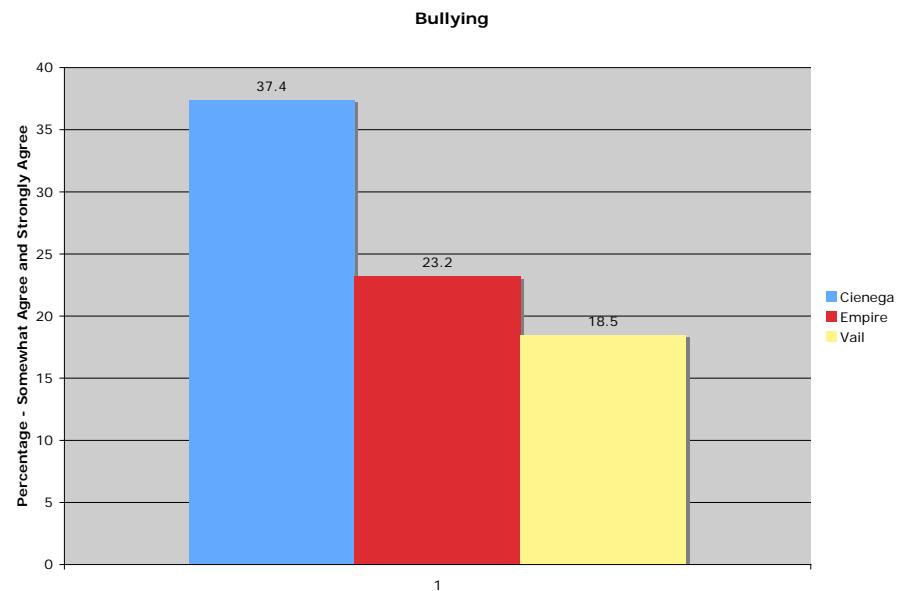
Adults at school care about the students

	Strongly Agree
Cienega	23.8
Empire	34.2
Vail	39.8



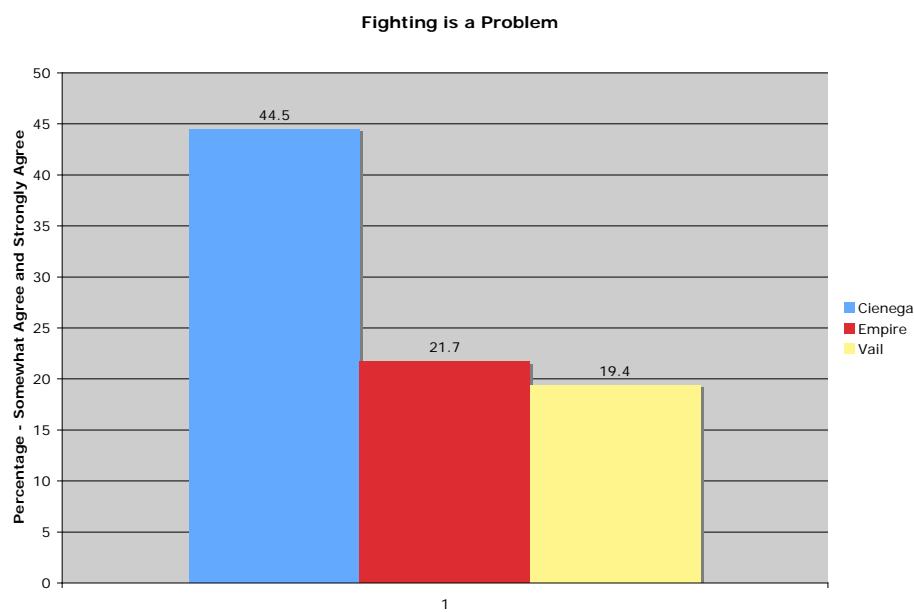
Bullying is a problem at my school.

