[DISCOVERY]

School describe their school as The Tree House. Nestled in the existing trees on the site, windows in every classroom look out onto a sea of natural Texas grasses and a forest of towering oak, elm and pine trees. This nickname is a perfect depiction for a school encouraging discovery and exploration, which was also embodied in the building's design process; Marshall Elementary became a journey of discovery for the entire project team. Throughout the years, Spring Independent School District, in partnership with the architect, had affected thousands of students through strong collaboration addressing curriculum, architecture, spirit and innovation. However, the design of Marshall Elementary School demanded something still greater.

A heightened awareness of sustainability issues in the general population and rising energy costs was resulting in a paradigm shift and – suddenly - students became the teachers.





SCIENCE LESSONS ABOUT SEDIMENTATION, GRAVITY, EROSION AND THE WATER ECOSYSTEM ARE LEARNED AT THE RIVER TABLE IN THE SCIENCE GARDEN AT GLORIA MARSHALL ELEMENTARY SCHOOL



2ND GRADE TEACHER, DIANE SAYLAK, ENGAGES HER CLASS OF EAGER STUDENTS AS THEY LOOK OUT OVER THE SCIENCE GARDEN FROM THE 2ND FLOOR RESOURCE ROOM.

In a video produced by the U.S. Green Building Council, elementary school students at Spring ISD told the world: "Don't cut down so many trees with your buildings"; "I wish I could ride my bike to school"; and "Maybe schools should have more windows to use less energy".

From the moment you arrive at Gloria Marshall Elementary School, you realize you are in a new kind of place. The entrance is not a traditional, imposing clock tower but instead a place encouraging activity and learning. A water cistern, an ecopond and an oak tree greet you adjacent to gardens planted by each grade level with identifying signs that say: "FIRST GRADE BLOOMS!"

These experiences are what start you on the journey of DISCOVERY at Gloria Marshall Elementary School.

PROTOTYPE

The design development of a typical Spring ISD prototype elementary school was being presented to the Spring ISD Board of Education at the same time that the project team was being selected to design Spring ISD's 26th elementary school.

Elementary School 26 was the last elementary school in Spring ISD's 2007 Bond, and just like previous elementary schools built in the district, was contracted to be a repeat of a successful prototype design already used multiple times in the district. The selected design was compact, efficient, and affordable to build.

The site for 26 was in a heavily wooded area on the northeast corner of the district and almost a perfect rectangle in plan. It would easily have accommodated the re-site of School 24's plan to the site of 26. However, a very forward-thinking Board of Education was paying attention to the interests and collective conscious of the world and its students.

STUDENTS WATCH ON AS THEIR TEACHER PLACES NATIVE TEXAS PLANTS IN THE BEDS AROUND THE ECO-POND AT THE ENTRANCE OF THE SCHOOL



A SLIDE IS A FAST WAY TO GO FROM THE SECOND TO THE FIRST FLOOR. IT ALSO TEACHES LESSONS IN STATIC ELEC-TRICITY!





PREVIOUS PROTOTYPE ELEMENTARY SCHOOL FLOORPLAN. ONLY 15 OUT OF 42 CLASSROOMS HAD WINDOWS FOR VIEWS, NOT DAYLIGHTING







ABOVE: RESEARCH WAS DONE TO LOOK AT VOLUME AND HARVESTING DAYLIGHT.

BELOW: THE SITE WAS LOCATED IN A DENSELY WOODED, SUBURBAN AREA AT THE NORTHEAST END OF SPRING ISD.



At the meeting, the Board asked hard, strategic questions about energy reduction, water conservation, increasing natural light in classrooms, and saving money on operating costs. These questions resulted in a new focus for Elementary School 26.

Elementary School 26 became the little elementary school that could. This new vision opened up a world of possibilities for what the newly named, Gloria Marshall Elementary School would eventually become. The ideas for the new design were quickly organized into a presentation of 8-1/2 x 11's that were presented to the Director of Construction and Energy at Spring ISD. Research was conducted to look at volume, surface area, building footprint, roof area, and natural light (the previously used prototype only had 15 of 42 classrooms on exterior walls). The question was asked: What if every single classroom in the new prototype design had access to natural light and, beyond that, could harvesting daylight reduce the necessary lighting and HVAC loads?

