Personal Mobility and Northern Development: A Vehicle Design Programme Geared to the Missions and Environments of the Canadian North

By Charles L. Rosenfeld *

Abstract: In an effort to improve personal vehicle concepts adapted to the mobility demands and terrain conditions of the Canadian Arctic, empirical terrain performance data was collected near Pond Inlet, N.W.T. Such data was summarized into terrain analogs, which can be used to test the feasibility of economically desirable mobility patterns.

Zusammenfassung: In dem Bestreben, Personenfahrzeuge zu verbessern und sie den Transporterfordernissen und Terrainverhältnissen der kanadischen Arktis anzupassen, wurden in der Nähe von Pond Inlet, N.W.T., Daten gesammelt. Dieses Material wurde in Terrainanalogien zusammengefaßt, die verwendet werden können, um wirtschaftlich erwünschbare Transportcharakteristiken zu erproben.

Beginning in 1972, Ontario Drive and Gear, Ltd. offered technical assistance to interested parties requiring special solutions to problems of terrain mobility in Arctic regions. The first product of this programme was the specially equipped 'Argo' eight-wheeled amphibious vehicle designed for the Canadian Arctic Channel Project (EOS) [1]. A subsequent critical evaluation of the operational mobility of these vehicles has resulted in the production of an advanced prototype, which is currently under evaluation, as well as research into the present personal mobility demands of Arctic settlements.

The requirements for improved personal transportation among the residents of Canada's north has been precipitated by a broad range of cultural, economic and ecological changes. Enticed by facilities such as the church, police, health services and low-cost rental housing Eskimo populations have concentrated around fur trading settlements at a rate far outstripping their capacity to increase the supply of food and fur [2]. Hunting and trapping efficiency have not increased as fast as economic pressures.

The motorized toboggan, or snowmobile, introduced in the early 1960's, was readily received by northern trappers. Although the pay load, about 600 Kg., was not appreciably greater than that of an average team of nine dogs, the rapid vehicle speeds attracted eager buyers. As these machines became larger and more sophisticated, the cost of ownership and operation has increased greatly. At present the reliability and service life of the newer models is decreasing, their maintenance is more difficult, and towing heavy toboggan trains (Komatiks) ruins high RPM engines designed for sport use. The estimated total annual expenditure on personal transportation is $ 1.500 to $ 2.300 per trapper at Pond Inlet. This is consistent with estimates obtained at Sachs Harbour [3].

In addition, extensive use of motorized toboggans has produced several health and safety problems. Rough and noisy operation of these vehicles has been identified as a cause of hearing loss and long-term spinal, liver, and kidney damage among users [4]. Higher bodily injury rates are partially due to the exposed position of the driver, who in any case, is apt to suffer from wind chill due to high speed operation.

Significant ecological consequences are not the least among present mobility problems. Although the motorized toboggan has allowed traps to be tended more frequently, its limited range of operation has not increased the length of trap lines. Because the density

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of traps, about three per kilometer, has not been increased, significant overtrapping has occured near most settlements and semi-permanent camps. Due to the danger of operating these vehicles over sea ice during freeze-up or spring melt seasons, certain activity such as early Fall caribou hunting has been discouraged, thus increasing hunting pressures during more opportune periods.

Even in the case of our limited experience it is apparent that specific solutions are required in the following areas:

1. Vehicle reliability: ability to complete mission
   — improved mechanical durability
   — increased range of terrain trafficability
   — expedient repair and retrieval characteristics
   — extended operational radius
   — prolonged service longevity
2. Reduced operating expenses
   — lower depreciation (presently 60—100% per year)
   — lower fuel consumption (new snowmobiles average 4 km/litre at 100% operating efficiency)
   — ease of maintenance, reduced parts costs
3. Increased human safety and comfort
   — enclosed driver position
   — reduced vibration and shock transmission to riders
   — amphibious safety capability

The continued, and expanded, use of motorized vehicles for personal transportation could have considerable value if solutions to some of these problems can be met. A significant increase in the operational radius of safe vehicles over present-day travel limitations could considerably reduce the effects of population concentration upon local ecosystems, by reducing local hunting pressures. As much of the North will long remain unattractive to white men, and there is a pressing need for additional sources of income for the Eskimo owing to the unprofitable position of the fur trade — reduced hunting time, using motorized techniques could free a larger proportion of the local inhabitants for outside employement in resource extraction field during certain periods of the year.

