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# THE TECHNICAL GROWTH AND DEVELOPMENT OF SIGNALS*

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My talk today on the Technical Growth and Development of Signals will not be confined to the sequence of changes that have taken place in our own Indian Corps of Signals during the past years, but to the technique of signalling as a generic subject with an international appreciation. I propose to explain very briefly, owing to the limitation of time, how through the ages, the supporting arm of Signals has been an inseparable part of the field Army and the manner in which methods of signalling and equipment have undergone changes to conform to the growing needs of land operations. As the fighting arms of the Army became more and more mechanised, complex, widely dispersed and capable of holding larger frontages, so did the signalling arm undergo development to cope with the ever growing needs of field commanders to maintain control over their troops. In this development, Signals drew more and more upon the funds of applied science and thus from its primitive methods of carrying reports and messages by physical means, Signals expended and grew into a technical arm utilising the most modern and rapid wireless and line communication inventions of the Telecommunication Engineers. But in this development, Signals have, throughout its history, neither lost its original meaning nor its importance.

## MEANING AND OBJECT OF SIGNALLING

Signalling means transmitting information according to some pre-arranged system or code in cases, where a direct, verbal or written statement is unnecessary, undesirable, or impracticable. The medium into which the transmitted idea is translated may consist of visible objects, sounds, motions or the medium of electricity or indeed anything that is capable of affecting the senses. You will thus appreciate that in order to convey intelligence, different agencies are utilised namely physical motions, light, electricity or wireless. Whereas all these agencies carry intelligence, they differ in their characteristics of flexibility and speed. Thus a lamp which flashes dots and dashes is not only a slow business but it requires the signaller and the lamp equipment to be stationary. On the other hand, wireless provides a fast means of communication capable of working on the move. We shall now see how the agencies of signalling have varied from time to time because of the change in standards demanded by the modes of warfare.

Before I go any further, I would like to say a word or two about the object of signalling. This is explained briefly in that it enables a commander to maintain control over his forces. A commander must know the situation of his own forces and that of the enemy

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before he strikes. All commanders grope in the fog of war and the extent to which that fog may thin from time to time or allow precious clear glimpse, depends very much on the state of signal communications. Signals, therefore, provide a means by which the forces remain united as an entity and it is the efficiency of Signals which will make a major contribution towards the achievement of that major principle of war, the Concentration of Forces.

## SIGNALLING IN RETROSPECT

In the olden days, when the Army was not so organised, when units and sub units fought independent actions, and were capable of holding very small frontages, the Kings and Captains were themselves present in the thick of battle and were content to command by voice or example. Because the troops fought in close order, the generals continued to command from the saddle, and used words of command, trumpet or bugle call, to convey the commencement of an action. They also used the galloping staff officers who gave the commanders information on the progress in battle. Thus in the far off days, the control in battle was entirely maintained by the use of physical agencies. The Duke of Wellington would say in the battle of Waterloo "the whole line will advance" and could personally watch the squares swing into line as his order took effect. Thus the signalling means of control in battle were more or less adequate to meet the needs.

Then came the Industrial Revolution which was to effect war no less than every other branch of human activity and within the space of half a century, we saw radical changes in the equipment and mobility of land forces. As a result of the Industrial Revolution, at the end of the First World War in 1918, the armies became so vast and complex in armaments in comparison with the previous years that the former signal system scarcely sufficed for the control of these elaborate forces. The process continued and in the Second World War we found a commander possessed of infantry armed with machine guns and automatic rifles, and gunners who could not see the enemy but fixed at it, the cavalry no longer mounted on horseback but fortified in armoured vehicles from which they directed their fire power. The fighting arms thus changed beyond recognition. Their deployment became more dispersed, their distances much greater than before and hence the need arose for superior means of signalling to ensure integration of such a complicated mechanism. With these widely deployed elements under enemy's fire, the commander required means by which he could weld them into a single living organism driven by one brain and working to one end. We shall now see how the demands placed on Signals were met and with what changes in equipment and techniques.