Spring ISD embraced the innovative ideas of this new prototype so completely that the Director wanted the ideas presented to the Superintendent. From there, the unassuming elementary school that would eventually become the most sustainable school in Houston took flight.



RESEARCH WAS CONDUCTED TO LOOK AT SURFACE AREA, BUILDING FOOTPRINT, ROOF AREA, AND NATURAL LIGHT.

PROCESS AND PLANNING

With so many ideas and possibilities for environmental engagement, the design team crafted a system of checks and balances to ensure all opportunities and synergies were explored and vetted.

For this, the design team created the "Butterfly". The Butterfly was a matrix of design objectives that looked at four aspects (or wings) of a successful, high-performance school: Craft, Sustainability, Recognition and Learning. In each of these major categories, the design team highlighted goals for the design of Gloria Marshall Elementary School. Under Learning, the team wanted to empower: higher test scores, less absenteeism, and teacher retention. Under Craft, the focus was on: high economies in construction, schedule and budget. The Sustainability category: addressed a healthier building environment, extensive energy efficiency, LEED certification, and a facility that is economical to operate. Lastly, under Recognition: Spring ISD sought to be a nationally recognized organization.

With these project objectives in place, no decision was made without returning to the Butterfly structure and assessing what affect the decision would have on each area and its identified goals. For example, if a decision was made to move forward with something that would create success in the sustainability category, such as using Geothermal Heating and Cooling; then extensive research was done to determine that this decision would not negatively impact the schedule and budget.

Equally importantly to the Butterfly system of checks and balances, the design team focused on how much energy the building would consume. Currently, buildings are the number one energy consumer in the world. The architect not only needed to bring in leaders in HVAC and lighting design, but also needed to determine a significant energy goal to unify the team and focus all individual efforts.

The engineer for the project was found in Louisville, Kentucky, in a firm that designed the first net zero energy school in the United States. With the MEP engineer on board, the design team analyzed the six most recent elementary schools built in Spring ISD to begin to understand the energy baseline with which they were working. To ensure fairness and equal opportunity, two schools from each different architect working in the district were analyzed and compared. Based on these numbers, it was determined that Spring ISD was already performing at 8 KBTU per square foot per year below the national average.

They were already out performing most schools in the area in energy consumption, and making strides to drop even lower. The design team set an aggressive goal that Marshall Elementary School would operate at 49 KBTU per square foot per year; this targeted a 25% savings over their already low average.

East Elevation

South Elevation

ABOVE: THE SINGLE OUTSIDE AIR UNIT USES AN ENERGY RECOVERY WHEEL TO SAVE ENERGY.

LEFT: CLASSROOMS ON THE SOUTH SIDE OF THE BUILDING HARVEST DAY-LIGHT USING LIGHT SHELVES AND ON THE SECOND FLOOR, TUBULAR DAY-LIGHTING DEVICES.

In dollars and cents, the district was currently paying around \$120,000 a year to operate their prototype elementary school. It was estimated they could save \$30,000 a year with the newly modified prototype design.

INTEGRATED TEAM APPROACH

In the case of Marshall Elementary School, the integrated design team went beyond the standard collaboration of the project team of architects, planner, engineers and consultants.

In a system where instruction actually does drive construction, like in Spring ISD, the Assistant Superintendent of C&I would be the final decision maker when it came to options such as a two-story school as well as what and how they would teach at this facility. Spring ISD arranged a meeting to team the architect with the top four elementary science and math teachers in the district, under the oversight of the Director of Elementary Education and the Director of Science and Math. The Assistant Superintendent of C&I said, "I want you to sit in the room with them and let them tell you how they teach, what they teach, and what they wish they had in their classrooms and in their school buildings that would help them do their jobs better."

At this meeting, hundreds of ideas poured out of these top educators' minds and into the design and plans of the new elementary school. The integration of the Curriculum and Instruction department and the teachers and educators of Spring ISD was absolutely vital in the success of Marshall Elementary School.

BIO SWALES LINE THE EDGES OF THE PARKING LOTS AND NATIVE TEXAS GRASSES FILTER THE RUN OFF BEFORE IT ENTERS THE STORM SYSTEM.

