What's going on over there?

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Video demonstration:  http://www.youtube.com/watch?v=8__AyQK32Lk

Abstract:

In this project, we propose an interactive sculpture to be installed in front of Clemson's Cooper library, in the square, open area between main bridge and the bridges to the entrance and exit. Clemson University is comprised of several colleges located in isolated areas on campus. Because of the location in the heart of campus and ecumenical nature of the library, it serves as a campus hub where students from all the colleges gather and study. The sculpture indicates the activity and energy flow around and in the library, giving students the opportunity to engage in the activities by indicating their location.

The sculpture is designed to register the flow of traffic in three locations: the 5th floor tutoring area, the Java City coffee shop, the library bridge.

Across the serious backdrop of the library, the structure is designed to be funny and quirky. It has a large, spring-enforced pointer suspended in the middle of the top ring of the structure that will swing in the direction of the area having the largest number of people.

Scenario:

Scenario 1- Daily Routine:

Jennifer heads to campus early in the morning before her first class. She notices that the sculpture is leaning towards the Java City coffee shop. She realizes that if Java City is the area of highest activity around the library that there will probably be a long line. She checks the time to be sure she will be able to make it to class, decides she has time for coffee and heads into the library.

Scenario 2- iRave:

As Joe walks around campus he hears noise and notices the library sculpture shift towards the bridge. He decides to head to the bridge to see what is going on and is able to catch the beginning of Clemson's annual iRave, a tradition during exam week in December.

Scenario 3- Exam week.

Exam week is about to start and Joe and Jennifer are heading to the library to study at midnight on a Sunday. They expect the sculpture to be relatively still given that it is late at night, but instead the sculpture is bouncing from left to right indicating the tutoring area and Java City area. Curious why there is activity in the library this time of night, they head up to the 5th floor and discover that dozens of students are in the middle of the "silent rave" a new Clemson tradition during exam week.

Ideation:
The initial idea was to have a sculpture that would respond to the movement of the people around it, such that some inference might be drawn from its action. We observed the people in and around the library and noticed the following aspects regarding the movement of the student population:

- In the mornings, people rush in to finish their work. The people moving into the library in large numbers.
- Typically as the clock strikes the hour or half hour past, the students rush off to their classes and simultaneously new students come in. In such cases there are also a lot of people rushing off to classes in either direction over the library bridge. During this time, number of people over the library bridge very high.
- At around 3pm, there is a surge of people at the Java City coffee shop getting their caffeine to get enough energy for the rest of the day.
- In the evening, the number of people coming to work on assignments and to work with tutors increases and hence, the tutoring section has greater occupancy.
- The library is the site new Clemson traditions such as iRave and midweek music that draw people into the library.

**Structure:**

The inspiration of this structure was drawn from several ideas with similar facets. We were intrigued by the idea of balance of life, and how over work/play/frenzy can tip this delicate balance. Therefore, the thought was to design a structure that would tip onto the side when, there were a lot of people around working, to indicate imbalance of “All work and no play”. The figure below was the preliminary design for this idea.

![Initial ideation sketch.](image)

From that, came the idea of indicating the traffic flowing different parts of the library. The structure was modified slightly, to tip in the direction of high traffic. The modification was to have a pointer that would swing towards the direction having the largest density of population detected. The inspiration for the pointer was derived from the ‘Time Piece’ sculpture in London. The top circular region was also modified to be a ring along with the pointer, in fashion of the sculpture shown in Fig.
Fig. 2: ‘Time Piece sculpture’ located on the north bank of the Thames near St. Katherine’s Dock, London. It was designed by Wendy Taylor and installed in 1973.

Based on the observations made in the library, we decided upon three areas that could be helpful to make a guess at what the major chunk of population was doing, by the area they were in: the 5th floor tutoring area, the Java City coffee shop and the library bridge. The tutoring section is an area that typically becomes crowded in the evenings. The students in this area tend to stay here for long periods of time. Java City tends to be crowded in the mornings and afternoons as students come in for their coffee. The library bridge is busiest between classes as students walk across the bridge from one side of campus to the other and into and out of the library.

The structure has three limbs supporting and held together by a ring at the top. This ring along with the wires has been used to anchor the pointer. In order to make the structure stable, in addition to the 3 supporting wires anchored by the ring, as in the Time Piece sculpture, we also had to add three supporting wires anchored to the limbs, in order to restrict the degrees of freedom the limbs had and to keep the structure stable. The principle of tensegrity in sculptures has been applied here (inadvertently).

Fig. 3: www.picasaweb.google.com/devsuroop9
Mechanics and sensing:

The three limbs of the structure are actuated by servo motors. These motors have been attached to the limbs at an angle such that the structure also swivels during the movement, giving it a more aesthetic and lifelike movement. Hinge joints have been used to attach the motor shaft to the limb and universal joints for attaching the limbs to the ring.

Initially, the motors rest at an angle, orienting the structure to a balanced, neutral position. IR sensors (SHARP GP2D12) installed in the three locations calculate the distance to the nearest surface (Range: 10-80 centimeters). Setting a range for the appropriate detection criterion, the count of people passing by, detected in a suitable time interval is monitored for each of the IR sensor by microcontroller AT-128 in the Arduino Duemilanove board which polls and keeps the count. The counts are compared and the sculpture tilts towards the direction having the highest density, by the motor of the limb facing that direction going forward and the other two motors remaining or moving to neutral position, thus creating a tilt in the desired direction. The tipping motion causes the pointer to swing in the direction of the tilt.

