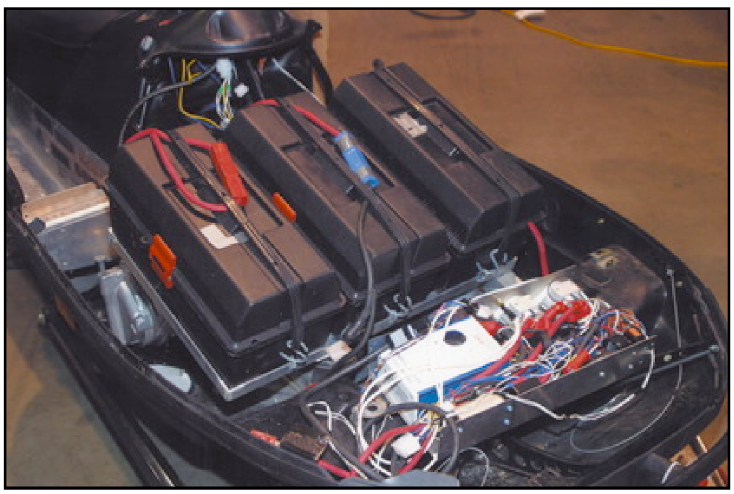
McGill University Electric Snowmobile Team : Modern day Wright brothers?

By Michel Garneau

Given all of the discussions and media coverage surrounding the topic of global warming lately, it is no surprise that many people see salvation for Mother Earth in the development of electric vehicles. We have already seen a small but significant shift in this direction with the introduction of hybrid cars and trucks which are powered by a combination gasoline engine and electric motor. "What about an electric snowmobile?", you ask. Well, it seems that some of the engineering minds at Montreal's McGill University were wondering the same thing.



Simon Ouellette, a Master's student in engineering at the University and the leader of the school's electric snowmobile project, openly admits that the snowmobile is, without a doubt, the most challenging application for an electric-powered vehicle. In explaining this, he cites four main reasons: first of all, unlike wheeled vehicles, snowmobiles have an extremely high degree of friction loss. It is well-known that a modern snowmobile only delivers about 50% of the engine's actual output to the track and subsequently the ground. Secondly, the typically cold weather in which a snowmobile is used has a negative effect on battery output as cold temperatures slow the critical chemical reactions which take place in the battery. Another issue relates to a lack of storage space for batteries. Unlike an automobile which is graced with substantial room for battery placement, a snowmobile offers very little in the way of useful storage space. Adding to this problem is the need to maintain a fairly even distribution of the weight, a particular concern given the elevated weight of most battery packs. Finally, and in a related matter, one must also consider the fact that the energy to weight ratio of batteries (using existing technology anyhow) is vastly inferior to that for gasoline. To illustrate, using last year's electric snowmobile as an example, the sealed lead acid batteries (sourced from an electric wheelchair) used weighed a total of 100 kg (compared to approximately 33kg for an average full fuel tank) yet contained only 1% of the energy contained in the tank of gasoline! This last fact in itself helps to paint an accurate picture of the magnitude of the challenge involved and tackled by the resourceful engineering students from McGill.

Given all of the above, then, why even bother trying to build an electric snowmobile? The answer is quite simple: to drive development of new technologies and innovative ways of using them. After all, if it works in a snowmobile, you can be certain it will work in other, much less demanding applications.

As the project began to really take shape last year, the initial objective was to build an operational model, plain and simple. As these were uncharted waters there were no real performance objectives. Given what they set out to do, the McGill team succeeded. In so doing, they first of all proved that it could be done, and also succeeded in drawing media coverage in the process. They capped off the year by giving a demonstration of their vehicle at the Clean Snowmobile Challenge (CSC). In fact, their project solicited such interest that future CSC's will henceforth have a separate class for electric snowmobiles. You know you have achieved something substantial when you have impressed members of the Society of Automotive Engineers.