DROUGHT-RESISTANT PLANTS, NATIVE TO SOUTHEAST TEXAS, WERE USED GENEROUSLY ON THE SITE SO THAT NO IRRIGATION WAS NEEDED.

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ENERGY AND SUSTAINABILITY

The Sustainability "wing" of the butterfly would be a challenge to the design team because, not only was there a goal of LEED Silver Certification, and Designed to Earn the Energy Star, but a 25% energy savings was promised to the district, and with considerable environmental hurdles. It's hot here! And it's humid! The key to designing an energy efficient and sustainable school is to start with smart decisions that do not add any cost to the project. Great care was put into form, massing, and orientation, as well as the location of spaces inside the building. Classrooms were placed on the north and south sides of a rectangle plan to take advantage of natural daylight. Kitchen and mechanical rooms were located on the west side to shield from hot Houston sun in the afternoon; the east side was opened up to an eco-pond and a courtyard filled with native Texas plants.

The principles of LEED provided a guideline for a total sustainable building design. On the site, native plants in bio swales along the parking lot flourished in a terrible drought in the summer of 2011.

ABOVE: TREES FROM THE SITE WERE HARVESTED AND RE-PURPOSED AS WALL COVERING AS SEEN HERE AROUND THE "SOLUTION STATION" IN THE COMMONS. BELOW: A HIGHLY-REFLECTIVE, WHITE ROOF WITH 10 KW OF PHOTOVOLTAIC PANELS TO CREATE ENERGY ON SITE.

Fuel efficient car parking spaces near the front door give priority to those who commit to using less fossil fuel and sends a powerful and tangible message to students. Bike trails allow Marshall's sustainablyminded students, staff and visitors to safely bike from the sidewalk to the secure bike racks near the front door, while a walking trail through the woods on the undeveloped south end of the property encourages teachers and students to explore the "rotten log hotel" to discover creepy crawly ecosystems and moss.

The Board of Education in Spring ISD stressed the importance of water conservation. In an area of the country where there is great emphasis placed on the value of shrinking water supplies and its availability, the building responds by collecting rain water in an underground cistern to flush toilets. It also collects rain water through a clear pipe in the science lab that gravity feeds a cistern in the science courtyard and then runs down a river table, eventually finding its home in the eco-pond filled with plant life, turtles and fish.

As one first grader told the design team: "Water is

important. Fish need water. Because the food is in the water."

Early energy models showed Gloria Marshall Elementary School using only half the energy of other typical schools in the region. This was accomplished by utilizing a very efficient ground source geothermal cooling/ heating system. The geothermal was adequately sized based on a number of integrated design approaches. For instance, there is a demand control ventilation system that only supplies outside air to the areas where high levels of CO2 are indicated (or, where the people are). There are large fans in the gym and cafeteria to create air movement over the occupants' skin, allowing the temperature to be higher by two degrees in those areas, lightening the load on the HVAC system. A few plugs were even removed from classrooms. This was a shock to some of the teachers, but studies show that if you provide plugs, people will -in fact - plug things in. Striving to be the most efficient school in the region, an analysis was done on plug loads, computer labs, kitchen use, and after-school security.

DAYLIGHT HARVESTING AND LARGE VISION WINDOWS ALLOW THE ELECTRIC LIGHT FIXTURES TO BE TURNED OFF THE MAJORITY OF THE YEAR.

DINING, GYM AND AUDITORIUM SPACES COULD BE INTEGRATED BY OPENING A LARGE PARTITION WALL. THESE SPACES HAVE AN INDEPENDENT ACCESS THAT ALLOWS THE COMMUNITY TO USE THEM EVEN WHEN SCHOOL IS CLOSED. LARGE WORLD MAP WITH TIME ZONES CLOCKS ON THE NORTH WALL.

VIEW OF THE COMMONS SPACE. EARTH TONED MATERIALS SELECTED WITH JUST A TOUCH OF PRIMARY COLORS.

