DCM Exhibitions – Staff Training Materials

Patents Pending (PART B)

Exhibition Particulars:

- *Patents Pending* is designed as an active work space filled with multiple work tables and testing stations. Visitors work with different materials throughout the exhibition, ranging from paper plates to Lego wheels. The intention is for visitors to use these materials to create inventions *for the testing stations in the exhibition*, and that **these inventions remain in the exhibition after the visitor is done**. Various pieces are then "recycled" by other visitors. (Unlike *Young at Art*, this exhibition is not designed as a "make and take" exhibition. Staff needs to be aware of this difference and help visitors understand the nature of the space as well.)
- Keeping track of various **materials** and replenishing them where needed will be a critical job of staff in this exhibition.
- **Work Tables** – Visitors will cluster around hexagonal work tables that have sunken bins in the center for materials. Each work table is associated with a testing station or other challenge-driven activity and has accompanying graphics and/or labels. One will have materials and ideas for inventions that float. Another will have parts for making a quake-proof structure. Some will offer invitations for open-ended tinkering – *What can you make with these?*
- **Testing Stations** – Throughout *Patents Pending* are testing stations – "equipment" for evaluating the effectiveness of children's inventions: their performance, durability, distance traveled, etc. Some stations, such as the *Drop Zone*, *Air Power* and *Air Towers*, are for testing inventions children create at work tables. Other test stations combine construction and testing in one environment, such as the *Contraption Challenge*, which features open-ended mechanical cause-and-effect systems.

Component Descriptions:

Orientation Label

The orientation label for *Patents Pending* points out how inventions often go through several failure stages before success. Four examples are given:

1. **Chocolate-chip cookies**

   Chocolate-chip cookies were invented in 1930 by Ruth Wakefield at her Toll House in Whitman, Massachusetts. She was making chocolate-butter drop cookies—in a rush—and skipped the part of the recipe that asks you to melt the butter. Ruth figured the chocolate would melt as the cookies baked. She figured wrong, but everyone was pleasantly surprised with the results. (From the book: *Girls Think of Everything: Stories of Ingenious Inventions by Women*)

2. **Post-It notes**

   United States chemist Spencer Silver (b. 1941) was working for 3M and trying to make a regular adhesive when he accidentally stumbled on an adhesive that wasn't very strong. He couldn't think of any use for it- but then his colleague, Art Fry, came up with one. Art sang in the choir, and found that he needed bookmarks that wouldn't fall out of the music - a strip of Silver's adhesive was the answer. Eventually they came up with modern-day Post-it notes, which were unveiled in 1980. (From the book: *Smithsonian 1000 Inventions and Discoveries*)

3. **Silly Putty**
During WWII, the United States faced a rubber shortage, so the government contracted with General Electric to invent a synthetic rubber using silicone. At the same time, Dow Corning Corp. was also trying to invent a synthetic rubber. Both companies discovered that by adding boric acid to silicone oil, a new material was made: Silly Putty. They found it was similar to rubber- it would bounce off the floor when dropped. But it would not hold its shape when squeezed – so they had no use for it. They sent it around the world to scientists and engineers and no one had any use for it. Finally a toy store owner bought it and marketed it as “Nutty Putty,” later re-marketing it as “Silly Putty.” (From the book: *Young Inventors at Work: learning science by doing science*)

4. **X-rays**
German physicist Wilhelm Rontgen discovered X-rays in 1895 when he was investigating cathode rays. He noticed that when the tube was working, some crystals lying nearby glowed, even though the tube was shielded so that no light could escape from it. He determined that the cathode rays, hitting the glass of the tube, were producing other rays that made the crystals glow. Further experiments showed that the rays could pass through solid objects and affect photographic plates. This led him to make the first-ever X-ray picture. (From the book: *Smithsonian 1000 Inventions and Discoveries*)

A. Drop Zone

- Visitors invent objects that “perform” as they fall – fluttering, opening or twirling on their way down.

