Rose Float Design Course

Mariappan “Jawa” Jawaharlal
Associate Professor of Mechanical Engineering
California State Polytechnic University, Pomona, CA 91768

Abstract

Design competitions provide a rich learning experience by combining both theory and practice. More and more engineering schools are taking part in student competitions such as Formula SAE, Mini Baja and autonomous vehicle projects as a way to provide team-based, hands-on design experience to their students. These design competitions offer an excellent opportunity for students to reflect on the world around them and develop practical solutions.

Cal Poly Pomona and Cal Poly San Luis Obispo students have the unique opportunity to design and build a float for the Pasadena Rose Parade every year. They have been participating with their own float in the Pasadena Rose parade for over 40 years. The planning and building process of the rose float is a year long undertaking and requires serious engineering. Students from both campuses work in multi-disciplinary teams and focus on various fields such as electronics, engines, hydraulics, construction, animation control and administration.

To improve student design experience and increase their participation, a new course has been designed and offered in the spring of 2006 at Cal Poly Pomona. This new course has been structured to assist students with special focus on the design and development of mechanisms for float animation. Weekly team meetings were structured similar to an industry design review. A number of guest lectures on topics such as mechanism design, hydraulics, vibration and control, with focus on float design, were organized. A visit to a major, professional float builder was arranged. Student teams established specifications, developed concept designs, created computer models, performed engineering analysis, simulated mechanisms and constructed the float. This was the only student designed float that took part in the Pasadena Rose Parade on January 1, 2007 successfully along with floats built by commercial float builders. This paper will present the structure of the course, float design process and designed mechanisms.

Background

The Pasadena Tournament of Roses Parade, popularly known as the Rose Parade, is by far the most televised and most photographed single day annual event of its kind in the world.

The first Tournament of Roses was staged in 1890 by members of Pasadena's Valley Hunt Club, former residents of the East and Midwest eager to showcase their new homes’ mild winter weather. "*In New York, people are buried in snow," announced Professor Charles F. Holder at a Club meeting. "Here our flowers are blooming and our oranges are about to bear. Let's hold a festival to tell the world about our paradise.*"[1]

Because of this, the Parade has become internationally known as midwinter burst of color. The Parade has had a long history since its beginning in 1890 with horse and buggy units. The Pasadena Tournament of Roses Association (the administration), which now consists of about one thousand active volunteers, has administered the parade since 1895. Beginning January of each year, the float builders start the design and construction of their floats for the next year while making sure they observe stringent rules to ensure the safety and reliability of the Parade.

California State Polytechnic University, Pomona (Cal Poly Pomona) and California State Polytechnic University, San Luis Obispo (Cal Poly SLO) have been taking part in the Parade since 1949. Student Don Miller deserves credit for initially involving Cal Poly into the annual Pasadena Tournament of Roses Parade. At the end of the summer in 1948, the Pasadena Rose Parade Committee asked Don Miller[2] if Cal Poly could produce a float entry within ninety days. With a budget of $258 and less than ninety days, the first Cal Poly float (Fig. 1) took part in the Rose Parade.

Fig. 1 – 1949 Rocking Horse[3]
Courtesy Cal Poly Pomona Rose Float Collection

Year 2008 will mark the 60th entry of Cal Poly Universities. To this day, Cal Poly Universities' float is the only student built float in the tournament along with commercial float builders. As with the tournament itself, Cal Poly floats have come along way since its early days. New floats now involve serious design engineering and feature high-tech computerized animation and exotic flowers from around the world. To enhance and structure the students learning experience, a new Rose Float Design Animation focusing the design of animation system was developed and offered in the spring of 2006.