	Somewhat Agree and Strongly Agree
Cienega	37.4
Empire	23.2
Vail	18.5



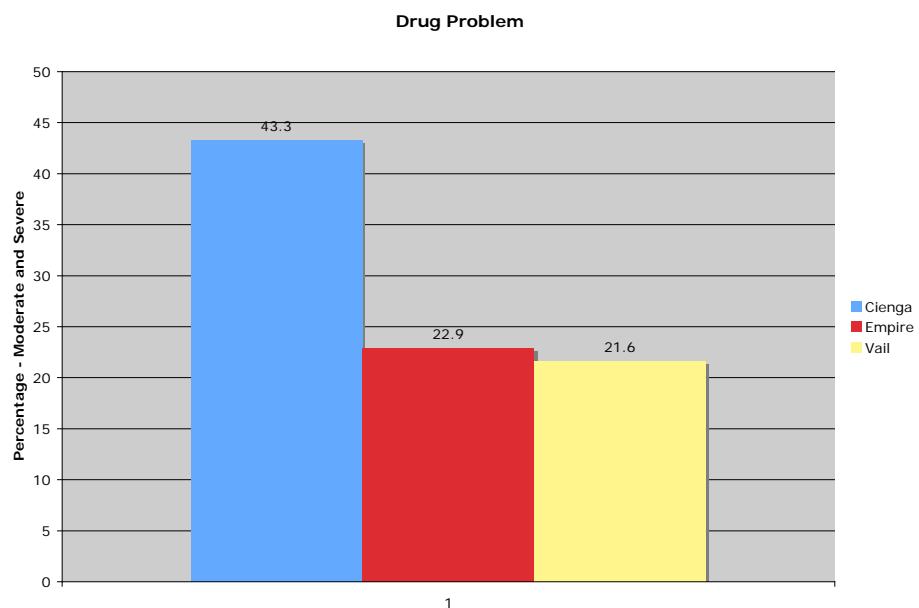
Fighting at my school is a problem.

	Somewhat Agree and Strongly Agree
Cienega	44.5
Empire	21.7
Vail	19.4



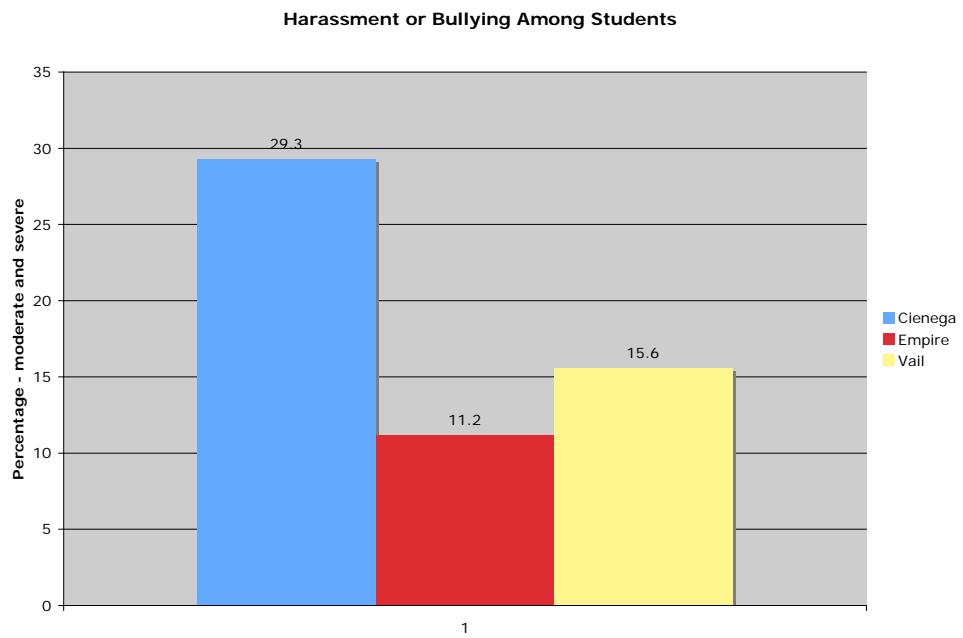
How much of a problem is drug use at your school.