When the powers entered upon the First World War in 1914 they were equipped in varying degrees with line, visual and wireless means of communications. It must be noted that the method of signalling by the use of physical agencies was not discarded but was retained as an ally and not as a rival to the electrical means of

communications which had now developed for use in the field. The despatch riders thus instead of being mounted on horse-back rode on a motor cycle and carried longer and less pressing messages in order that the electrical means could deal immediately with short and more urgent reports. I shall now briefly touch upon the three methods of signalling namely, visual, line and wireless as they existed in the beginning of 1914 and the usage they were put to in the First World War.

## SIGNALLING IN THE FIRST WORLD WAR

Visual signalling was first discovered in 1861. It had occurred to Royal Navy service officers that dots and dashes could be transmitted by visual signals no less than by electric impulses over a wire. These officers working together developed what they called a "flashing system" which made use of flags by day and lamps by night and which stand to this day with little changes except in detail. These methods were also used extensively in the North West Frontier Province of the former India. They suited the mode of warfare of the time which was essentially of a static nature consisting of occupying positions on high features. As the speed of operations was very limited compared with the present times, the visual means of communications served the purpose.

Another means of communication, which was developed in India, consisted of the helliograph. This instrument gave greater range of communications than lamp, shutter or flag and became a very popular instrument of signalling in the North West Frontier Province.

Although, as I have stated before, the visual means served the purpose of the time, these could not hold their identity on the signalling field for long. They suffered a setback in the First World War because of the obvious insecurity attached to the man who standing square on his feet, waved his flag in his traditional soldierly manner. In addition to this was the fact that any form of visual signalling working from the rear to forward positions was more than likely to be seen by the enemy and draw his fire. Visual signalling therefore could not stand the test of modern needs.

### Line signalling

The first application of line signalling was made by the British Army in 1854. It was for the first time that science and organisation had intruded into a military system. In the Indian Mutiny three years later, the scattered British forces were kept in telegraphic touch with one another and with the Government in Calcutta, and although it was an application of a civil telegraph service to military needs, yet it was remarkable as the first example of how the new system could be used to coordinate the movements of armies and above all to transmit vital intelligence. That the newly established telegraph system was controlled by the Government and not by the forces of mutiny was one of the deciding factors in that struggle.

In 1914-1918, line communication was the most popular means of signalling. It suited the static nature of operations which were

inherent in trench warfare. In that war, the combatants for a long time fought where they stood with the front line sagging and swaying a little here or there. There were thus no problems of coordinating movement to direct fire power and to administer formations to the extent as in open warfare. The result was that line communication system came into its own being best suited to serve the needs of static defence. As the war progressed, on each side, there grew an immense gridwork of buried cables with arteries every few thousand yards along the front running upto the rear from the forward trenches and joined across by lateral routes. Each buried cable might contain 10, 20 or 50 or more conductors and the system included underground test points and distribution centres. In the back areas which were more immune from shelling, the buried cables gave place to overhead systems stretching back over the communication zones and conforming to the normal practice of civil telegraph engineering. This war, therefore, saw a great development in line communications and the armies introduced into the service the permanent line construction practice. These routes became the life line in strategic areas and bases.

**Wireless signalling**

Wireless signalling was not in great use during the 1914-1918 War. It suffered from the drawback that an exposed aerial became a prominent feature amongst statically disposed forces and was therefore liable to be shot away or give away the nature of formations around it. Nor did there arise the need for wireless signalling because wireless is essentially a weapon of rapid communications required for highly mobile operations. As the operations in the First World War had little mobility, wireless did not develop at all in course of that war.