Float Design Process

Float construction starts with the preparation of preliminary design sketches. Below is the general sequence of operations from the beginning to end:

- Early January, the theme for parade is announced
- Concept development.
- Concept approval and development of details
- Animation system design: Parametric design. Estimate weights are calculated. Determine the best location for the driver and animation operators.
- Chassis Design: Cal Poly Universities use an existing chassis. The engine and transmission are installed.
- Complete detail designs and begin construction in summer. The steel supports and main framework for each character are fabricated and welded together. Animated portions are fabricated and welded separately, and the hydraulic components are installed. The individual pieces are welded in place on the chassis. The hydraulic and electrical systems are connected.
- Wire screen is cut and molded around the shape of the steel rods to form the outer skin of each part of the float. The screen is glued to the rods and sprayed with a special liquid that hardens to form a solid surface.
- Decorating the float: Flowers start arriving in late-December. Hundreds of students and volunteers begin the round-the-clock job of decorating the floats. Most flowers are glued in place. Delicate flowers are placed in narrow plastic vials filled with water before being secured in place. Each float requires an average of 10,000 lbs of flowers and takes thousands of man-hours to decorate.
- On New Year's Eve, the floats are towed from the construction sites to the parade staging area.
- The parade starts at sunrise on January 1. The parade route covers 5.5 mi and it takes about three hours for all the floats to pass the starting line. Over a million people line up the route, many of them having camped there all night to get good viewing spots.
- Parade ends. Many of the components used in the float are salvaged and reused to make next Year's floats. When the flowers start to wilt, the floats are taken back to the float design facility and dismantled. The steel structure is cut up and recycled, and the major components such as the engine, hydraulic cylinders, transmission, tires, wheels, and electronic equipment are removed and stored for next year’s use.

Float Concept Design and Artistic Rendering

Modern float design is a year long process involving a number of areas. At Cal Poly Universities, float design starts with a concept contest in January. The contest is open to students, faculty and the rest of the community on the two campuses of Cal Poly Pomona and Cal Poly SLO. After all the entries are submitted, six top concepts are selected and ordered from first choice to sixth and sent to the Tournament of Roses for approval. An artistic rendering of the concepts are also created.

Artistic rendering is, in essence, the representation of the float for the specific year. Fig. 2 shows the original concept design and Fig. 3 shows the artistic rendering of the sketch. The challenge is

now to design and construct the float that must match the rendering as close as possible with animations.

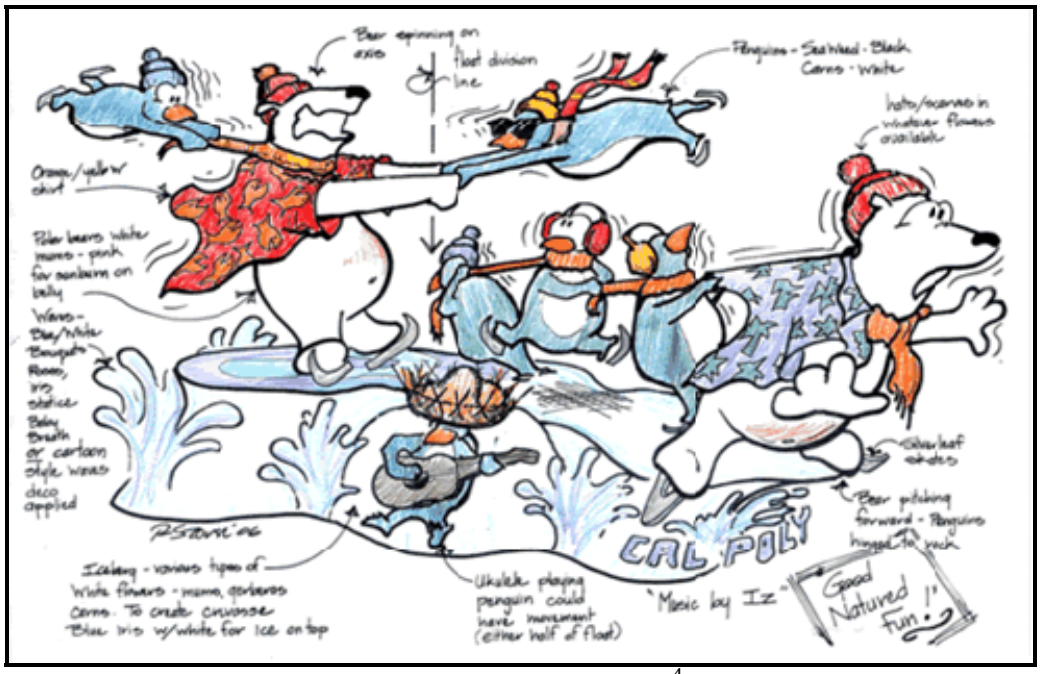

Fig. 2 – Concept Design[4]