ABOVE: STUDENTS CREATE DAMS AT THE RIVER TABLE AND WHEN ALL BOARDS ARE LIFTED, A WATERFALL INTO THE ECO-POND. BELOW: RECLAIMED PINE FROM THE SITE IS THE CEILING OF A CANOPY THAT KEEPS THE ENTRANCE AT A CHILD'S SCALE.

Every single aspect of how this project was going to be used, what hours it would be operated, and how it would be secured was analyzed so that the final product was the most energy efficient, high performing elementary school in the Houston area.

As children are the end users of school environments, tremendous importance was placed on indoor air quality at Gloria Marshall Elementary School. One student was asked, "What is a green school to you?" And her answer: "A place where maybe I won't have to use my inhaler so much?" Children take more breaths per minute than adults; their brains are still developing at a rapid pace. Children miss more days of school due to asthma related incidents than any other ailment. And, if students have to strain to hear the teacher talk, they could miss every third word in a lesson. Walls at mechanical rooms and corridors have high STC ratings and every classroom has a CO2 sensor to monitor the number of children in the room. This directly relates to the amount of natural air that is required.

Low VOC paints and adhesives were used throughout the project and the entire building was flushed for ten months so that no furniture or materials were off gassing fumes when school started.

Materials were also chosen based on their regional properties and their recycled content; more than 95% of the construction waste was diverted from landfills.

Let's remember how one student asked architects to stop cutting down so many trees to build buildings. That was taken to heart at Marshall Elementary School. What trees were cleared for the building were taken to a local mill, and the lumber was dried and re-purposed into the school as wall materials, the suspended tree house over the library and the reception and circulation desks. There are even benches and conference room tables made of large oak and elm trees harvested from the site.

ABOVE: MARSHALL STUDENTS DEMONSTRATE THE GRAV-ITY SLIDE IN THE COMMONS AREA. BOTTOM: A VIEW OF THE LIBRARY AND OF FLO, THE FEARLESS DIVA OF FLIGHT, AS SHE DIPS AND GLIDES THROUGH THE NATURALLY LIT SPACE.

ABOVE: TRACKING LIGHT MOVEMENT WITH THE "SOLSTICE WINDOWS" BELOW: WATCHING THE AMOUNT OF A SOLAR-POWERED BATTERY USED WHEN OPERATING A SMALL FAN

DISCOVERY APPROACH LEARNING (DAL)

As the design team made important decisions regarding energy and sustainability, Spring ISD was moving forward in tandem with a different approach to learning and teaching. The Curriculum and Instruction Department had been investigating a Problem Based Learning curricular approach for students. Teachers in the district were already implementing PBL and benchmarking the performance of their students to see if the different approach to learning allowed them and their students to achieve at the same - or higher levels - as their peers. They were seeing good results. Because of that comparison, and because of the district's forward-thinking approach to education, Spring ISD established a team for collaboration, and developed a new curriculum based on the premise of Project Based Learning, but more aptly named; Discovery Approach Learning (DAL). The idea was that DAL would be implemented into

Gloria Marshall Elementary School to provide a model for the way that Spring ISD could eventually engage and teach all students in their district.

The premise of DAL is that every class in every grade level is given a real life problem to solve and to which to respond. The problem must be relevant, understandable and age appropriate. To discover the answer, students must work together - collaborate with their peers, do research, and figure out how to solve the stated problem. Once they have a solution, they must present it, either to their class, to their school, or to a group of adults. If they get stumped along the way, they are encouraged to ask the teachers for help and small group or individual instruction. The teachers believe that this is a more rewarding way for children to learn because the students are encouraged to take responsibility for their own learning. Teachers are no longer standing in front of the class and delivering a lesson; they are instead guiding students on a journey of discovery to answer relevant questions and solve real-life problems.

MARSHALL STUDENTS USE THE LEARNING TOOLS THROUGHOUT THE SCHOOL: THE RIVER TABLE, THE BALL BOUNCE AND THE FAHRENHEIT AND CELSIUS THERMOMETER.

ABOVE: THE SECURITY VESTIBULE KEEPS THE SPACE AT A CHILD'S SCALE AND INCORPORATES REGIONAL MATERIALS AND COUNTERS MADE OF RE-CYCLED GLASS BOTTLES. BELOW: STUDENTS USE THE SELF-MADE SUN-DIAL IN THE PLAYGROUND AREA.