With last year under their belts, Simon and the other members of the team (15 in all with 7 being considered "full-time") set out to improve on their initial groundbreaking model. The objectives for this year consist of essentially doubling the performance envelope of last year's sled. More specifically, they are aiming to reach a minimum top speed of 50 km/h and range of 20 km (versus last year's maximums of 25 km/h and 10 km respectively). Furthermore, they hope to build some versatility into the new version, for example, by increasing torque to an extent that climbing reasonable grades becomes possible (something last year's version was unable to do).

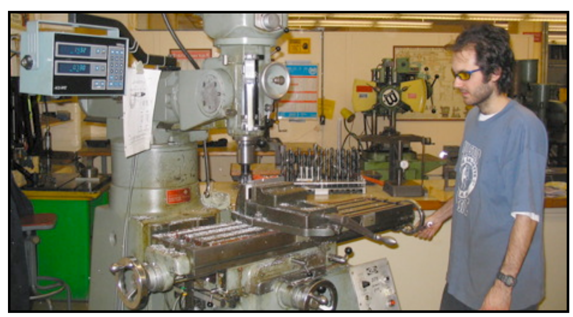
How do they intend to get there? For starters, they will be building the sled on Ski-Doo's new lightweight RF platform (as opposed to the ZX chassis used last year), in addition to using lighter and stronger lithium batteries (such as those used in lap-top computers). This change alone will help save about 67 kg (not to mention requiring much less space) while providing twice the energy supply. If you do the math, this change alone represents a 600% improvement in the energy to weight ratio!

A constantly variable transmission will replace last year's direct drive set-up and should go a long way towards helping them to reach their versatility goals. The CVT will be calibrated to capitalize on the lighter eCycle 12 hp electric motor's (half the weight and 2 hp more than last year's e-TORQ unit) power characteristics by having a zero rpm engagement. In other words, the clutch will be permanently engaged but this does not pose a problem for an electric motor as it would for a gasoline engine. Although there will a loss of efficiency resulting from the use of this system (when compared to a direct drive), the improvement in driveability will more than compensate.

One other benefit from adopting the CVT will be that this system's inherent ability to compensate for the load being placed on the drivetrain (by shifting ratios) will help to stabilize current draw from the motor by keeping the load much more constant. An electric motor will draw current (amps) in direct proportion to the load being placed on it. While this seems harmless at first glance, the loads can increase to such an extent that the components inside the engine are made to overheat and fail. In a direct drive set-up as was used last year, the constant ratio between engine speed and track speed means, logically, that the engine load varies directly with the load placed on the vehicle. For example, climbing a hill will cause the current draw to increase, the steeper the hill, the greater the increase. You can easily see how this could cause component durability problems. The CVT will help to minimize this potentially harmful fluctuation. The result? Better driveability and improved reliability.

Other changes this year include replacement of last year's chaincase with a lighter and more efficient toothed belt (sourced from the original Boivin SnowHawk 500F). Lightweight (aluminium, titanium) shafts and a new lighter braking system will further help to reduce overall weight and efficiency loss. It is worth noting that the brake system is currently under development as it has been given to a group of undergraduate students to design. All told, the weight is expected to be brought down from last year's 700 lbs. to less than 450 lbs. This in itself will yield a significant reduction in sliding friction and help to improve all aspects of performance.

Finally, every single component (track, bearings, suspension) is being studied for efficiency gains using, ironically enough, last year's model. While now obsolete, it remains useful for development of future incarnations by being used as a sort of dynamometer for testing purposes. How, you ask? As we had discussed earlier, it used a direct drive system and this means that change in load on the vehicle will result in a change to the current draw of the motor. As we all know, friction is a load, therefore, by running last year's sled in identical conditions but with different components, one can analyze the changes in current draw (made possible by the data acquisition system, similar in principle to the systems used on F1 cars) to determine which components or combinations of components generate the least friction. Ingenious wouldn't you agree? For those of you wanting to find out more about this project, please visit **www.electricsnowmobile.mcgill.ca**



At the end of the day, the challenges are formidable and Simon is quite honest about the magnitude of the task they face in developing a trail sled that would be even close to viable for the modern snowmobiler. No one knows for sure or can accurately predict how fast or where development will take them. Those of you who doubt the long-term potential of this project, however, would do well to remember that they laughed at the Wright brothers too before their famous flight at Kitty Hawk.