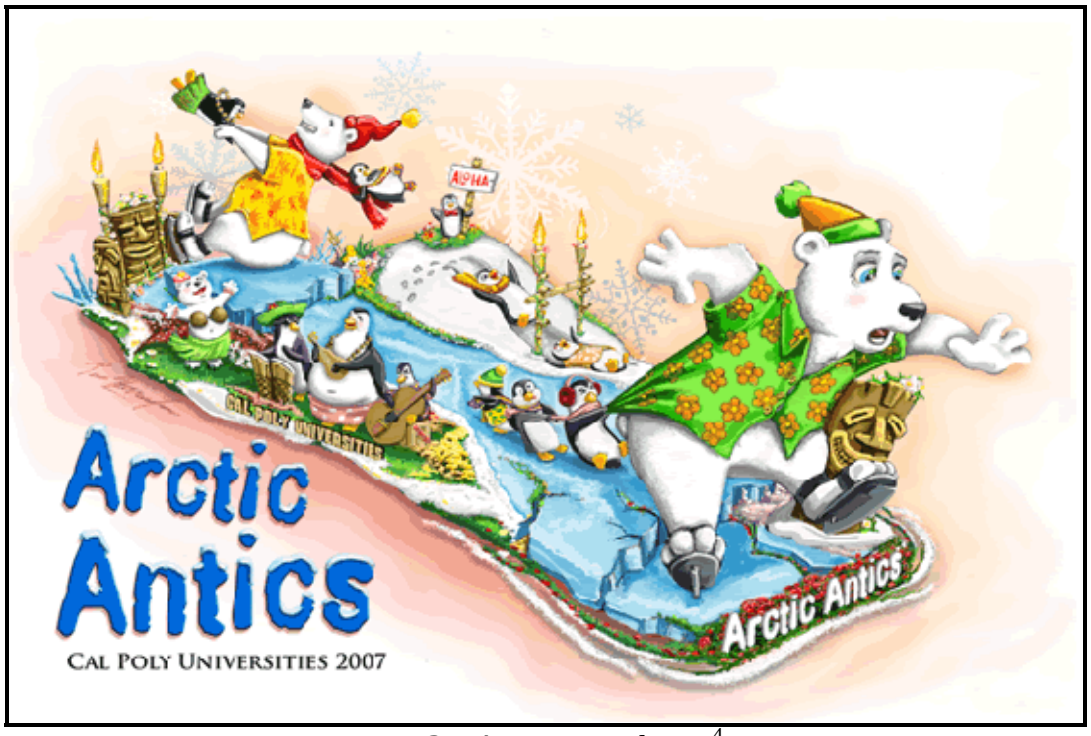

Fig. 3 – Artistic Rendering[4]

Design, Decoration, and Construction

Each float is an original piece of work combining creativity and engineering. After a design decision has been reached, officials from the two float committees meet in Santa Barbara to discuss the overall details of the float. Since the float is built in two halves, one on each campus, both sections must be carefully coordinated early in the process. Pomona is in charge of the float animation, and SLO is in charge of the float's drive system. Each campus has the same float frame components to work with every year, which are reshaped accordingly. Student teams from both campuses meet and plan every detail of the float.

Rose Float Design Course

Design and construction of Rose Float requires the involvement of several people. During the final phase, literally hundreds of volunteers from local community take active part in decorating the float. However, the design and actual construction of the float involves about fifty active students working over a period one year.

The Rose Float design course was offered in spring 2006 as a 2-units technical elective for mechanical engineering students. However students from other disciplines were allowed to enroll for general credit (not counted towards their graduation). Eighteen mechanical engineering students and 3 non-engineering students took the class.

