

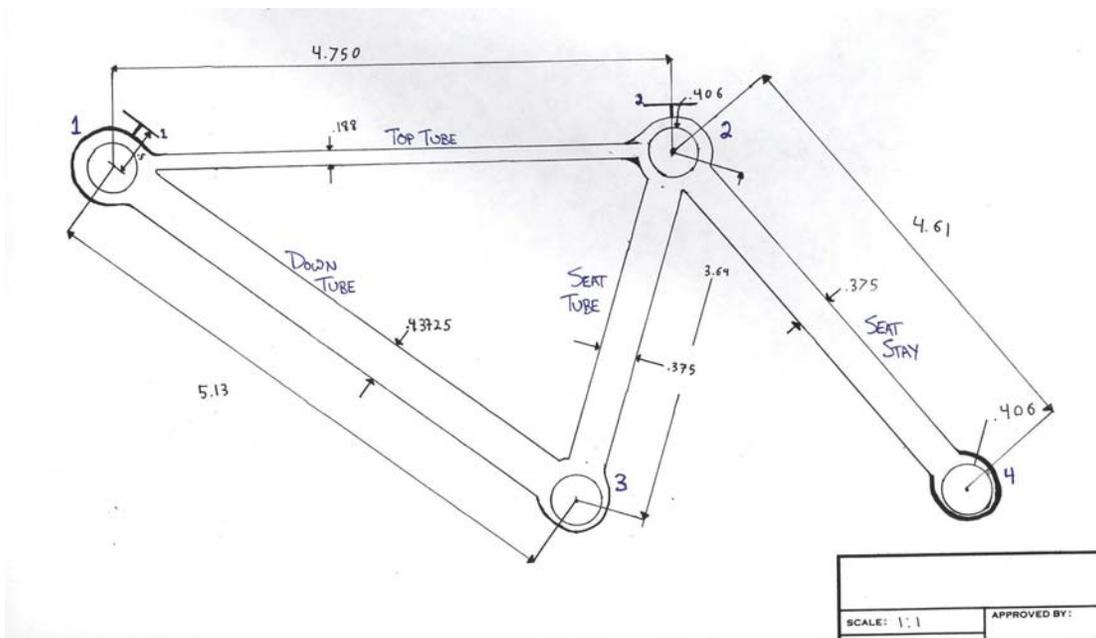
# The VeloCITY (City Bike Design)

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The **Group 4** design team's challenge is to develop a mass-marketable consumer city bike that respects its market's important product characteristics. Foremost, the bike design should be optimized to meet a cost requirement of \$4.2/part. Once this threshold is met, the VeloCITY should be optimized to first better performance and second minimize mass.

The VeloCITY's frame is made out of 6061 Aluminum that is machined from a .25" plate stock. The design is primarily a truss-structure, with 4 beams connecting 4 cylindrical axes (in 2-D, this is 4 solid rectangles connecting 4 hollowed circles – refer to Figure 1 for the 2-D design). The two bottom cylindrical axes (circles 3 & 4 in Figure 1) are fixed in translation (in the 2-D plane), and the two top cylindrical axes (circles 1 & 2) have loads exerted on them in the 2-D plane as shown in Figure 1.

Beams 3 & 4 (seat tube and seat stay) must be designed to be relatively sturdy structurally (their width in 2-D is much wider than Beam 1, the top tube, and very close to Beam 2, the down tube) as they are the principal vertical supports for the load on axis 2. The vertical performance specification measured near axis 2 is very tight compared to the other displacement specification – so prioritizing to support this load is paramount to a successful design.



Beam 1 (top tube) is designed much narrower than Beam 2 (down tube) since it principally supports only the horizontal load at axis 1, which is smaller than the vertical loads at axes 1 and 2; Beam 2, oriented roughly at a 45-degree angle must support both the horizontal and vertical loads at axis 1.

A fifth beam could be added between axes 3 & 4 in order to complete the truss structure, but the design team determined this beam is not necessary since it would connect two

axes which are both fixed in translation (in the 2-D plane), and rotation is not predicted to be a significant impact on the design structure.

Two small laser displacement sensor tabs were placed above axes 1 & 2. Since these tabs need to support no load, these tabs were designed with as little material as possible.

An initial finite element analysis (using COSMOS) of the VeloCITY design determined that under the applied loads, displacement tab 1 is displaced .03mm in the negative x direction and .015 in the negative y directions, for a total diagonal displacement of 0.032mm ( $\sqrt{.03^2 + .015^2} = .032$ ), meeting the requirement of under 0.071mm. Displacement tab 2 is displaced .010 mm in the negative y direction, meeting the requirement of under 0.011mm. The first natural frequency of this design was determined to be 314 Hz, meeting the requirement of being greater than 245 Hz. Finally, the mass is 0.15 lbs, also meeting the requirement of being under 0.18 lbs.

Therefore, a finite element analysis predicts that the VeloCITY should meet all the necessary requirements for a city bike except possibly cost (so far unknown).

**Summary of Results:**

Cost	?	$\leq \$4.2/\text{part}$
Displacement 1	0.032mm	$\leq 0.071\text{mm}$
Displacement 2	0.010mm	$\leq 0.011\text{mm}$
First natural frequency	314Hz	$\geq 245\text{Hz}$
Mass	0.15lbs	$\leq 0.18\text{lbs}$