The wheeled, amphibious, "all-terrain" vehicle (ATV) concept has some distinct advantages when assessed relative to Arctic transportation requirements. The ATV is capable of negotiating rough overland terrain, with or without snow cover. Its sea-ice operation is comparable to that of snowmobiles, except for its reduced ground pressure and amphibious capability. Multispeed transmissions enable the ATV to retain high-torque for towing, and prolong engine life. Low pressure tires reduce vibrations and ease the enclosed driver position may be fitted with a cab and heater. Finally, although fuel consumption remains comparable to alternative vehicles, the normal compliment of 40 litres greatly extends its operational range.

In an effort to improve vehicle concepts responding to the problem areas identified, a terrain/vehicle evaluation programme was undertaken in August 1973. The site selected for this study was Pond Inlet, on the northern coast of Baffin Island in the Northwest Territories (Figure 1). This site was chosen due to its proximity to a variety of Arctic terrain conditions, its large population of professional hunters, and its facilities to service motorized vehicles.

Utilizing an eight-wheeled amphibious ATV (Figure 2) as a test bed, basic terrain values were obtained which provide valuable input into the Arctic vehicle design programme. Insight was gained in four critical areas of vehicle design: (1) vehicle form criteria, (2) agility characteristics, (3) mechanical design criteria, and (4) mission capability.

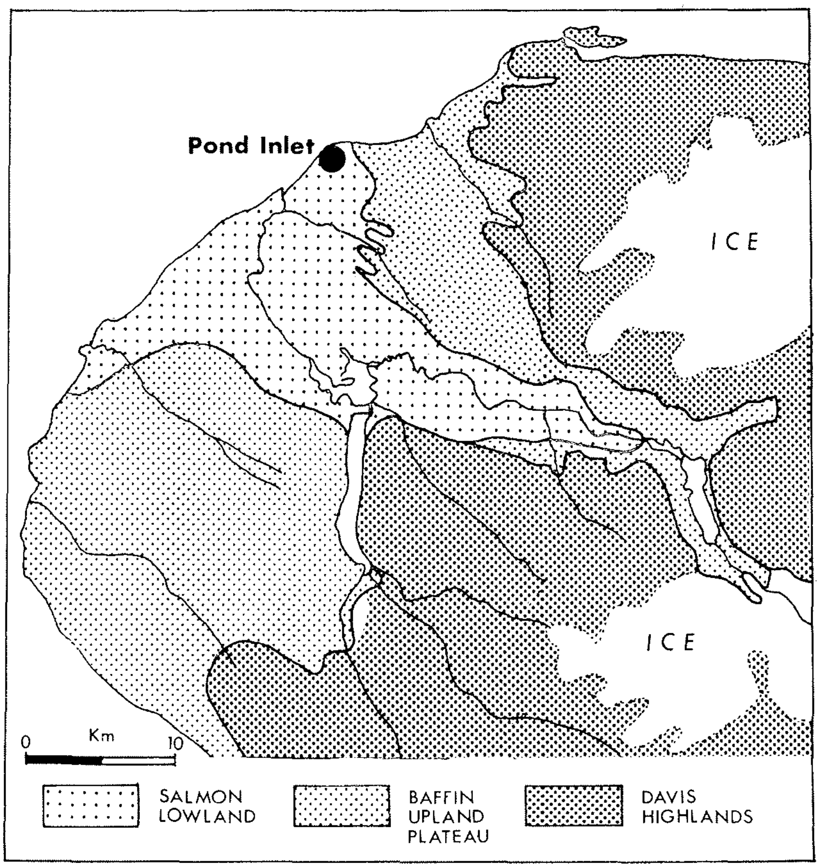

Fig. 1: Physiography of the study area. Abb. 1: Physiographie des Untersuchungsgebietes.