The course was structured to assist students in the design and construction of Rose Float with special focus on the on the design and development of mechanisms for animation. The weekly meetings were structured similar to an industry engineering review. Students worked in teams and closely interacted with Rose Float committee members. The course was designed to help student teams to establish engineering specifications, develop several concept designs, identify the optimum concept for implementation, create CAD models, perform engineering analysis, simulate mechanisms, create part drawings, build mechanisms and complete integration with the system. All activities were to be completed under strict deadlines. The topical outline for this course is given below:

Week	**Topics** (Lecture – L; Activity – A)
1	Introduction & History (L) Understand the working structure of the Rose Float Program – Rose Float Committee, Club, Alumni Association, Cal Poly SLO and the class. Understanding of all major systems in the float (Rose Float Lab)
2	Identification of all mechanisms Team formation Frame – CAD Model Develop specifications – Decision matrix (L) Visit to Rose Float Lab – Introduction equipment and machinery available (A)
3	Concept designs and concept evaluation (A) Designing Linkage Mechanisms (L) Rose Float Lab – Using the equipment and machinery (Contd.)

4	Concept Design Review and concept Selection (A) Designing Linkage Mechanisms (L) Rose Float Lab/Computer Lab
5	Parametric/Detail design (A) Motion Animation (L) Rose Float Lab/Computer Lab
6	Detail design review (A) Hydraulic Machines - Guest Speaker Rose Float Lab/Computer Lab
7	Vibration - Guest Speaker Design review – (A) CAD Model Animation
8	Prototyping and Fabrication – TBD (L) Cardboard or erector set models of mechanisms Visit to one of the Professional Float Builder
9	Final design review Part drawings
10	Final report Model demo Presentation

Animation Systems

2007 Rose Float theme was playing in a winter wonderland. The characters of the float were polar bears and penguins. The animation system for the Cal Poly Pomona part of the float was divided into following sub-systems.

1. **Penguin Band**
    a. Ukulele strumming
    b. Bongos drumming
    c. Bass playing
    d. Band swaying together
2. **Bear Dancer**
    a. Hula bear "hula shake" swinging hips or rolling hips
3. **Penguin sliding down the hill**
4. **Big polar bear skater (in the front)**
5. **Baby penguin waving a sign**

Refer to Fig. 5 for various mechanisms and Fig. 6 and Fig.7 for scaled drawings of the entire float. A few of the mechanisms from the above list are discussed briefly below.