Drop Zone challenges visitors to begin an investigation of the principles of aerodynamics (lift, gravity force or weight, thrust and drag) that will be further explored at other components. Here at *Drop Zone*, visitors design and build a falling object that can meet a number of challenge criteria: *What can you do to increase the fall time? Can you add something to make it spin?* Children crank their assembly to the top of one of two Drop Towers. When it reaches the top, it begins its fall. If they wish, they can start a digital timer as their object begins its descent and measure the length of time it takes for it to reach the floor. Associated signage challenges visitors to test, rebuild and retest.

Drop Zone objects are constructed using a variety of materials including: foam sheets, fabric, pipe-cleaners, paper plates or other assorted materials found at Work Tables nearby.
Aerodynamics: *How is an airplane able to fly?* The answer is explained by the science called aerodynamics. This is the study of air in motion and the forces that act on solid surfaces moving through the air. The name aerodynamics is a combination of the Greek terms *aer*, meaning “air,” and *dynamis*, meaning “power.” It is the reaction of the air on the specially shaped wing, or airfoil, that lifts an airplane off the ground and supports it aloft.

[Source: http://kids.britannica.com/comptons/article-195997/airplane]

Principles of Aerodynamics: **Lift** is one of the four forces that act on an airplane. The others are **weight** (or gravity), **drag**, and **thrust**. Lift is an upward force that offsets the airplane's weight. Drag is air resistance to forward motion. Thrust produced by the power of an engine (or other source) counteracts drag.

[Source: http://kids.britannica.com/comptons/article-195998/airplane]

[http://www.cfinotebook.net/notebook/aerodynamics-and-performance/principles-of-flight]

Engagement Tools and Tips

- Use laminated Conversation Cards to facilitate an inquiry-based approach to learning.
- Use products from the retail store that correlate with the Patents Pending experience.
- Use open ended questions to promote the design engineering process. Example: Can you make an invention that spins (floats, drops, glides, etc.)? How can you accomplish that? Did your invention work the way you intended? What can you alter to improve the function of your invention?

B. Quake Proof

- Visitors try to construct earthquake-proof structures and initiate simulated "tremors" to test the structural integrity of their designs.

At *Quake Proof*, a round central platform (simulating the earth's crust) rests on a vibrating mechanism. The platform serves as the building surface for a construction challenge where children act as structural engineers: *What type of structure will best withstand an earthquake?*

Using CitiBlocs® precision-cut blocks, Lincoln Logs, foam cubes, and geometric connectors, children work to build, test and retest structures that can survive or partially survive a simulated earthquake. At any time during the activity, children press the "Quake It!" button to begin a timed vibration that simulates an earthquake's tremors.

Earthquake: The sudden shaking of the ground that occurs when masses of rock change position below Earth's surface is called an **earthquake**. The shifting masses send out shock waves that may be powerful enough to alter the surface, thrusting up cliffs and opening great cracks in the ground.

Most of the worst earthquakes are associated with changes in the shape of Earth's outermost shell, particularly the crust. These so-called tectonic earthquakes are generated by the rapid release of strain energy that is stored within the rocks of the crust, which on continents is about 22 miles (35 kilometers) thick. A small proportion of earthquakes are associated with human activity. Dynamite or atomic explosions, for example, can sometimes cause mild quakes.

The strongest and most destructive quakes are associated with ruptures of crust, which are known as faults. Although faults are present in most regions of the world, earthquakes are not associated with all of them. Pressures from within Earth strain the tectonic plates that make up the crust. The strain builds until suddenly the plates move along faults, thereby releasing energy. The plates slip and slide in opposite directions along this fracture in the rock, shaking the ground above. The masses may move up and down, sideways, or vertically and horizontally. On Earth's surface, displacement of the ground may vary from a few inches to many feet (or several centimeters to many meters). Some fault lines appear on the surface.

[Source: http://kids.britannica.com/comptons/article-199868/earthquake]

Building Practices: The most effective way to reduce the destructiveness of earthquakes is to design and construct buildings and other structures capable of withstanding strong shaking. When a site is proposed for the construction of an office building, for example, factors such as the geometry and frictional properties of a nearby fault line, the passage of seismic waves through surrounding subsurface rocks, and the condition of the soil and rocks that will be surrounding the building must be considered.

In many cases an accelerogram, a diagram showing the acceleration of, the velocity of, and the displacement caused by a simulated earthquake, is used to determine the viability of a site for safe building construction. In many countries, economic realities usually require that buildings are constructed not for the complete prevention of all damage, but to minimize damage from moderate earthquakes and to ensure no major collapse during the strongest earthquakes.

