INTRODUCTION
The stability of transfemoral amputees is a key factor in the prevention of falls (Schmid, 2005). Difficult movements, such as standing, are likely to result in instability. This study shows the difference in instability between healthy control subjects, and prosthesis users based on knee type (C-Leg, Mauch, and Power Knee). The level of instability (LoI S) during standing, and the time to reach high, and low levels of instability, were calculated and are presented for each group. The LoI S measure used in this study was designed to incorporate both sway and cardiac activity, and to quantify instability at any instance in time. Previous methods measured stability by measuring sway via center of pressure or cardiac activity by vertical ground reaction force (Karlsson, 2000). Improved stance stability has been observed under conditions where sway path and sway area were reduced (Tarantola, 1997).

METHOD
Subjects: Twenty subjects (5 from each knee type), 18 male, 2 female. Of the 15 amputee subjects 12 are functional level (K-Level) K3, and 3 subjects are K4. Subjects were required to have 3 seconds of standing without taking a step after the standing peak (SP), defined by instance of maximum total vertical ground reaction force, which occurs during the transition from sit to stand.

Apparatus: Two AMTI (Watertown, MA) force plates.

Procedures: Data trials of subjects standing with one foot on each force plate were recorded. Each subject was asked to stand from a platform adjusted to a height where the initial knee flexion was 90°. Three trials were completed for each subject.

Data Analysis: The LoI S was defined as the sum of the variation of vertical ground reaction force (Fz), with respect to time, for the left and right side (Eq. 1).

\[ \text{LoI S} = \frac{\text{abs} \left( \frac{d}{dt} (Fz_{\text{left}}) \right) + \text{abs} \left( \frac{d}{dt} (Fz_{\text{right}}) \right)}{\text{Body Weight}} \]

(Eq. 1)

Standing LoI S was defined as the maximum LoI S of the last second of each trial. This is a measure of instability during normal standing for each subject. Averages of standing LoI S were then calculated for each group. Stability thresholds ST1, and ST2 of 1.50, and 0.85sec⁻¹ were selected based on the average standing LoI S values, which represent high and low LoI S. The ST2 is the lowest LoI S achieved by approximately 99% of the subjects, which only excludes one trial of one subject. ST1 is a moderate level of instability based on initial observation of subjects.

Time to stability was calculated from SP to the stability thresholds, ST1 and ST2. The LoI S must remain below the threshold for at least one second to be considered stable. Since instability is inversely related to stability, the high instability (ST1) threshold is the low stability threshold.

The average of the three trials was taken for each subject and used to calculate the group averages and the statistics. A one way ANOVA was conducted to determine if there were differences between group means.

RESULTS
The average standing LoI S, time required to reach the stability thresholds ST1 & ST2, and age are shown in table 1 for each subject group.

<table>
<thead>
<tr>
<th></th>
<th>STANDING LOIS (SEC⁻¹)</th>
<th>ST1 (SEC)</th>
<th>ST2 (SEC)</th>
<th>AGE YEARS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.14(±0.02)</td>
<td>0.28(±0.30)</td>
<td>0.81(±0.37)</td>
<td>24(±5)</td>
</tr>
<tr>
<td>Mauch</td>
<td>0.29(±0.14)</td>
<td>1.16(±0.46)</td>
<td>1.99(±0.97)</td>
<td>41(±14)</td>
</tr>
<tr>
<td>C-Leg</td>
<td>0.26(±0.27)</td>
<td>1.30(±0.52)</td>
<td>1.53(±0.36)</td>
<td>49(±21)</td>
</tr>
<tr>
<td>Power</td>
<td>0.23(±0.18)</td>
<td>0.70(±0.28)</td>
<td>1.13(±0.28)</td>
<td>39(±12)</td>
</tr>
</tbody>
</table>

Table 1: Standing LoI S, time to stability levels ST1 & ST2. AVG(±S.D.), and group average age. [ Denotes significant difference (p-value < 0.05).

DISCUSSION
It was found that the controls reached the ST1 levels significantly faster than the Mauch and C-Leg groups, and the ST2 level faster than the Mauch group. No significant differences were observed between the knee types and controls for standing stability. Due to the potential correlation between age and stability, it is possible that the results are influenced by the difference in subject age.

CONCLUSION
A significant correlation between the microprocessor knees studied and stability after standing was not found. Control subjects were able to reach a stable stance significantly faster than the Mauch and C-Leg groups. Further research to better determine dependence on functional level and age is needed.

REFERENCES