

Fig. 1.5 TMSUK's humanoid robot prototype. Photo by Author.

work piece into a specific shape. In this process, the important motion parameters are position and velocity.

- **Assembly:**

This is the process of either adding components to form a single entity, or affixing components to a base unit (e.g. to place components on a printed circuit board). In this process, the important motion parameter is position.

- **Material Handling:**

This is the process of either packaging parts into a compartment (box) or loading/unloading parts to/from another station. In this process, position is an important motion parameter.

1.4 Impact of Industrial Robots

The industrial robot, a combination of arm and hand, can advantageously be deployed in the manufacturing industry to automate many processes, which have motion parameters as input. Obviously, automation using robots shifts the use of human labor from direct interaction with a process to various indirect interactions. These indirect interactions include process monitoring, process diagnostics, equipment setting, equipment program-

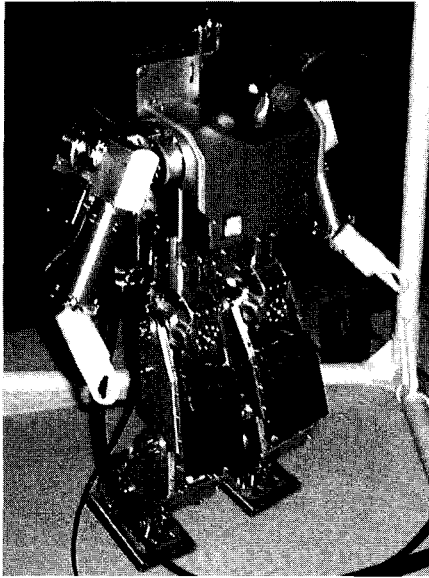


Fig. 1.6 FUJITSU's humanoid robot prototype. Photo by Author.

ming, the development of automation solutions etc.

Despite all these new job opportunities, one major concern in the manufacturing industry is that the proliferation of robots will cause displacement of human labor and eventually, unemployment. This is a real problem, faced by both developed and developing countries. There is no simple solution to this issue. However, it can be addressed at various levels:

- *Individual Level:*

It must be clear that we are living in a changing environment. We are now witnessing the third wave of the industrial revolution: Information Technology. The tools for us to make things are constantly evolving with increased complexity and sophistication. Therefore, individuals must constantly learn new knowledge and skills in order to make use of the modern tools being deployed in the industry.

- *Industrial Level:*

Perhaps, there should be an adjustment in the company goals . The initial goal of a company is to earn profits for the shareholders through the manufacturing and supply of goods and/or services. It is clear that a second dimension should be added to this initial goal. This second dimension is the social responsibility of the company to constantly shape

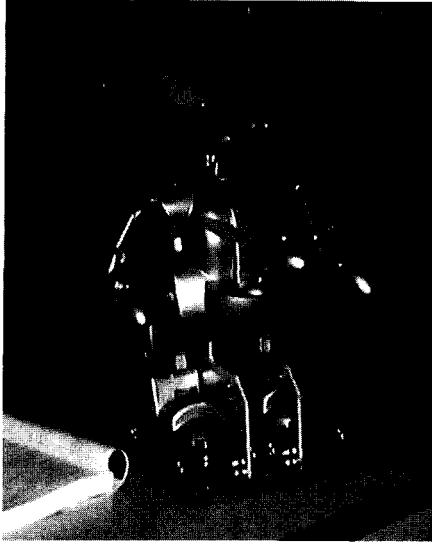


Fig. 1.7 SHARP's Animal-like entertainment robot prototype. Photo by Author.

the knowledge and skills of its employees into a pattern, which will keep them relevant to the current market condition and the evolution of the industry (or emergence of new industry).

- *Education Level:*

Perhaps, we should re-emphasize the true nature of education. It should be a process of developing brain power in mastering knowledge and acquiring skills, on top of understanding theories in a specific field of science and technology. The development of brain power should be considered more important than the memorization of theoretical facts and data. For an individual to be adaptable to a changing environment or job market, which is increasingly dominated by knowledge and skill, it is necessary that he/she adequately develop his/her brain power in philosophy, physics, mathematics, and computing.

- *Social Level:*

The deployment of robots in the manufacturing industry will undoubtedly increase the productivity and quality of goods. This, in turn, will generate more wealth for companies and society. We should make sure that the re-distribution of wealth, generated by the deployment of robots, is wisely regulated, in order to create more jobs and activities for human beings in other employment sectors (i.e. service, entertain-

ment, sports, arts, healthcare, education, research etc.)

Despite social concerns about the displacement of human labor, the wide use of robots in the manufacturing industry will certainly have positive impact, as well:

- *Productivity:*

It is impossible to achieve a high production yield using human labor, because the biological system cannot deliver continuous physical effort without rest. There is no doubt that automation with robots will increase productivity.

- *Flexibility:*

The winning characteristics in manufacturing today are volume, price, quality and service. Automation using robots will add a fifth characteristic: choice. In other words, the ability to supply customized products or services in a timely manner. A company which wishes to offer choices to its customers must have flexibility in configuring and operating its production line. Therefore, flexible automation or agile manufacturing is the key to success in today's manufacturing industry. The robot, being re-programmable equipment capable of executing various motions within a reasonably large working space, is undoubtedly one of the best types of equipment for flexible automation.

- *Quality of Products:*

Humans are not capable of making things with a consistent degree of accuracy. For example, our vision does not make metric measurements when performing tasks. And, without accurate visual guidance, we cannot perform motions with any reasonable degree of accuracy or replication. Robots can not only execute accurate motions repeatedly, but are immune to the emotional states which affect human's performance.

- *Quality of Human Life:*

The use of robots can free humans from doing dirty, dangerous, and difficult jobs.

- *Scientific Discipline:*

The proliferation of robots in industry reveals the importance of *robotics*, the study of robots as a scientific discipline for education and research. Indeed, robotics is an important subject in engineering, and is being widely taught in any university having an engineering department.