Summing up the 1914-18 War from the Signals view point, therefore, it will be appreciated that wireless did not come into play to any appreciable degree. Visual signalling received a setback because of its slowness in transmission and the fact that it made the operator a prominent target. Line communication, on the other hand, being the most suitable and favoured means of communication developed most. The Army introduced permanent lines, the underground cables and the light field cables in order to provide a sure means of communication which gave the commanders a feeling of personal touch when they spoke on the telephones. Although line was slow in erecting and dismantling, it was adequate for the limited mobility of operations obtaining at the time.

## CHANGES IN WARFARE

In the years that followed the First World War, little or no development took place in signal communications. This is perhaps mainly due to the fact that the strategists and tacticians did not propound new modes of warfare. Everyone thought in terms of the slow and ponderous moves and static defence inherent in the trench stalemates of the Western front in the First World War. The result was that in the beginning of 1939, the Army possessed one or two types of telephones, two or three types of switchboards, sounder as

the means of telegraphy on line circuits and an extremely limited number of wireless sets, perhaps not more than three. This 'armoury' of Signals was completely inadequate when the storm burst in 1939 and a unique mode of operations contrary to all previous notions of warfare appeared on the scene. Let us study what changes took place in the concept of operations in the Second World War and we shall then see the impact of these changes on the signalling means and equipment. During the Second World War, the armies were mechanised and hence very mobile. The tank had made its appearance and could provide a source of fire power in a mobile form. The aircraft began to cooperate with the land battle and raised war in the third dimension. The sum total of all these changes was that the armies in the field advanced or withdrew many miles during a day, cooperation was no longer confined to the guns of the Artillery, but extended to that of the tank and the aircraft. Integration of these mechanised forces operating in more than one medium became extremely essential. The demand thus placed on Signals called for highly flexible communications, rapid communications and communications which could cover large distances. This created changes in Signals overnight and the growth and development was therefore very rapid. I shall deal with some of the changes very briefly.

## SIGNALLING IN THE SECOND WORLD WAR

Since the Army was so widely separated from the strategic bases and since their administration had become an important principle of war, it became necessary in the rearward areas to establish communication circuits offering stability and rapid clearance of traffic. For this purpose, permanent line circuits were introduced. Since the physical routes can never offer the number of channels required for the complex army mechanism in strategic and communication zones, for the first time, the carrier and voice frequency telegraph equipment was introduced. In the rearward regions, equipment of the type such as was in use by the civil Posts and Telegraphs agencies was brought into use. In the forward areas and in the communication zones, more compact and mobile carrier and voice frequency telegraph equipment was required. These were developed and introduced into service. The famous Apparatus Carrier Telephone 1+1, 1+4, S+Dx and voice frequency telegraph 3 and 6 channels which are familiar to some of the audience were innovations of the Second World War. These equipments could be mounted in vehicles and travelled as the communications extended into the areas wrested from the enemy.

### Wireless communications

Amongst all the means of communications, wireless is the one which lends itself to mobility and rapid installation. Wireless therefore came into its own in the Second World War. A series of equipments were developed to serve the varying needs of the various zones. In the strategic bases, heavy wireless sets providing long range communications were installed. These were of the commercial pattern and the automatic telegraph equipment was added in order to increase the speed of transmission. The automatic telegraphic equipment was, in the main, the same as used in the commercial

firms, but slightly modified to increase their robustness and ease of installation. Forward of strategic areas, in the communication zones, wireless sets of output upto 5 Kilowatts were developed and installed in vehicles to cope with the administrative traffic which had greatly increased in the communication zones. Forward of the communication zones, more robust and less powerful equipment was required for the fighting field formations and these were developed and supplied down to the infantry platoons. All this development was a great innovation for the Army. Wireless preponderated the signal instruments of communications. In all, about 100 different types of wireless sets were developed as compared to the three which existed at the end of the First World War.

Gentlemen, in the foregoing talk, I have tried in the limited time available to give you how the applied science has come to the help of Signals in developing signal equipment for the field. Of all the changes in the long years of military history, the years 1939-45 have been one of great significance and development for Signals. The process is a continuous one and will not cease as long as the weapons of war and mode of warfare continues to become more complex. Since the end of the last war, the development of signal equipment has continued and this is in line with the planners of operations. I shall now briefly touch on some of the development problems which face Signals these days.