	Moderate and Severe
Cienega	43.3
Empire	22.9
Vail	21.6



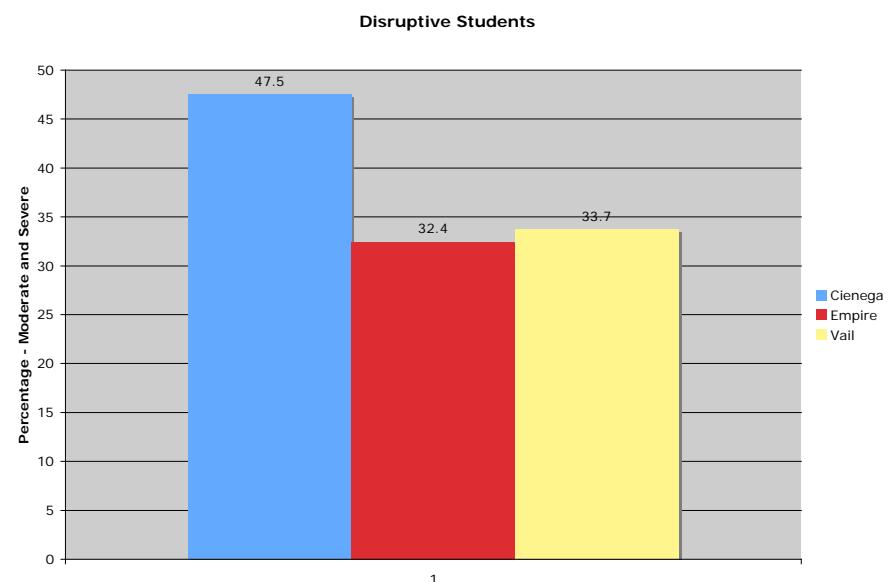
How much of a problem is harassment or bullying among students.

	Moderate and Severe
Cienega	29.3
Empire	11.2
Vail	15.6



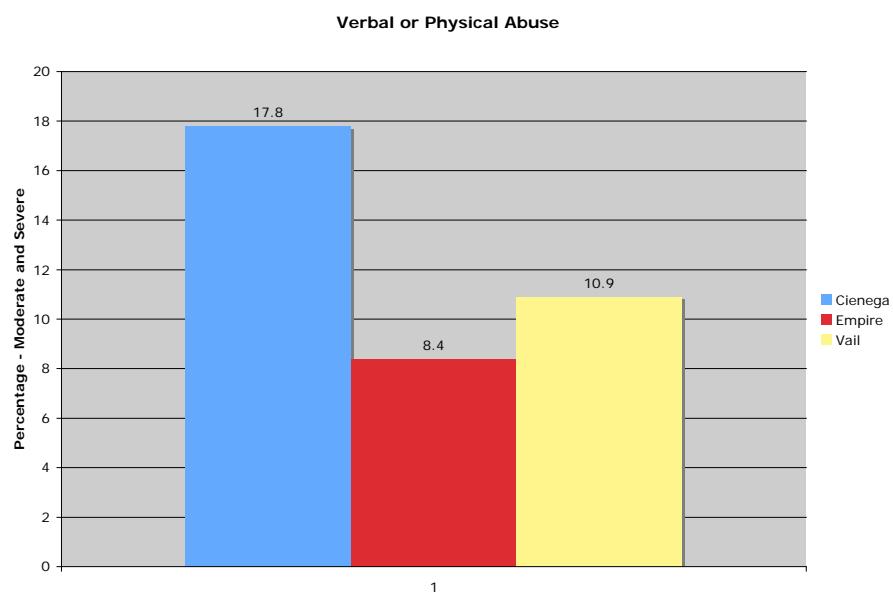
How much of a problem is disruptive student behavior to your schools.

