

Chapter 2

Machine Team Management

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Abstract It is pointed out that such emerging technologies as IoT, CPS, etc. will dramatically change our relationship with machines. Relationship between humans and machines has long been basically master-slave. But machines will communicate with each other in the coming Connected Society so that they will behave like humans. The group of machines are no more just a group of physical entities. We have to deal with them just as we do with humans. Thus, machine team management becomes very important in the Connected Society and the problem of leadership will emerge to better control and manage these machine teams.

2.1 Machine Team

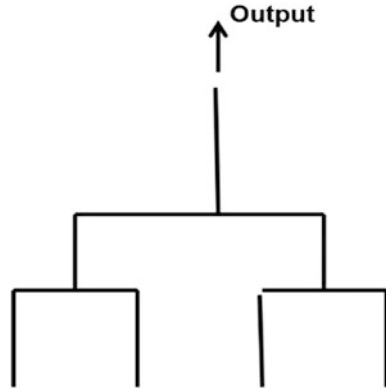
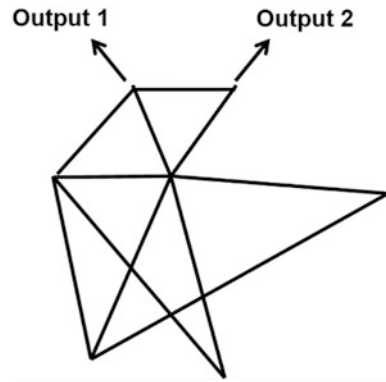
IoT, CPS, etc. are now quickly transforming our society into the Connected Society.

It is pointed out in this chapter that in the Connected Society, we have to deal with machines (Machines, here, include systems and products) as a team and a group of machines in the Connected Society are no more just a group of traditional machines which operate individually under human instructions. In the Connected Society, machines exchange information among them.

Until now, when machines work as a group, they do not change their structure and they follow human instructions. They do not have any information or knowledge of their own. Thus, most of these groups are tree-structured, because tree structure has only one output node and if the instruction does not change from case to case, it is the most effective structure to cope with the contexts and situations (Fig. 2.1).

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Fig. 2.1 Tree structure**Fig. 2.2** Network structure

In fact, in the 20th century, there were changes, but they are small and smooth. Therefore, engineering designers can foresee the operating conditions and could prepare instructions for the user to use their machines appropriately.

As we come close to the end of the 20th century, changes come to take place more often and extensively. This calls for a change from a tree to a network, because if it is a network structure, any node can be an output node so that it becomes easier to adapt to the frequent and extensive changes of the outer world (Fig. 2.2).

As we enter the 21st century, changes occur more frequently and extensively. So we have to change a network structure flexibly and adaptively in response to the changes of the outer world. But at that time, machines were not connected in the sense of the Connected Society today. They may have been connected, but their roles are fixed. Machines were expected to play their assigned roles exactly as they were instructed.

The Connected Society changed the whole scene. Machines are not only connected, but they are now able to communicate. Machines can store information and with the accumulation of information, they can have knowledge of their own. In other words, machines come much closer to humans.

Thus, until very recently, even when machines worked as a group, their roles were fixed so we could give instructions to the group easily. And even if we had to re-organize the group, we could take time, because changes were slow and smooth.

But recent frequent and extensive changes make such a strategy no more effective. Such changes make it impossible for engineering designers to foresee the operating conditions. Today, only a user knows what is happening now. Thus, what becomes increasingly important in these days of frequent and extensive changes is how we can help our users judge the context and situation correctly and let them make an appropriate decision.

2.2 From 11 Best to Best 11

If we turn our eyes to the world of sports, it affords a good lesson for us, engineers.

Knute Rockne, famous American Football coach, said that even if we have 11 best players, they would not make the best team. The best team is composed of 11 players who do their best to change their roles to adapt to the situation. Rockne demonstrated this by bringing up University of Notre Dame to the ever winning team. Until then, University of Notre Dame was at the bottom. But almost nobody knows who played in these games, which brought the University to the top.

This example is American Football. But in soccer, too, Der Kaiser Franz Beckenbaur introduced Libero system, in which midfielders give instructions to other players what roles are expected from them and how they should move. Forwards are concentrating their focus only on the goal and it is the midfielder who really can see how the game is going on and what strategy should be taken to win. In other words, fast adaptability is the key element in today's soccer.