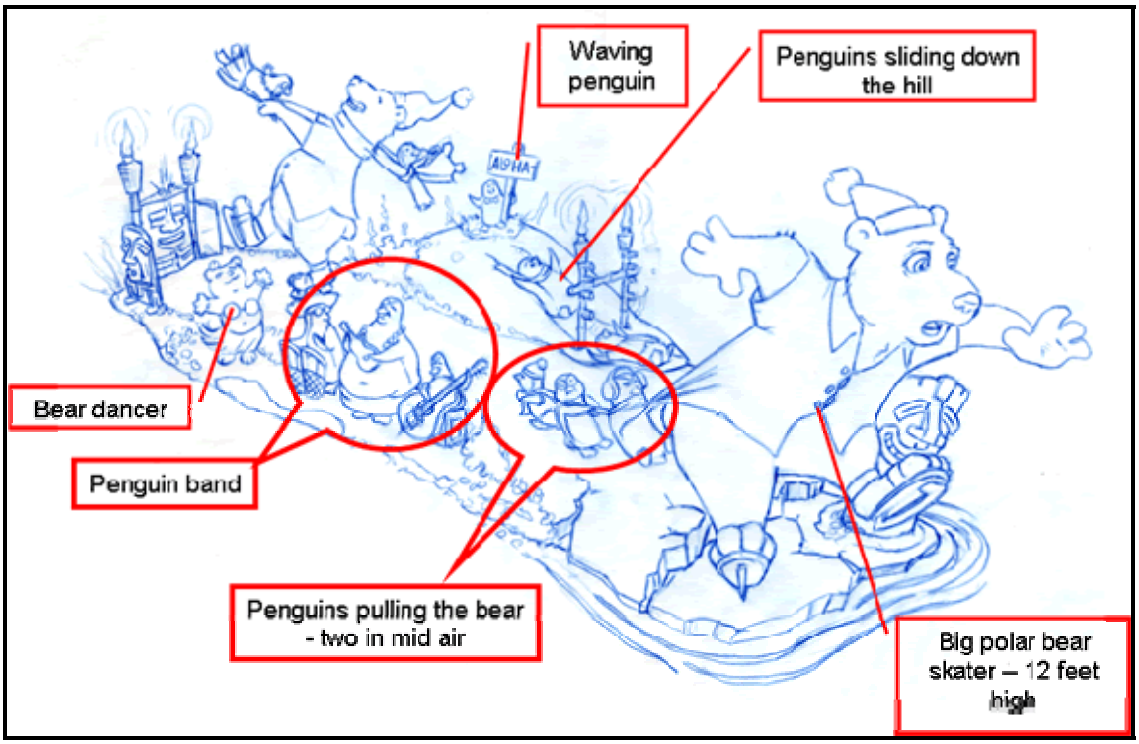

Fig 5 – Layout showing Animation Systems

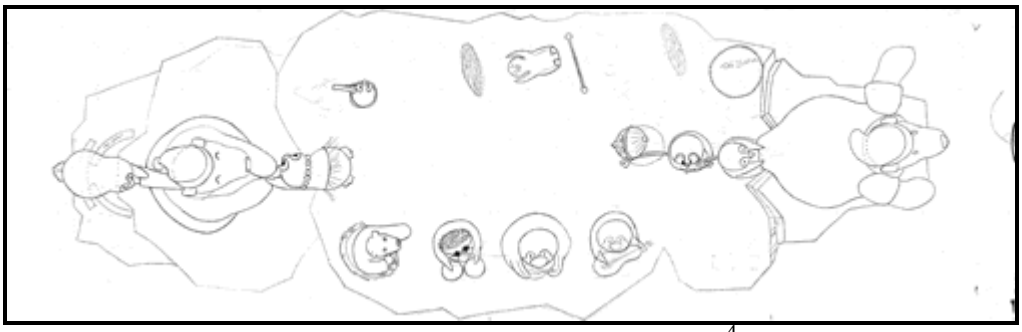

Fig 6 – Scaled Drawing Top View[4]

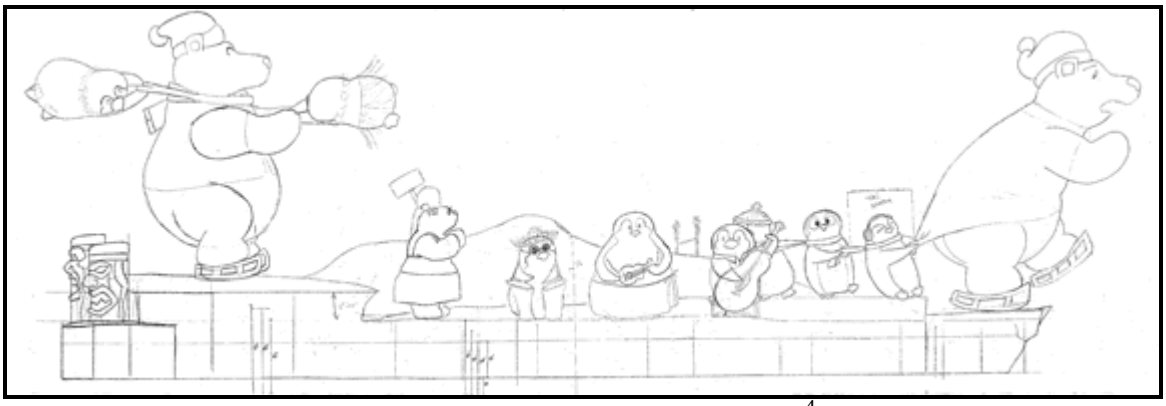

Fig. 7 – Scaled Drawing Side View[4]

Penguin Band – Ukulele Strummer

The penguin band includes a Ukulele strummer, drummer and bass player. Fig. 8 shows the selected concept design for the strummer. The strummer has two identical mechanisms to hit each drum. The drummer mechanisms must be small enough to fit into penguin's body. Fig. 9 shows the actual device built.