Air photos, maps and previous terrain reconaissance reports were utilized to divide the study area into physiographic regions, (Figure 1)[5]. Three distinct terrain types were identified and mapped: (1) the Davis Highlands, (2) the Baffin Upland Plateau, and (3) the Salmon River Lowlands [6].

Randomly oriented linear traverses were planned and evenly distributed throughout each of the major physiographic regions, in an effort to encounter the widest possible variation in terrain types. Deviations of up to 100 meters to either flank of the transect line were considered normal manoeuvering space. During the field traverse the micro-relief type and vehicle speed were denoted for each 100 meter segment negotiated by

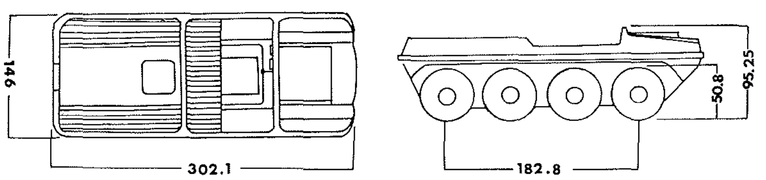

Fig. 2: Argo "8" vehicle configuration, all dimensions in centimeters.
Abb. 2: Argo "8" Fahrzeug, alle Maße in cm.

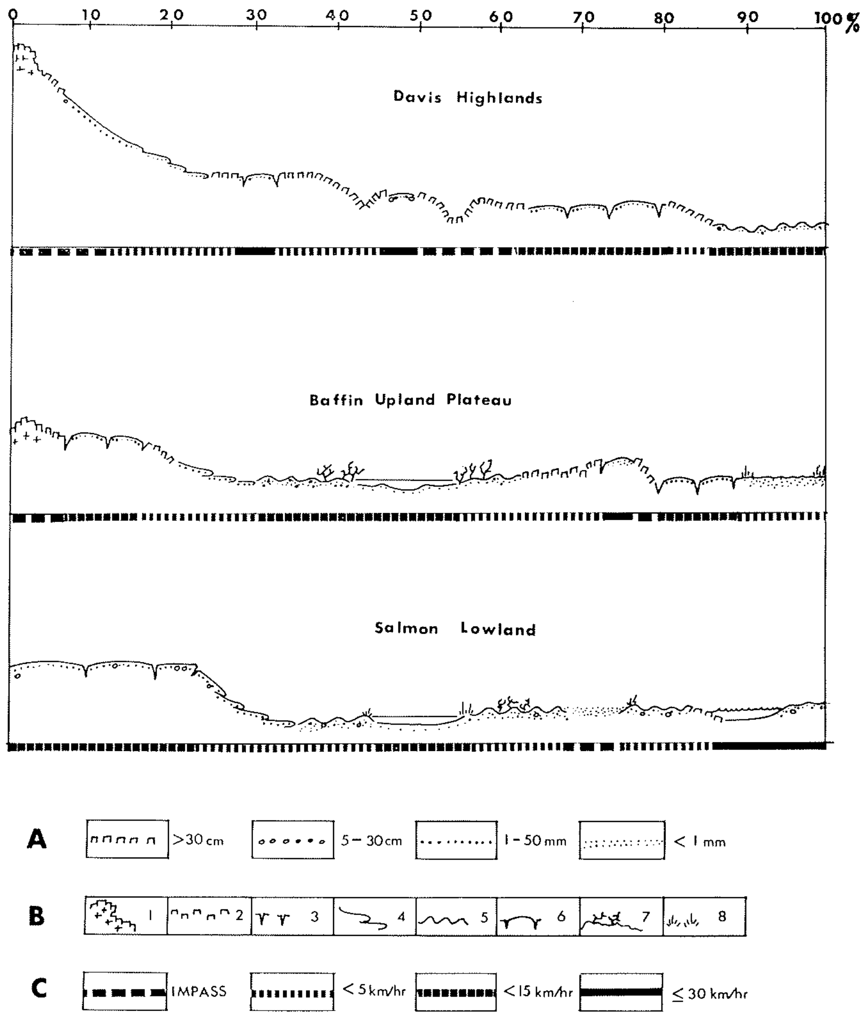

Fig. 3: Terrain analogs: Northern Baffin Island.
(a) Surface material size: boulders, cobbles, gravel, sand and clay.
(b) Micro-relief features affecting trafficability:
(1) outcrops, (2) boulder fields, (3) frost fissures, (4) solifluction lobes, (5) palas, (6) high-centered polygons, (7) willow thickets, (8) bunch grass.
(c) Average vehicle speeds (km/hr.)

Abb. 3: Terrain-Analogien: Nördlicher Teil von Baffin Island.
(a) Oberflächen-Materialgrößen — Gestein, Geröll, Kies, Sand und Lehm.
(b) Mikro-Relief-Merkmale, welche die Befahrbarkeit beeinflussen:
(1) Vorspringende Felspartie, (2) Felsenmeer, (3) Frostrisse, (4) Fließerdewülste, (5) Palsen, (6) Konvexe Polygone, (7) Weidengebüsch, (8) Grasbüschel.
(c) Durchschnittliche Fahrgeschwindigkeiten (km/h).

the test vehicle. Where major obstacles forced longer course modifications the by-passed segments were labled "impass" and the evaluation was resumed only when the vehicle returned to the planned transect route. Terrain analogues were constructed by recording vehicle behaviour during numerous traverses in each physiographic region. Figure 3 presents a graphical summary of each terrain analogue. Each profile represents a composite of the major terrain components of each physiographic region, scaled to reflect the probabality of encountering each component during a random traverse. The diameter of surface materials and the major micro-relief features affecting trafficability in the study area are represented symbolically in the synthetic profile, while the mean ground speed attained by the test vehicle is denoted by the velocity line beneath the profile. Non-trafficable terrain components are labelled "impass".