Equipment used:
- 3 motors
- 3 IR sensors
- 1 Arduino Duemilanove board
- Laptop USB port for power supply
- 3 U-joints from RC car half shafts
- 3 Brass rods
- 3 wooden rods for limb-actuator attachment
- 3 wooden supports
- Hollow cable enforced with spring
- 3 air-plane model elbow joints
Pictures:

Fig. 5: Sculpture during development

Fig. 6: Sculpture during late development
Fig. 7: Finalized sculpture from perspective angle

**Code:**

```c
#include <Servo.h>
#include <Wire.h>

int IR1=0;
int IR2=1;
int IR3=2;
Servo servo1;
Servo servo2;
Servo servo3;
int count1=0;
int count2=0;
int count3=0;
int pos1=160;
int pos2=80;
int pos3=90;
void setup()
{
    Serial.begin(9600);
    servo1.attach(9);
}
```
servo2.attach(10);
servo3.attach(11);
servo1.write(pos1);
servo2.write(pos2);
servo3.write(pos3);
delay(100.00);
}

void loop()
{
  for (int i=0;i<50;i++)
  {
    float volts1 = analogRead(IR1)*0.0048828125;
    float dist1 = 65*pow(volts1, -1.10);
    float volts2 = analogRead(IR2)*0.0048828125;
    float dist2 = 65*pow(volts2, -1.10);
    float volts3 = analogRead(IR3)*0.0048828125;
    float dist3 = 65*pow(volts3, -1.10);
    Serial.print(dist1);
    Serial.println("cms");
    Serial.print(dist2);
    Serial.println("cms");
    Serial.print(dist3);
    Serial.println("cms");
    delay(25);
    if(20<dist1 && dist1<100)
    {
      count1 = count1+1;
    }
    if(20<dist2 && dist2<100)
    {
      count2 = count2+1;
    }
    if(20<dist3 && dist3<100)
{ 
    count3 = count3+1;
}

Serial.println("Count1=");
Serial.print(count1);
Serial.println("Count2=");
Serial.print(count2);
Serial.println("Count3=");
Serial.print(count3);

  //count is greater and move motors
int pos, poss, posss;
if (count1>count2 && count1>count3)
{
    Serial.println("Count1 greater");
    for(pos = pos1; pos > 110; pos -= 10) // goes from 0 degrees to 180 degrees
    { 
        servo1.write(pos);       // tell servo to go to position in variable 'pos'
        delay(100);              // waits 15ms for the servo to reach the position
    }
    pos1= pos;
    for(poss = pos2; poss<80; poss+=5) // goes from 180 degrees to 0 degrees
    {
        servo2.write(poss);       // tell servo to go to position in variable 'pos'
        delay(100);               // waits 15ms for the servo to reach the position
    }
    pos2=poss;
    for(posss = pos3; posss>90; posss-=5) // goes from 180 degrees to 0 degrees
    {
        servo3.write(posss);      // tell servo to go to position in variable 'pos'
        delay(100);               // waits 15ms for the servo to reach the position
    }
    pos3=posss;
}
/****** count 2 greater move motors
if (count2>count1 && count2>count3)
{
    Serial.println("Count2 greater");
    for(pos =pos2; pos>30; pos -= 10) // goes from 0 degrees to 180 degrees
    {
        // in steps of 1 degree
        servo2.write(pos);       // tell servo to go to position in variable 'pos'
        delay(100);              // waits 15ms for the servo to reach the position
    }
    pos2 = pos;
for(pos = pos1; pos<160; poss+=5)  // goes from 180 degrees to 0 degrees
{
    servo1.write(poss);        // tell servo to go to position in variable 'poss'
    delay(100);                // waits 15ms for the servo to reach the position
}
pos1 = poss;
for(poss = poss3; poss>90; poss-=5) // goes from 180 degrees to 0 degrees
{
    servo3.write(poss);       // tell servo to go to position in variable 'poss'
    delay(100);              // waits 15ms for the servo to reach the position
}
pos3 = posss;
}  

/////For count3 greater move motors
if (count3>count2 && count3>count1)
{
    Serial.println("Count3 greater");
    for(pos =pos3; pos<140; pos += 10) // goes from 0 degrees to 180 degrees
    {
        // in steps of 1 degree
        servo3.write(pos);       // tell servo to go to position in variable 'pos'
        delay(100);              // waits 15ms for the servo to reach the position
    }
    pos3 = pos;
for(pos = pos2; pos<80; poss+=5)  // goes from 180 degrees to 0 degrees
{  
servo2.write(poss); // tell servo to go to position in variable 'pos'
  delay(100); // waits 15ms for the servo to reach the position
}

pos2=poss;
for(poss = pos1; poss<160; poss+=5) // goes from 180 degrees to 0 degrees
{
  servo1.write(poss); // tell servo to go to position in variable 'pos'
  delay(100); // waits 15ms for the servo to reach the position
}

pos1=posss;
}

**Conclusion:**

The sculpture went through several iterations to ensure structural integrity. While the weight and strain placed on the servos was an initial concern, the use of lightweight materials made the structure feasible. The IR sensors are an adequate way to do the sensing for this project. However, the sensors are very sensitive and easily pick up noise. Other sensors should be considered that can sense movement more reliably. Overall, the sculpture would be an intriguing and quirky addition to the campus. It would add engagement and aesthetic appeal in an area that lacks character.