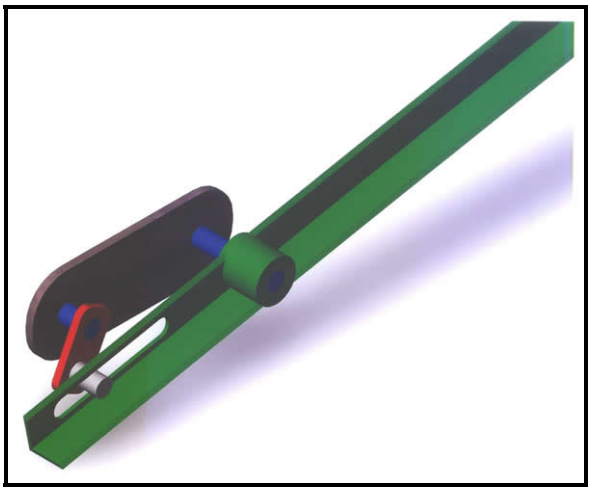

Fig. 8 - Concept Design for Penguin band mechanism[5]

Fig. 9 – Actual design that was built[5]

Penguin Limbo Mechanism (Penguin sliding down the hill)

The purpose of the mechanisms is to create a means capable of running a penguin down a hill and reloading it via mechanical procedure within a timely interval. The objective is to make it seem that the penguins are having fun in a party scene environment. There are several constraints associated with the design of this animation. The penguins must be able to slide down smoothly without binding. The mechanism must be capable of sliding a penguin that is about 3 feet tall, 18 inches "thick" and approximately 18 inches wide. Vibrations must be kept to a minimum to preserve the decorations materials. Fig. 10 shows the track and Fig. 11 shows the carriage assembly.

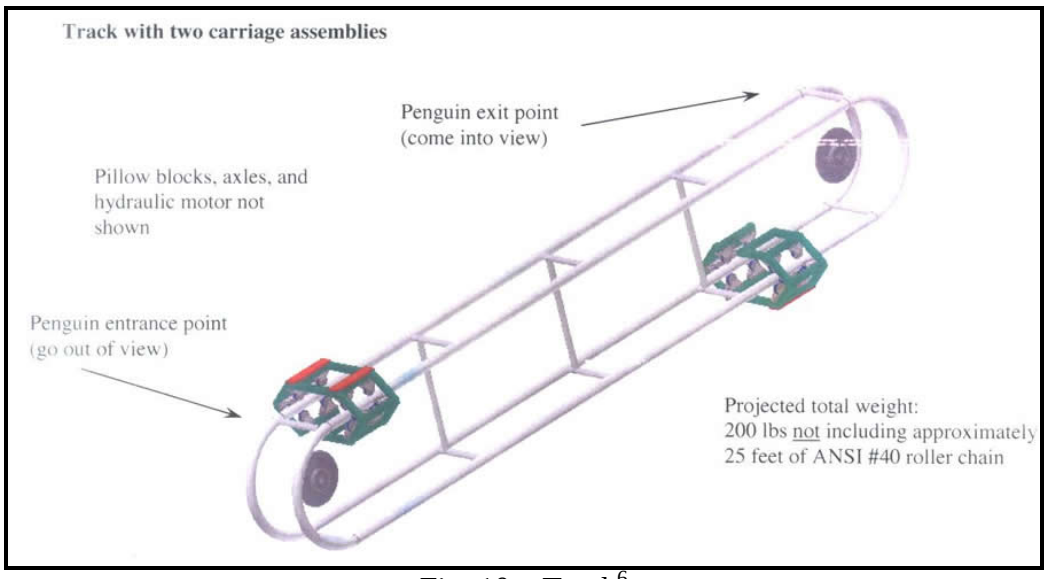

Fig. 10 – Track[6]