As the Spring ISD C&I Department was leading the development of DAL in cooperation with various Directors of Education, the pedagogical shift strongly influenced the design of the school. The strong relationship between the design team and educators in the Spring ISD school district resulted in a series of advanced learning tools that were able to be implemented into the school. Sustainable features like the photovoltaic panels on the roof and a wind turbine demonstrate alternative energy on a Solution Station located in the commons for students, teachers and visitors to use. The Solution Station is a touch-screen computer that allows students to track the energy use of the school, as well as how much energy the wind and sun are creating on site. These strategies provide research opportunities at the fingertips of the students, and they find it fascinating!

In the Commons area, there are gravity slides for balls of different sizes to be rolled at different speeds, and a ball bounce where students change out the ground material to measure how high the ball will bounce. These installations allow students to experience and conceptually understand measurement, force, and pre-algebraic concepts. Other interactive displays are scattered throughout the project, helping students to understand various concepts across subjects. There is a manual thermometer at the south entrance that teaches Fahrenheit and Celsius, and a digital thermometer that indicates temperatures both inside and outside. A giant world map in the cafeteria shows time zones with 12 clocks below it, displaying actual times in different parts of the world. Upstairs on the Resource Bridge, there is a giant scale chess board with life-sized game pieces. A tree house is suspended over the library that houses a gravity drop to test velocity and impact.

ABOVE: THE TREE HOUSE THAT HANGS OVER THE LIBRARY IS MADE OF RECLAIMED OAK FROM THE SITE AND RECYCLED BLUE PLASTIC. CENTER: STUDENTS PLAY CHESS ON THE RESOURCE BRIDGE. BELOW: THE LIBRARIAN TEACHES CLASS WITH VIEWS TO THE ECO-POND.

STUDENTS ARE HARD AT WORK GATHERING DATA IN THE SCIENCE GARDEN AND THEN RESEARCHING WHAT THEY FOUND, UPSTAIRS IN THE SCIENCE LABS.

And the second grade corridor has colored windows in a unique pattern so that students can track both the winter solstice and summer solstice, as colors and shapes from the window pattern moves across the carpet. All of these teaching tools were incorporated as a result of conversations with teachers; because of an Associate Superintendent of C&I being hands on, involved in 100% of the design of the project; and as a result of the architect engaging in curriculum development meetings. As Spring ISD worked through the creation of DAL, the architect actively participated with all of the Directors of Education from the school system and shared architectural expertise on how the building could offer additional opportunities for each of the different learning foci: the building could help teach find arts, could engage students in math concepts through built form and much, much more.

The dream of learning through discovery in a state-of-the-art elementary school became a reality for students.

RESEARCHING IN THE SCIENCE LAB

COLLABORATION IS ENCOURAGED AMONG DAL STUDENTS AND WATER CONSERVATION AND MECHANICAL SYSTEMS ARE FRONT AND CENTER FOR LEARNING.

As a high performance school is designed with consumption and resources in mind and the results are high performing students graduating from that school – one element can potentially be missing. The design team embraced a core belief of Spring ISD. Spring ISD wants their students to be volunteers at school. In other words, they do not want their students to come to school and volunteer for things, but actually volunteer every morning to come to school and to participate in learning. To get kids to volunteer to come to school, you have to make it a lot of fun. The entire design team was dedicated to putting fun at the core of this elementary school. Let's be honest, the target audience and end users are students and they are the final test to determine if the building is successful. If they are learning, if they are having a good time, if they are excited to come to school every day – then the design team has done their job. This philosophy created the tree house, the slide, and a hang glider that flies over the library. This glider is flown by a vivacious woman named "Flo" who serves as an instigator for students to engage and inquire while also being a symbol of the elementary school – and its students – who both have the ability to truly take flight.

AN OUTDOOR LEARNING KIVA FOR GROUP LEARNING AND DISCOVERY

THE SOLUTION STATION IS A TOUCH-SCREEN COMPUTER THAT PROVIDES RESEARCH OPPORTUNITIES AT STUDENTS' FINGERTIPS. IT ALLOWS THEM TO TRACK THE ENERGY USE OF THE SCHOOL.