## TREND OF SIGNAL EQUIPMENT DEVELOPMENT

One of the major factors which faces the developers of Defence Science is the conflict between the Army which requires light equipment with maximum performance, and against it the limitations of scientists who can only provide a certain performance in relation to a certain weight and size of equipment. In order to accommodate the requirements of the Army in producing equipment of decreased weight and size, miniaturisation is a technique which is receiving major attention in the technical development establishments. Already a number of Carrier and Voice Frequency Telegraph equipments I have referred to before, have been reduced in weight by the use of miniature valves without any loss of efficiency. This process has similarly affected the wireless sets. Some of the latest models now in hand weighing 20 lbs. have the same performance as their predecessors of the Second World War weighing 100 to 120 lbs. This aspect of development is, I feel, going to continue with greater intensity.

### Very high frequency wireless equipment

The greatest limitation of wireless is that it can be intercepted by the enemy at all times in his own country. This applies to wireless equipment which is multi-directional. In order therefore to limit the chances of interception by the enemy, production of very high frequency equipment is receiving major consideration. Practically, all the field equipment up to brigade level will, in future, operate on very high frequency and this will accord immunity to our transmissions at that level. Another use of very high frequency

band is in the development of mobile equipment using pulse modulation technique in order that it may be installed to provide point to point system as a whole replacing the physical line routes. Their advantage over the line route consists in their ease of installation, mobility and capacity to provide multi-channels by the coupling of carrier and voice frequency telegraph equipments.

**Climatic conditions**

Climatic conditions have a very banal effect on delicate telecommunication equipment. Humidity and dust are its greatest enemies. In order therefore to afford protection to the signal equipment, sealing devices are now being incorporated in signalling equipment in order that variations of temperature or terrain do not impair the performance of these equipments. The sealing device also helps in reducing the chances of bacteriological damage such as by fungus.

**Radio warfare**

A new technique of warfare called the radio warfare has now made its appearance in the field. We last heard of its use by the Chinese in KOREA whereby they were able to blot out the allied radio communication network in a certain operation. The technique of radio warfare attempts to nullify the wireless communications of the opposing party by the use of such equipment as will jam or drown the enemy signals. The tactical advantage of this is that wireless system which provides for cooperation amongst the forces would be destroyed by its use. The effect would be that the forces would be cut off from each other and isolated into small packets without direction from a signal agency. The technique of radio warfare has great possibilities for the future and the equipment produced to wage this war will in due course become an important addition to the Signals Ordnance.

**Frequency congestion**

There are a number of other problems which have to be overcome to attain a high standard in the performance of signal instruments. As the time is limited, I cannot go into them all. However, one of them which stands out prominently is the congestion in frequency spectrum. You have all heard of the international battles that are fought under the flag of United Nations, whereby each country is attempting to obtain the best allocation of frequencies for itself. The reason is obvious in that wireless network in all countries has increased and each country must therefore have a greater number of frequencies. This problem faces the Army also. Imagine a limited area where a number of wireless sets are operating. There is bound to be interference amongst them. Some of it can be avoided by producing equipment which operates in the very high frequency or ultra high frequency bands but the difficulty of moving into higher bands is that it reduces the working range of wireless equipment. How are we to overcome this difficulty? The use of frequency modulation may perhaps answer the problem partly. Other solutions I leave you to think of and express to assist the armed forces.

## CONCLUSION

In conclusion, I would say, that I have tried to survey the progress of Signals in the course of past years. I must however, emphasise, that this progress has not taken place unilaterally that is to say, with Signals working and growing in "cold storage". Signals can only develop in relation to the fighting arms they serve. It would therefore be well to remember that all those who work for developing equipment or extending the field of science to the armed forces, must identify themselves with it or else their scientific investigations will be unrealistic and unpractical.