A REVIEW OF TRANSMISSION SYSTEMS FOR TRACKED MILITARY VEHICLES

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Abstract. The transmissions and drivelines for many wheeled and, especially, tracked military vehicles have diverged considerably from those of their civilian counterparts over the last 40 years. The high performance, good cross-country mobility and 'drivability' demanded by military users have lead to complex, sophisticated and specialised transmissions, which are usually produced in small numbers and often owe little to commercial practice. Economic constraints on defence procurement and recent developments in the commercial sector have narrowed the technology gap but, as yet, resulted in little collaboration between the two fields. This paper reviews the development of transmissions for tracked military vehicles and examines the potential for greater cross-fertilisation and collaborative development. It is considered that, especially for lighter vehicles such as armoured personnel carriers, it would be technically feasible and economically beneficial to synthesise military transmissions largely from commercial hardware.

INTRODUCTION

Military vehicles include a wide range of types, from motorcycles to main battle tanks. Many have equivalents on the civilian market; sometimes the military vehicle is sourced directly from it. Other classes of vehicle may be developed from civilian designs or indeed, like Supercat for example, provide a civilian opportunity from a military requirement. Modern tanks, which are *fast* tracklayers, stem from a common heritage of slow tracklayers, which included early tanks and tractors.

Military vehicles, with the exception of staff-cars and some load carriers, require much better off-road mobility than most other vehicles. Tracked vehicles, by their very nature, have good traction, low ground pressure and hence good cross-country mobility. However, they are difficult to steer; most tracklayers are steered by allowing or imposing a difference in speed on the two tracks. This is called *skid steering*, and requires a complex transmission system to provide the finesse of control needed for fast tracklayers.

Early military vehicle transmissions drew heavily on technology and hardware from the commercial sector. However, as military demands have become more varied and taxing, there has been a trend, particularly since the 1939-45 war, towards 'military specials' – sometimes almost regardless of cost. For the future, it is likely that the escalating cost of small volume production will necessitate a return to greater interdependence between commercial and military technology and, consequently some compromise of performance.

EVOLUTION OF TRACKED VEHICLE TRANSMISSIONS

There are four major methods of steering tracked vehicles: auxiliary steering wheels, track setting, vehicle articulation and skid steer. Though examples of all are to be found, only skid steer has achieved general widespread application and is singular in offering the facility to achieve pivot turns. Skid steer is achieved by allowing or forcing the right and left-hand tracks to move at disparate speeds, thereby inducing the vehicle to slew. It is relevant to examine the development of skid steer systems briefly in order to arrive at modern requirements for such systems and propose ways of realising them. Skid steer can also be used for wheeled vehicles; some are in current service, for example the GIAT AMX10.

Early Systems

The earliest skid-steered tanks used separate engines and transmissions for each track; an engine man and a gearman being required for each side of the vehicle to control their respective systems. Mobility therefore required a crew of five, including the driver, who shouted orders to the others as best he could. This cumbersome approach was quickly supplanted by single engines and by transmission systems of much less mechanical (and human) complexity.

Clutch-brake Steer

In this system, (Figure 1) the engine, through a change speed gearbox, drives a transverse cross-shaft, via which the right and left hand sprockets are driven through suitable final drive gearboxes. Each side of the cross-shaft carries a clutch and, outboard of it, a brake.

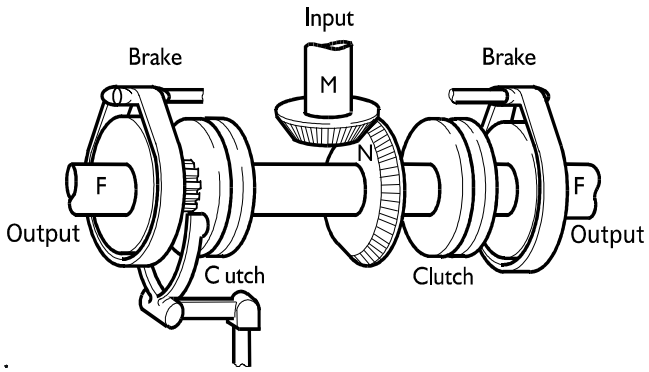

Figure 1. Clutch-brake skid steer system.

To steer, the driver first disengages the clutch on the appropriate side, thereby interrupting the drive to that track and inducing a *free turn*. The vehicle's response depends on the going: on soft, heavy terrain or an up-grade, the undriven inside track will rapidly slow, stop, or in extremis, start to rotate backwards. On a hard, level road the inside track will slow to give a turn radius in the order of 50-100m for a vehicle of typical aspect ratio. Under such conditions, the undriven track may be slowed further, to achieve a tighter