In the traditional team sports, most efforts were paid to bring up best players. These best players were best indeed in their own position, when the formation or the organization did not change.

But today, what is expected from players is versatility and flexibility. They are expected to play many different roles as required. They do not have to be the best player. What is required from them is how quickly and flexibly they can adapt to the situation and how well they can play the new assigned role in the continuously changing team formation or organization,

Traditional team sports were a tree structured, but today in order to win, we have to introduce a network structure, which changes continuously in response to the frequently and extensively changing flow of the game (Fig. 2.3).

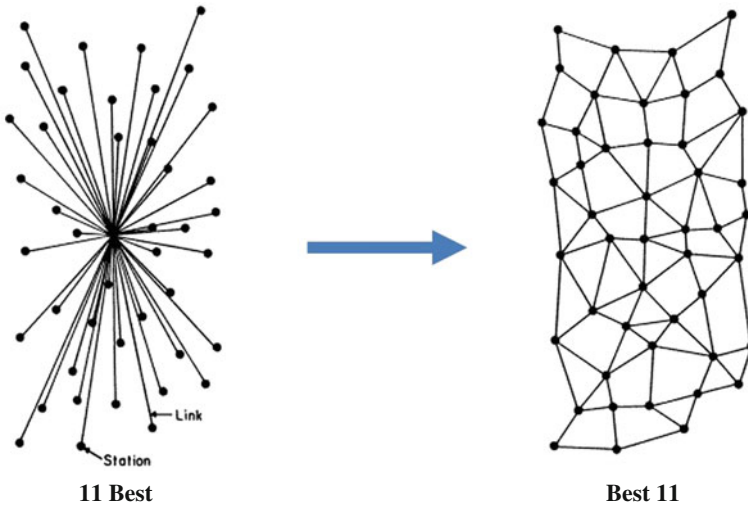


Fig. 2.3 11 Best to Best 11

In the traditional engineering, we have paid our efforts to make an individual machine best. We have been producing Best Playing machines. But what is needed today in an age of frequent and extensive changes is how flexibly and adaptively we can vary their formation or organization at any given moment. Each machine may not be the best individually, but as a team, they work together most effectively and adaptively to cope with the frequently and extensively changing contexts and situations.

2.3 From the Connected Society to the Communicating Society

To achieve such flexibility and adaptability, it is not enough that machines are connected. They have to communicate. If information is passed from machine to machine one way, the machines may be connected in the sense of data transfer, but they are not communicating. Communication has to be both ways. And not only data, but their meanings have to be conveyed. Such emerging technologies as IoT etc. are quickly making it possible for machines to communicate.

Once they are able to communicate, they can accumulate their experience and share the knowledge with other machines. In other words, the Connected Society at this stage should be called the Communicating Society, where machines behaviors become very close to those of humans.

2.4 Machine Team Management

The advent of the Communicating Society brings to us a new problem, i.e., how we manage a machine team. We have to organize and manage our machines to get our task done at any given moment. Before the advent of the Communicating Society, we organized our machines, but that was carried out once at the beginning because the outer world did not change appreciably. And substantially the problem of management did not exist. Machines were there to listen to our instructions.

But machines are becoming closer to humans in their behaviors so that their management becomes increasingly important. Machines are no more just physical entities, but they are putting on personalities beyond individualities, because machines grow with accumulation of experience.

And in the age of frequent and extensive changes, there are many different ways to deal with the problem. Yesterday, even if there were several ways, we could select the best way in an easy and straightforward manner. But a user in the Communicating Society has to lead the team of machines in order to get his job done as he wants.

2.5 Leadership

There are many researches on leadership in human behavior science. But the problem of leadership in a human-machine mixed team emerged as a new issue in the Communicating Society. Until now, the relationship between humans and machines has been master-slave so that how adequate instructions can be prepared is important. But the relationship between human and machine and between machine and machine change from situation to situation. So just like Rockne or Beckenbauer, we have to be a good team leader to fully utilize a machine team. We have to develop another leadership theory which can be applied to mixed human-machine teams.

2.6 Summary

The importance of developing leadership theory to apply to mixed human-machine teams is described in an age when not only humans, but also machines communicate with each other.

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