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THE CENTERPOINT SCORE PROGRAM INCENTIVIZES ENERGY EFFICIENT MEASURES AND AWARDS SPRING ISD WITH A CHECK FOR THEIR EFFORTS TO REDUCE ENERGY USE IN THE DISTRICT.

ENERGY METERING SHOWS MARSHALL ELEMENTARY SCHOOL TRACKING TOWARDS SUCCESS! CHART COMPARING AVERAGE ENERGY COMSUPTION OF SEV-EN SIMILAR SIZED ELEMENTARY SCHOOLS IN THE DISTRICT. DATA TAKEN FROM AUGUST 2011 TO JANUARY 2012

MARSHALL ELEMENTARY SCHOOL EARNED LEED GOLD CERTIFICATION IN DECEMBER 2011 AND WAS DESIGNED TO EARN THE ENERGY STAR.

SUCCESS

If the success of an educational facility could be measured in smiles alone, Gloria Marshall Elementary School would be, by far, one of the most successful schools in the entire world! Community engagement might well be measured by parents asking if they can go down the slide again, in which case, Marshall Elementary is also amazingly successful. Success can be measured in many ways at a school facility; true collaboration and careful planning by an integrated design team, allowed Gloria Marshall Elementary School to succeed in many different areas.

After only five months of operation, numbers show that Marshall Elementary is soaring by tracking at 24 KBTU per square foot per year. This is almost 64% more efficient than the average KBTU per square foot per year of the last six elementary schools built in Spring ISD.

In addition, Marshall Elementary School's design process and product has had a significant influence on the design and operations of all of Spring ISD's facilities and is changing the face of "school design" in the south east Texas region. In December 2011, Marshall Elementary surpassed its goal of LEED Silver Certification and became the first public school in Houston to achieve LEED Gold Certification from the U.S. Green Building Council.

The school principal will tell you that her students excel, hands down, in collaboration and communication. The DAL approach is producing engaged learners who can speak effectively, as well as excel in student engagement and critical thinking in problem solving. All of these abilities are soft skills, and are the types of skills that are the number one thing that employers seek from graduating seniors. Employers want to know: if graduates can work in teams, if they can communicate effectively, and if they use critical thinking and creativity to solve problems.

ABOVE: LOW MAINTENANCE MATERIALS SELECTED FOR THE EXTERIOR, VIEW OF THE GABION WALLS NEXT TO THE STAIRS. BELOW: VIEW OF THE COMMONS SPACE, LIBRARY AND TREE HOUSE TO THE LEFT, ART AND MUSIC ROOM TO THE RIGHT.

With building integrated DAL curriculum, children take responsibility for their own learning. All students at Gloria Marshall Elementary School are encouraged to – and love to - DISCOVER in their learning.

DAL and Marshall Elementary students are making waves on all levels throughout the district. One of the biggest success stories is that the teachers at Marshall, (who also never call in sick) asked if they could start creating their own Discovery Approach lessons instead of using those created by the C&I department. The teachers are increasingly taking ownership and are genuinely enjoying time preparing lesson plans and teaching their students. Middle School principals in the Spring ISD system are seeking DAL knowledge from Marshall Elementary's principal and teachers so that they can be adequately prepared when Marshall Students move into 6th grade.

By incorporating an integrated design approach and engaging the district and end users in the entire process of planning, design and construction, Spring ISD was able to create a learning environment unlike any other. Heating and cooling systems rarely seen in the Houston area were discovered to be incredibly energy efficient. A twostory, rectangle plan can flood classrooms and central community spaces with an abundant amount of natural light. A unique curriculum was developed to empower critical thinkers and encourage effective communication skills and teamwork. It was a journey of discovery for everyone involved with Gloria Marshall Elementary School and the result was an incredible facility - the proverbial Tree House in the woods that is forever changing the lives of those who visit, those who teach there, and those who graduate from Gloria Marshall Elementary School.

THE EAST ENTRANCE AT EARLY EVENING AND ANOTHER VIEW OF THE "SOLSTICE WINDOWS" IN THE SECOND GRADE WING.

A JOURNEY OF DISCOVERY