	Moderate and Severe
Cienega	47.5
Empire	32.4
Vail	33.7



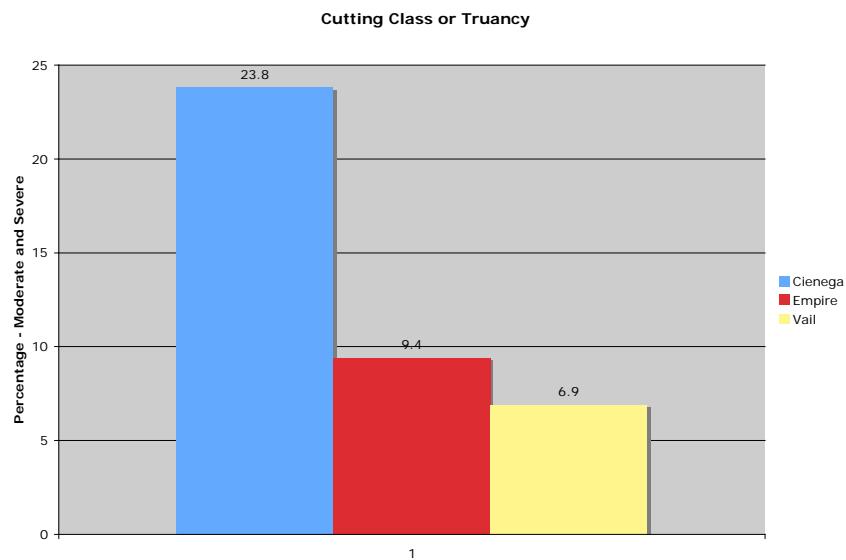
How much of problem is verbal or physical abuse of school staff by students in your school.

	Moderate and Severe
Cienega	17.8
Empire	8.4
Vail	10.9



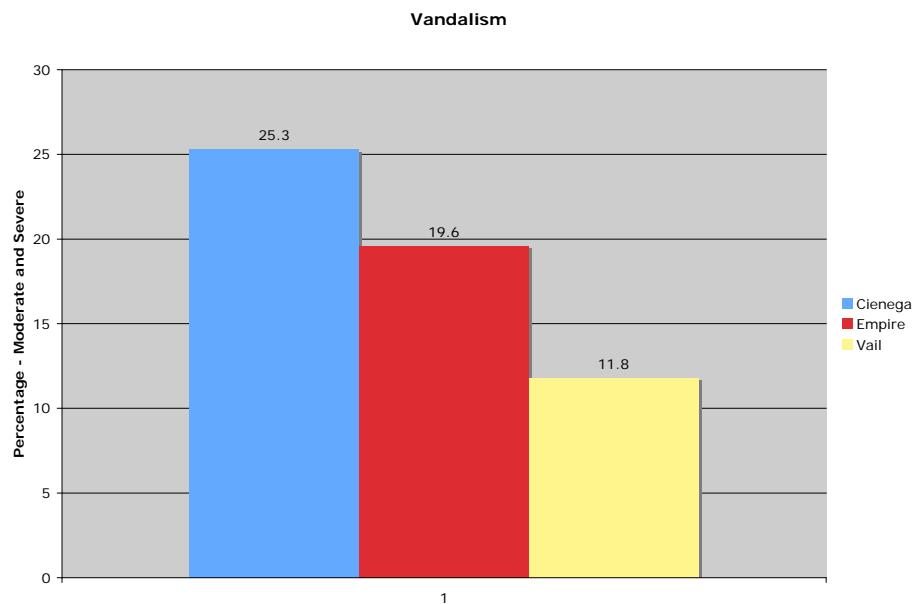
How much of a problem is cutting classes or being truant in your school.