[Source: http://kids.britannica.com/comptons/article-199873/earthquake]

Engagement Tools and Tips:

- Use laminated Conversation Cards to facilitate an inquiry-based approach to learning.
- Use products from the retail store that correlate with the Patents Pending experience.
- Ask visitors to build a structure that could possibly survive an earthquake using materials provided at the exhibit table. Once the structure survives, encourage them to increase the length, width and height of their structure.
- Encourage visitors to work together to build a small city that will survive an earthquake.

C. Tinker Table/Challenge of the Day

- Visitors solve a daily challenge by building an invention to meet a specific goal.

At the *Tinker Table/Challenge of the Day* stations, Museum staff present visitors with a specific, changing challenge to be solved using a variety of construction materials.

Invent a machine that can lift the most dominoes.
Build a bridge from A to B.
Make a home for a family of 3" goats.

The challenge is written on a whiteboard that slides into the central bin. Materials such as dominoes, fabric, paper fasteners, or coffee stirrers are supplied for each unique challenge.

Engagement Tools and Tips:

- Use laminated Conversation Cards to facilitate an inquiry-based approach to learning.

- Use products from the retail store that correlate with the Patents Pending experience.
- Ask visitors how they can use the available materials to design an invention that meets the requirements of the challenge. Work together to build something new, or try to replicate a prototype that has already been made.

D. Air Towers

- Visitors build objects to launch in two Air Towers with different velocities of upward air currents.

At the *Air Towers,* visitors use an assortment of lightweight materials to construct objects that will float and soar. Material bins near the towers hold a variety of paper, foam, fabric and recycled materials to choose from, as well as safety scissors and tape to construct with. Children place their creations inside either of the two *Air Towers* and watch what happens as they encounter different velocities of air. Flying inventions launch up as they are blasted with strong currents of wind at the *Air Blast* tower. Alternatively—at the *Air Breeze* tower—flying inventions encounter softer, more gently flowing air—capable of keeping a strategically designed creation hovering above the surface. The applied principles of thrust, weight, and lift are keys to success at either tower. Associated signage challenges children to create objects that will float, fly, spin, etc. and encourages hypotheses about how the creations will respond when placed in the two different *Air Towers*.

Thrust is the force that drives an airplane forward and opposes drag. A propeller or a jet or rocket engine develops thrust. The power for moving a vehicle may also be furnished by a natural process such as wind or gravity.

Weight is the force of gravity acting on the airplane and its contents. The point where the total weight of the airplane is concentrated is the center of gravity. The loading of an airplane must be planned with care so that it will be in balance. The lift force must act on or very near the center of gravity if the airplane is to be level in flight.

[Source: http://kids.britannica.com/comptons/article-230863/airplane]

Factors affecting lift: Larger wings have more lift, as do wings with greater camber, or curvature. A long, narrow wing has more lift than a short, wide one because less of a swirl, or vortex, develops at the smaller tip to produce drag. The ratio between length, or span, and average chord width is aspect ratio. Wings with high aspect ratio are more efficient.

The faster the airplane flies, the greater is the lift. At higher speeds, the air travels faster around the wing, decreasing the pressure on the top surface and increasing the impact pressure on the lower surface.

[Source: http://kids.britannica.com/comptons/article-230862/airplane]

Intrepid Museum - Four Forces of Flight
https://www.youtube.com/watch?v=n8NeW6A-LR4

Engagement Tools and Tips:

- Use laminated Conversation Cards to facilitate an inquiry-based approach to learning.
- Use products from the retail store that correlate with the Patents Pending experience.
- Promote unique invention building by making some of your own. A whirly-gig, kite, parachute, or paper plane can serve as examples.
- Use simple pieces of paper to construct paper planes with visitors.

E. Air Power

- Visitors construct and test vehicles or whirligigs that use wind for power.