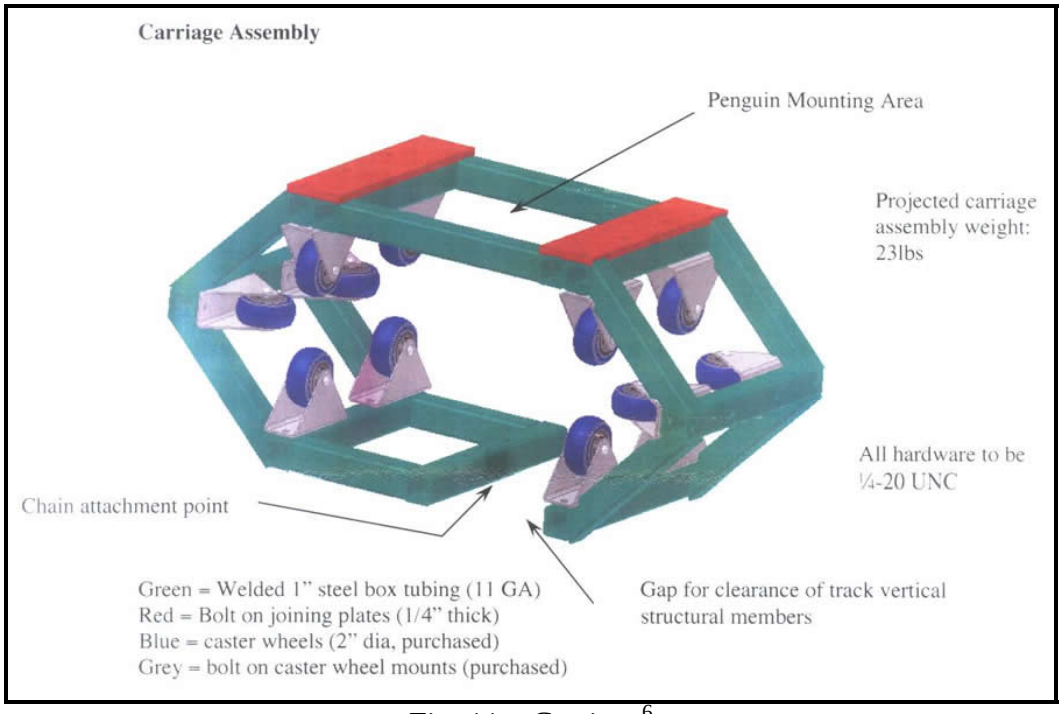

Fig. 11 – Carriage[6]

Big Polar Bear Skater

The centerpiece of the float was a 12 ft tall polar bear (Fig. 12) that was to look like it was falling through the ice. To keep from falling, it was to appear that three penguins were pulling the bear back from falling. This resulted in a type of rocker motion, with the polar bear rocking back and

forth. This rocking motion was to be achieved by hydraulic actuation; with the cylinder attached to the base of the foot of the bear. The space frame was needed to hold the components of the control system, and to hold the bear itself. It was the machine's frame and it had certain aesthetic requirements, as well as strength requirements.

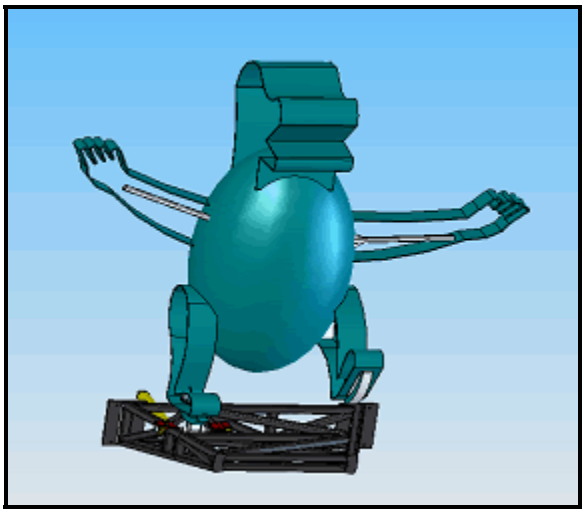

Fig. 12 - Conceptual design of bear with frame[7]

Power for the rocking motion is provided via a hydraulic cylinder. The weight of the polar was estimated to be around 1000 pounds. With the available 1200 – 1500 psi output hydraulic system, a 2 inch cylinder bore was considered sufficient.