	Moderate and Severe
Cienega	23.8
Empire	9.4
Vail	6.9



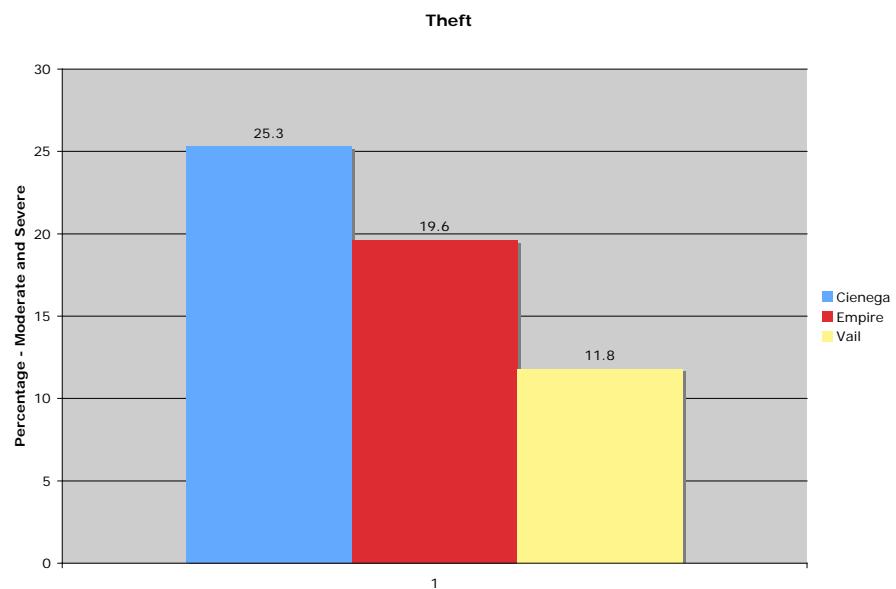
How much of a problem is vandalism (including graffiti) in your school.

	Moderate and Severe
Cienega	15.7
Empire	6.9
Vail	6.9



How much problem is theft in your school.

	Moderate and Severe
Cienega	25.3
Empire	19.6
Vail	11.8



**Exhibit D.**  
Feedback and Comments  
received during the Public Review period  
September 6 – 22, 2007

For comments received and the results of two surveys visit [www.azsfb.gov](http://www.azsfb.gov) and click on the "21<sup>st</sup> Century Schools button on the left side of the home page, then click on the "Documents" button, and go to "Feedback."

**Exhibit E.**  
Acknowledgements.

# Acknowledgements

The following chronology lists the formal discussion groups convened by John Arnold, Executive Director, of the School Facilities Board as part of the fact finding and opinion research in preparation for this report. The School Facilities Board wishes to express our gratitude to the participants in these discussion groups who were generous with their time. We are grateful for their thoughtful insights into the issues that are the focus of this report.

March 26, 2007

## **Arizona School Administrators**

Bryce Anderson, Agua Fria High School; Guillermo Zamudio, Nogales Unified; Calvin Baker, Vail Unified; Mark Tregaskes, Safford; Grant Turley, Chino Valley Unified; and Eldon Merrill, Willcox Elementary. Board Member Penny Taylor was in attendance.

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April 4, 2007

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## **Maricopa County Community Colleges**

Arlen Solochek A.I.A., Roger Yohe, Ph.D.

April 20, 2007

## **Arizona Education Association**

John Wright

April 24, 2007

## **Estrella Community College Campus Tour**

Roger Yohe, Ph.D., Director Center for Teaching and Learning

Clay Goodman, Vice President

Linda Garcia, Doctoral Candidate in Education

August 7, 2007

## **Arizona Technology in Education Association**

Hank Stabler, Christopher Johnson, Ph.D., Dan Hunt, Cathy J. Poplin

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Monica Petersen	Deputy Director – Finance & Legislative Liaison
Dean Gray	Deputy Director – Facilities
Mike Barfield	School Facilities Liaison
Gerry Breuer	School Facilities Liaison
Kerry Campbell	Manager's Assistant & Public Information Officer
Jim Chang	Demographer
Carol Civiello	Special Projects (through June 30, 2007)
Richard Dern	Staff Consulting Architect
Tom Halverstadt	Land Consultant
Heather Gamby	Administrative Assistant
Kristen Landry	Public Information Officer (through May 31, 2007)
Sameer Pandey	School Facilities Liaison & Energy Analyst
Ron Passarelli	Government Liaison & Special Projects
John Penczar	Information Technology Consultant
Amber Peterson	School Finance Specialist
Al Sawyer	Business Manager
Judy Shurley	Administrative Assistant
Staci Shurley	Intern