The range of action, or operational radius, of the test vehicle varies with the mobility characteristics of each physiographic type. However, one may calculate a mean ground speed for each physiographic region, and estimate the probability of mission success [7].

The results of this testing has led to the production of an improved prototype, equipped with a cable winch for one-man retrieval as well as mounting ice flows from the water, and a removable track systems has also been developed for deep snow operation. Future designs include a light weight desel version, to reduce fuel consumption, and an amphibious trailer

Economically, the initial cost differential between an equipped ATV at $ 2.300 and an equivalent motorized toboggan at $ 1.700 is offset by the long-term cost of depreciation and maintenance. The ATV requires a major overhaul at 2 to 3 year intervals, which cost from $ 400 to $ 600, rather than the annual or bi-annual replacement of the entire machine. Mechanical simplicity facilitates the local repair of both vehicles.

Efforts are continuing to relate these mission capabilities to extend personal mobility to economically significant hunting areas in northern Baffin Island [8], as well as generating additional uses for this general class of light activity vehicle, such as tourism, pipeline maintenance, and light hauling within settlements.

Summary

In an effort to expand personal mobility among hunters and trappers in Canada's North experiments were carried out near Pond Inlet utilizing amphibious wheeled vehicles. The potential of these vehicles having greater overland mobility and safer sea-ice operation is being gauged against mission requirements designed to extend the economic source area of the settlement. As additional design criteria are established and translated into vehicle improvements it is hoped that safe, economical personal mobility will help alleviate mounting economic and ecological pressures in the settlements of Canada's North.

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