This document is intended to provide more information for developing evaluation criteria and evaluating concepts.

2(+) - wheel concepts:

Trade-off → wheel width vs trail width

* Research the relative importance of these two things.
* What’s the minimum trail width that we would expect?
* What’s the quantified mechanical advantage of adding a wheel for stability? How much moment do Sherpa’s currently apply to balance the TrailRider? How would adding a wheel or two change this?

Trade-off → Less volunteers vs difficulty of possible trails

* Research what kinds of inclines are expected to be encountered on regular slopes, such as Pacific Spirit Park, Stanley Park and Jericho Beach
  + Call parks staff, go measure some slopes in PSP/Jericho beach ourselves
  + Estimate, slope

Trade-off → Device complexity vs user independence

* Speak to more clients about the need for independence. Get more insight into how important it is. Maybe just get some info from forums.
* Estimate the max power that could be added from a user with each design

Evaluation criteria brainstorming:

* *Stability in the x-axis*
* *Number of sherpas required*
* *Diversity of possible trails*
* Device complexity
* *User independence*
* Cost

Patent Links

<http://brevets-patents.ic.gc.ca/opic-cipo/cpd/eng/patent/2371409/summary.html?query=%28lever-drive+system%29+AND+inventor-country%3A%28CA%29&type=advanced_search>

Expiry date: “ then the term is 17 years from the issued date or 20 years from the filing date, whichever term expires later.” Taken from <http://www.ic.gc.ca/opic-cipo/cpd/eng/help/content/help_general_information.html>

**Hand-rim propulsion vs hand pedal propulsion**

<https://www.rug.nl/staff/l.h.v.van.der.woude/120420ursinathesis.pdf>

* Factors that affect efficiency: sitting position, trunk inclination, crank position, moment arm, gear ratio, propulsion mechanism, propulsion characteristics
* Hand pedals more efficient and less straining over long distance
* Synchronous more efficient and less straining than asynchronous.
* Rider position remains fairly constant on inclines with handbike, but changes with hand-rim propulsion
* 30-57% of the propulsion cycle can be used for power production in handrim wheelchair propulsion but the entire 360 degrees of hand cycle can be used for propulsion

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1332474/pdf/brjsmed00001-0049.pdf>

* The power output of an arm crank (hand pedals) was measured against a manual wheelchair. Page 42 shows the direct comparison of power output and the discussion section talks about the mechanical efficiency (ME). ME for hand pedals is ~20% and ME for conventional wheelchair is ~10%.

The repetitive strain imposed on the upper body by pushrim propulsion leads to very high prevalence of shoulder and wrist pain in manual wheelchair users.

<https://www.tandfonline.com/doi/abs/10.3109/17483107.2015.1099747?src=recsys&journalCode=iidt20>

**Lever propulsion vs hand pedal propulsion**

<https://me.queensu.ca/People/Deluzio/JAM/files/various_propulsion.pdf>

* Heart rate of 2 hand pedal system is higher than lever drive system BUT strain of hand pedal system is less?

<http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.462.7986&rep=rep1&type=pdf>

* Pedal (hand crank) about 3-5% more efficient than hand rim (regular wheelchair), *Pedals ME about 12-13%*
* Figure 7 compares energy cost in operating hand rim vs. hand pedal vs. lever in sections of a track. It shows hand pedal costing the least energy, and hand rim costing the most. Hand pedal better than lever in terms of caloric expenditure, which can translate to efficiency.

**Rolling Resistance Quantification**

<https://www.rehab.research.va.gov/jour/2015/527/jrrd-2014-10-0235.html>

* Table 4 shows that rolling resistance in a straight line of a manual wheelchair is ~7 N, this number is used in a rough estimate of the ratio of Sherpa effort to Rider effort.