At *Air Power*, visitors investigate airflow by constructing objects to test with horizontally flowing currents of air. The *Air Power* activity challenges visitors to build upon Lego™ wheel bases to create vehicles that will sail across an air track. Children are encouraged to construct their vehicles for distance and/or speed, employing principles of physics such as acceleration, friction and mass. In addition, small holes drilled in the surface of the work table allow visitors to use straws and dowels as the base from which to design a wind-capturing machine (whirligig). Associated signage challenges children to investigate ways to improve upon the aerodynamics of their creations.

Acceleration is the rate at which the velocity of a body or object changes. According to Newton's second law, it is a direct result of the action of forces. For example, suppose that a car is moving in a straight line at 30 kilometers (19 miles) per hour at a certain second, and a second later it is going 34 kilometers (21 miles) per hour in the same direction. During that second, it has received an **acceleration** of 4 kilometers (2.5 miles) per hour per second. A change in speed can consist of slowing as well as speeding up. Many people call anything that reduces speed a deceleration.

[Source: http://kids.britannica.com/comptons/article-204449/mechanics]

Friction is a force that slows movement between objects that are rubbing against one another, such as air molecules and a falling ball.

[Source: http://kids.britannica.com/comptons/article-206533/physics]

Mass: In physics, mass refers to the amount of matter in an object. The standard unit of measurement for mass is the kilogram. Although the terms **mass** and **weight** are often used interchangeably, in science the terms have quite different meanings. The mass of an object remains constant, but its weight varies from place to place according to the strength of gravity. Thus, as a satellite moves away from Earth's gravitational pull, its weight decreases, but its mass stays the same. Mass is related to **inertia**, or the resistance of a body to a change in motion. The greater the mass of an object, the smaller the change produced by an applied force.

[Source: http://kids.britannica.com/comptons/article-9341219/mass]

Engagement Tools and Tips:

- Use laminated Conversation Cards to facilitate an inquiry-based approach to learning.

- Use products from the retail store that correlate with the Patents Pending experience.
- Encourage visitors to observe different material behaviors when influenced by air currents.
- Encourage visitors to create air driven vehicles to race across the surface of the exhibit.

F. Contraption Challenge

- Visitors design and build a gravity-operated ball run using an assortment of simple machines, gutters, loops and carriers.

At *Contraption Challenge,* children build and test unique mechanical cause-and-effect systems, ball runs, and other assorted inventions to move an object from START to FINISH. Gravity drives the movement of a golf ball as it drops from START and traverses the MouseTrap®-esque track to the FINISH. Along the way, visitors explore the nature of the forces that cause the ball to accelerate, discover what they can do to decrease resistance due to friction, or determine how they can create additional momentum.

Bin compartments contain an assortment of building materials that can be used on their own or combined to create simple devices. Visitors utilize simple machines (like inclined planes) to build a complex mechanism of their own creation. Scientific concepts such as kinetic and potential energy, work, momentum and transfer of energy are central to *Contraption Challenge*, and visitors apply these concepts as they configure the available materials to build a ball track that spans the 4-foot divide between the START and FINISH points.

Kinetic & Potential energy: **Kinetic energy** is the energy of motion. A speeding bus, a falling raindrop, and a spinning top have kinetic energy. Any moving object has this type of energy. **Potential energy** is the energy an object or system has because of the position of its parts. It is often thought of as "stored" energy (though it is important to remember that energy is not a substance). For example, a stretched spring has potential energy. **Force** has been applied to stretch the spring, creating stored energy. The more the spring is stretched from its normal position, the greater its capacity to do **work** when released. Likewise, a steel ball has more potential energy raised above the ground than it has after falling to Earth. In the raised position it is capable of doing more work because of the pull of gravity.

[Source: http://kids.britannica.com/comptons/article-300855/energy]

Momentum: A fundamental quality in dynamics is **momentum**. The momentum of a body or object is the product of the body's mass times its velocity.

[Source: http://kids.britannica.com/comptons/article-204449/mechanics]

Transfer of energy: A hammer uses mechanical energy to drive a nail into a board. When raised above the nail, the hammer has potential energy from the work done in lifting it. When the hammer is moved toward the nail, the potential energy becomes kinetic energy, which can do the work of driving the nail. Contact between the hammer and the nail **transfers energy** to the nail and then to the board.

