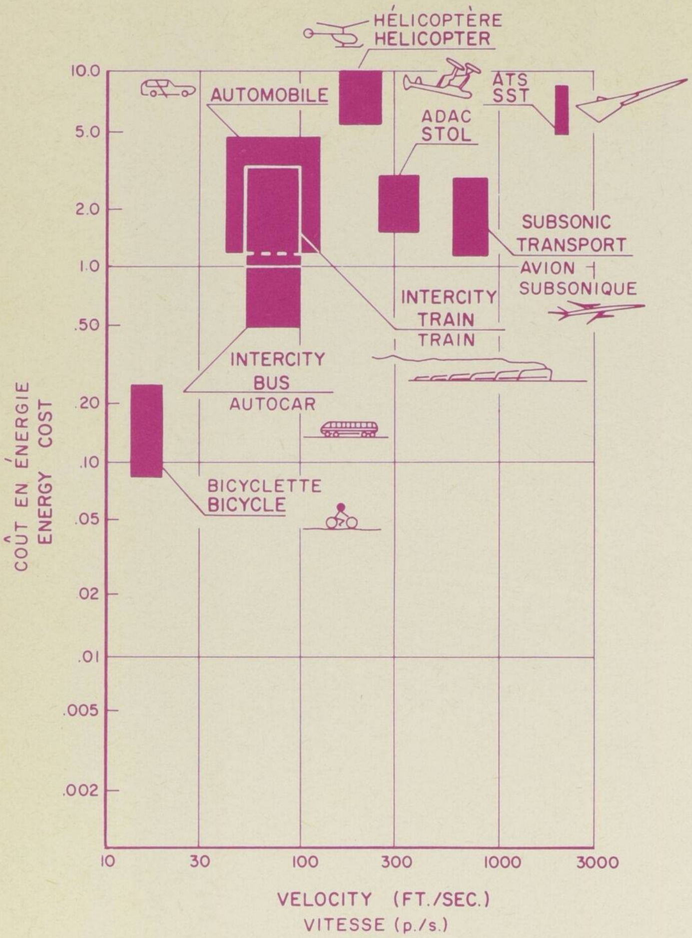

Fig. 2

Energy Costs for Passenger Transportation. • Coût en énergie pour le transport des passagers.

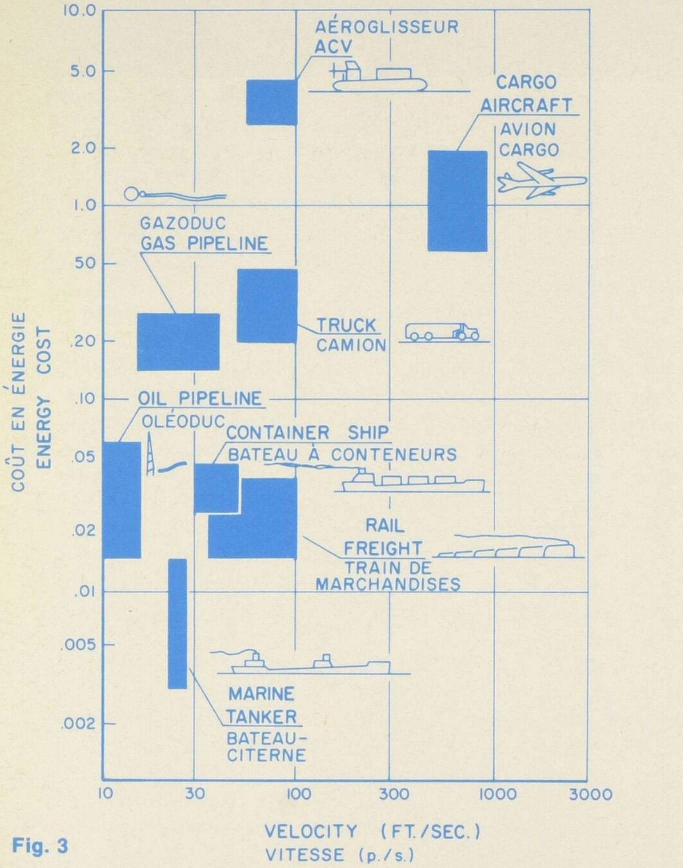

Fig. 3

Energy Costs for Cargo Transportation. • Coût en énergie pour le transport des marchandises.

Energy cost

of merit but not strictly of efficiency).

"Consider the example of a 200-pound man who drives a distance of 20 miles in a car that averages 20 miles per gallon of gasoline," says Dr. Cockshutt. "In our treatment, the useful work performed, measured in foot-pound units, will be the transport of the man (the payload) over the 20-mile distance without considering the work necessary in transporting the car. If the energy content of the fuel expended is expressed as foot-pounds rather than the more conventional British Thermal Units (BTU's), the units in the ratio cancel out to give a dimensionless parameter, the Energy Cost. In this example the value of the Energy Cost is 5.25 — in other words for every foot-pound of useful transportation work done, over five foot-pounds of energy are consumed performing the task."

The details of the Energy Cost calculation for the automobile are shown in Figure 1. If the payload is increased, say by carrying another man of about the same weight, then the parameter value is effectively halved; if a third man of the same weight is added the value reduces to about one third, and so on.

A summary of the Energy Costs for passenger transportation as affected by travel velocity is given in Figure 2. Perhaps the most striking fact illustrated by the graph is the relative inefficiency of the car as a means of travel (efficiency decreases from the bottom of the graph to the top). The block representing typical Energy Costs for the automobile embraces a wide range of conditions, and has been drawn for values 1.2 to 5.0 over speeds from 25 to 75 miles per hour. An interesting comparison from an energy conservation point of view is between automobiles and current subsonic aircraft such as DC-8's, DC-9's, and 747's. These aircraft actually are an improvement over an automobile's Energy Costs with values ranging from 1.5 to 2.5, and they do so at velocities almost ten times higher than the automobile. Even the controversial supersonic transport aircraft (SST), operating at an Energy Cost of about seven compares favorably with the automobile. The intercity bus shows an improvement over the automobile by three or four fold, and the bicycle at the bottom of the graph is more efficient than the car by a factor as high as 50.

A similar graph for cargo transportation systems is shown in Figure 3. The Energy Cost values descend from high speed vehicles like the hovercraft (ACV) and cargo aircraft through trucks, pipelines and trains to the marine tanker, the most efficient means of transport available in terms of the energy used-work done ratio.

In comparing Figures 2 and 3 it can be seen that passenger transport systems have Energy Cost values that are much higher than the cargo systems. However, they also travel, on the average, at velocities far greater than cargo carriers. To better appreciate why a given transport system achieves a particular Energy Cost value, it is necessary to examine in detail the steps involved in going from fuel input to work done.

"The Energy Cost of a transportation system has three distinct components," explains Dr. Cockshutt. "These are: the thermopropulsive efficiency of the power plant, the frictional resistance of the vehicle, and the structural efficiency or ratio of payload to vehicle weight.

"Consider first the thermopropulsive efficiency," continues Dr. Cockshutt. "This can be described as the efficiency of the engine in turning input fuel into thrust, or forward urge. There is remarkably little difference in various drive systems in this