The polar bear was designed to support the entire load on the right heel. In designing the structure of the polar bear, a ¼ pencil steel frame was used to shape the frame, which was welded together. A support beam in the center of the polar bear structure was approximately 8 feet in height. Welded at the bottom of the center beam were two beams approximately 2 feet in length that were welded to each of the legs of the polar bear. The distance between the polar bear and the third penguin was 10 feet.

A space frame to support the polar bear was designed. Fig.13 shows the CAD model of the frame. Fig. 14 shows the actual frame that was fabricated.

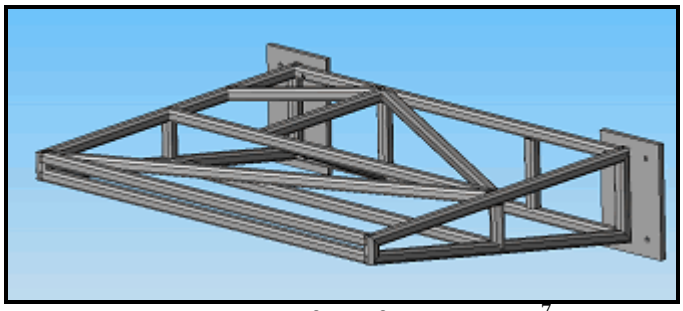

Fig. 13 - The final frame design[7]

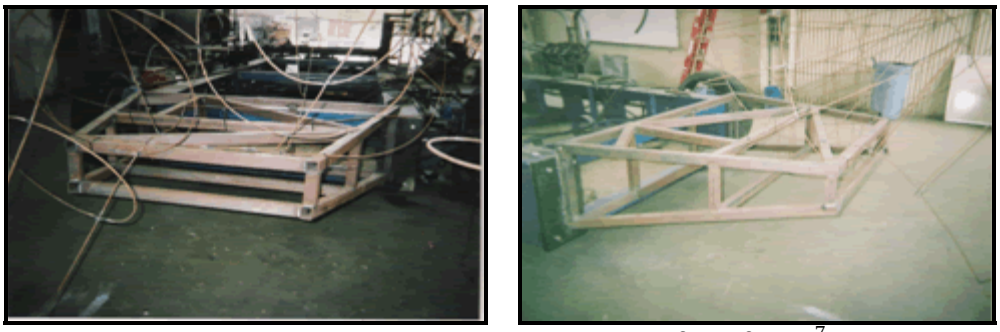

Fig. 14 - Front and an isometric view of the frame[7]

Once all the mechanisms were designed and integrated, the float was decorated. Fig. 15 shows the picture of actual float taking part in the Rose Parade. It is extremely important at this point for all involved in the design to compare the functional float to the rendering created early on which represented the essence of the float.

Fig. 15 – Cal Poly Universities Float taking part in the Rose Parade, 2007

Summary

The creation of a functional float requires the collective efforts of designers, graphics designers, artists, engineers, fabricators and many others. The management of this entire process stretching over a year is a serious undertaking requiring multidisciplinary student teams. Rose Float Design course primarily focused on the design of mechanisms for animations. After the course, students

continue to work and spent hundreds of hours in summer and fall focusing on the construction. The course has helped students to learn and do engineering in a more structure environment, complete the design on time, eliminate costly manufacturing errors and delay in the schedule.

References

1. The Pasadena Tournament of Roses Parade website, http://www.tournamentofroses.com
2. History of Rose Float, http://www.csupomona.edu/~library/specialcollections/rosefloat/
3. Cal Poly Rose Float Collection, http://www.csupomona.edu/~library/specialcollections/rosefloat/rosefloat02/index.html
4. Jennifer Woo, 2006, Project Report, Rose Float Animation Course
5. Michael Aldridge and Nichole Dimassa, 2006, Project Report, Rose Float Animation Course
6. David Black and Tyson Diaz-Lapham, 2006, Project Report, Rose Float Animation Course
7. Ron Diet, Project Report, 2006, Rose Float Animation Course