[Source: http://kids.britannica.com/comptons/article-300856/energy]

Gravity: The first scientific studies of **gravity** were performed by the Italian astronomer Galileo at the end of the 16th century. Galileo measured the speed of falling objects by timing metal balls rolling down an inclined plane. He concluded that gravity imposes a constant acceleration on all objects. That is, with each second of fall an object acquires a constant additional downward velocity. On Earth this acceleration of gravity is 32 feet (9.75 meters) per second. Thus, at the end of one second, a falling object is moving at a velocity of 32 feet per second and at the end of two seconds, 64 feet (19.5 meters) per second, and so on, before any adjustment for the resistance of the air it passes through.

[Source: http://kids.britannica.com/comptons/article-201704/gravitation]

Engagement Tools and Tips:

- Use laminated Conversation Cards to facilitate an inquiry-based approach to learning.
- Use products from the retail store that correlate with the Patents Pending experience.
- Deploy multiple balls that vary in weight. Ask open ended questions regarding the relationship between the weight of the balls and the ease and speed of travel through the tracks.
- Encourage the use of different building materials to solve specific challenges.
- Build with visitors and work together to determine what your contraption needs to succeed in moving the ball from one end of the table to the other.

G. Track It!

- Visitors design and build race cars to test on different tracks, or design and build the race track itself.

A series of tracks with different configurations of dips and curves form the testing stations for custom-built vehicles at *Track It!*, a multi-user, multi-station raceway. The *Double Tracks* are two separate tracks with different characteristics: the first has a steady, steep upward grade and the other has two crests and a trough. There is also a 12-inch, changeable (by staff) insert in the track that highlights friction as a factor. *Change Your Tracks* is an additional raceway mounted to the nearby wall. Here, children build their own race track—shaping the position of a flexible track by manipulating a series of adjustable supports.

Children construct their vehicles at a nearby Work Table, either for a specific track or to test on all three. The *Double Tracks* allow children to compare the results of one vehicle on different tracks. Visitors are challenged to consider ways to make their vehicle more successful during the trial-and-error process of invention (e.g., *What happens when you make the vehicle heavier?*).

Engagement Tools and Tips:

- Use laminated Conversation Cards to facilitate an inquiry-based approach to learning.
- Use products from the retail store that correlate with the Patents Pending experience.

- Line the race tracks with pieces of fabric or other materials that will result in friction and alter the course of vehicles. Ask visitors to predict what will happen when they send their vehicles down the different tracks.
- Invite visitors to redesign their cars considering the results of their test run.
- Challenge visitors to a vehicle race.

H. Design a Vehicle

- Visitors take on the role of engineers at a factory, designing vehicles from available materials to meet “client” specifications.

Children use available parts to create a customized vehicle that best matches client needs, as outlined on table signage.

Sample client needs: *Sweet Tooth Candy Labs needs a rugged vehicle capable of traveling over land and swamp in a remote jungle area. The vehicle needs to be able to chop and transport large amounts of sugar cane.*

Engagement Tools and Tips:

- Use laminated Conversation Cards to facilitate an inquiry-based approach to learning.
- Use products from the retail store that correlate with the Patents Pending experience.
- Encourage visitors to reflect on why their vehicle designs resulted in different performance levels on the racetrack.
- Work with visitors to build vehicles that will perform on different terrains. Test the vehicles on different gallery surfaces.

I. Patent Office & Wheel of Ideas

- Visitors devise and diagram their own inventions and submit a patent application for consideration by the “Patent Office.”

The *Patent Office* encourages visitors to think about the inventive process. Children see other visitors’ patents on display, and can draft, devise and submit their own invention patents. Blank “Patent Application Forms” invite visitors to sketch their invention, describe what it does, highlight materials used, and list their name, age and email address. (Name, age and email are optional, and can be included if visitors want the Museum share information with them about upcoming programs.)

If visitors need some inspiration to get started, they can crank the *Wheel of Ideas* to identify a random pair of materials to start with and then design an invention that uses those two objects. Object possibilities include items such as a toy car, tape measure, pocket watch, net, tree branch, plate, beach ball, metal spring, hula hoop, table, telephone, chair, row boat, flower pot or wagon. The vertically mounted activity is a triplet of meshing gears, and does double duty as both an activity component and motion sculpture.

Engagement Tools and Tips:

- Use laminated Conversation Cards to facilitate an inquiry-based approach to learning.

- Use products from the retail store that correlate with the Patents Pending experience.
- Encourage visitors to share their ideas or inventions by submitting an application to the Patents Office.
- Encourage visitors to read patent applications to enhance their design thinking process.

J. Heroes of Invention & Invention Spotlights

These poster-like graphics are located near the *Patent Office* and spotlight key inventors and inventions. The people and inventions highlighted here will change over time. The following have been developed for the opening of the Museum:

<u>Heroes of Invention</u>

Leonardo
Leonardo da Vinci (1452-1519) was a great artist, academic *and* inventor! Leonardo is famous for his paintings (like the *Mona Lisa,* painted between 1503 and 1506), discoveries about human anatomy, astronomy, architecture, geography and flight. He developed plans for a flying machine 400 years before we even had the technology to build an airplane.

Thomas Edison
As a child, Thomas Edison (1847-1931) was always very curious about the world. It's been said that his teacher removed him from the classroom for asking too many questions. What his teachers didn't know was that Thomas would grow up to be a great inventor. Asking questions and thinking critically about the world around you is an important part of inventing new things for it.

Temple Grandin
Temple Grandin (b. 1947) is a successful inventor who became famous after the award-winning movie "Temple" told the world her story. Temple invented a new standard of uniquely humane cattle equipment. She is a Professor of Animal Science and is also autistic. People with autism don't experience the world in the usual way, and face challenges adapting to everyday life. Temple Grandin used these challenges to help herself become a great inventor.

Lonnie G. Johnson
Lonnie G. Johnson (b. 1949) is an engineer, inventor and former NASA rocket scientist. He is also the inventor of the world famous Super Soaker! Lonnie earned a fortune from sales of his wildly popular water toy, but he didn't stop there. He used that money to jumpstart more inventions–this time in the field of energy technology.

<u>Invention Spotlights</u>

Cell Phone
The invention of the mobile cellular telephone was a group effort. Hundreds of thinkers, tinkerers and scientists played a part. (Graphic in exhibition tracks cell phone innovations over a timeline.)

Elevator
In the 19th century, as very tall buildings became possible, builders needed a way to lift people and materials to the higher floors. That need led to the safe and reliable passenger elevator we know today. The first Otis Elevator Co. passenger elevator started service in 1857. The latest in 21st-century elevator technology is the vacuum elevator. It operates with air pressure and is more efficient than past models.

Sailboat
No one person in human history invented the sailboat, but people have been using wind to travel by water for thousands of years. Sailboats use pieces of fabric to catch the wind and direct its force to move the boat. The rudder, or keel, balances and steers the boat. The masts hold up the sails.

Parachute
Leonardo da Vinci's design from the year 1483 is the origin of the parachute, a device meant to slow down a fast-moving object by creating wind drag. The most important 20th-century parachute innovation was the quick-release mechanism called the "ripcord," used in a backpack-style parachute patented in the U.S. in 1914.

Engagement Tools and Tips:

- Use laminated Conversation Cards to facilitate an inquiry-based approach to learning.
- Use products from the retail store that correlate with the Patents Pending experience.
- Ask visitors to reflect on the Invention Spotlights, and discuss how their lives have been influenced by the inventions.
- Work with visitors to design an original invention to serve an immediate need in their lives.

K. Science Demo Area [Program Space]

There is a *Science Demo* area within *Patents Pending* for staff to use when facilitating educational programs with visitors about science topics. Programs are designed to augment, reinforce or complement concepts addressed in exhibit components. Key takeaways are tied to individual programs and addressed in program training materials. This space includes a monitor and lab-equipped table & storage. Bleacher seating is available for groups.

Engagement Tools and Tips:

- Use laminated Conversation Cards to facilitate an inquiry-based approach to learning.
- Use products from the retail store that correlate with the Patents Pending experience.
- Use Nano Kits to demonstrate how the science of nanotechnology is impacting our lives.
- Display inventions that have been left behind or created by team members. Allow visitors to test them in various parts of the gallery. Encourage visitors to design their own inventions based on their observations.
- Between facilitated programs, place themed programming signage and materials t in the *Science Demo* area, to encourage hands-on exploration.