# Human performance

When we use humans to control things (either manually or as supervisor), we would like to know how well they are doing. For this, we need human performance models. In this chapter, we first examine supervisory control, and how humans are involved in it. Second, we look at the errors which humans make. Finally, we examine human thoughts; we delve into the secrets of cognition.

## 1 Supervisory control

### 1.1 What is supervisory control?

When dealing with very complicated plants, human operators cannot control everything theirselves. So instead, we let machines control everything. The humans then only act as **supervisors**, exerting supervisory control. Here, **supervisory control** is defined as giving instructions to automatic controllers, who then translate these commands to detailed actions.

When applying supervisory control, there are several steps that have to be done.

1. **Plan** – Think of what you want the machine to do.
2. **Teach** – Tell the machine what it needs to do.
3. **Monitor** – Check if the machine is doing what it needs to do.
4. **Intervene** – If the machine doesn't exactly do what you want it to do, manually change things.
5. **Learn** – When a plan doesn't fully work out, insert a better plan into the machine.

Even when you use supervisory control, humans still need to be informed of what is happening in/around the plant. This can be very complicated, as tens of thousands of variables may be involved. These data need to be displayed in a simple and intuitive way. One example in which this could be done is the **synoptic display**, which shows a schematic overview of the plant. Another type of display is the **polar star display**. Here, several parameters are displayed together in a circular fashion. The higher a parameter is, the further away it is displayed from the center.

### 1.2 Supervisory control and humans

Automation isn't always positive. There are often risks involved. When there is too much automation, humans might get unemployed, lose skills, feel unproductive and/or feel like they lost power. Next to this, for automation to work, humans must also trust automation. When they don't know what machines are doing, why they're doing it and/or how to influence them, then they will not gain trust in the automation technology. Trust can only be achieved when a human perceives competence in automation.

Let's examine a human applying supervisory control. A model describing the human performance is called a **human performance model** (HPM). One way to get such a model is by modeling the processes/physics in a human. We then wind up with an **anthropomorphic model**.

When examining a human, we also need to keep track of what this human knows and perceives. The knowledge of the human operator about a system and the task to be performed is called the **internal representation**. However, it is usually quite hard to find out exactly what the human perceives/knows. So we use a model of this internal representation. This model is called an **internal model** and is used in a human performance model.

# 2 Human errors

## 2.1 Types of errors

Making errors is human. But what exactly is an error? An **error** occurs when an action, or a series of actions, fails to achieve the desired result, and this failure cannot be attributed to some chance event.

There are two kinds of errors: slips/lapses and mistakes. A **slip/lapse** occurs when the intention of the operator is correct, but the action is wrong. (E.g. misreading an altimeter.) A **mistake** occurs when the intention is wrong. (E.g. reading an altimeter and interpreting it as the height above the ground.) While slips/lapses are generally skill-based errors, mistakes are rule-based or knowledge-based errors.

We can also make a distinction between active and latent errors. An **active error** is an error with (nearly) immediate consequences. (Think of accidentally pushing the control stick all the way forward.) On the other hand, a **latent error** is an error with delayed consequences. Only after days, weeks or years will the consequences take place. (Think of a design error which will only cause problems when the aircraft becomes a bit old and rusty.)

## 2.2 Why do errors occur?

Let's ask ourselves, why do errors occur? Slips/lapses generally occur due to **underattention**, when you accidentally apply the wrong action, or due to **overattention**, when you apply an action too fast/too eagerly. Rule-based mistakes can be caused by two things. You could apply the right rule at the wrong time/place. (E.g. when you quickly break in front of a red traffic light, not noticing that there's a huge truck closely behind you.) But rule-based mistakes can also occur due to bad rules. (E.g. when you have the habit of accelerating when you see an orange traffic light.) Finally, there are also knowledge-based mistakes. These can be caused by misinterpreted information, overconfidence, illusory correlations, etcetera.

**Error shaping factors** are factors that make your errors more likely or less likely. For example, the frequency of use influences the likelihood of making skill-based slips. Similarly, the mind set of a person influences the likelihood of making rule-based mistakes. Finally, the amount and the usefulness of the available information influences the likelihood of making knowledge-based mistakes.

## 2.3 Preventing and predicting errors

How can we prevent errors? Making errors is human. So you could argue to apply as much automation as possible. However, there are a few problems with this. The designer of the automation is also human. So errors may slip in there too. Next to this, there are always tasks that cannot be automated. By automating the rest of the tasks, you reduce the amount of practice which the human operator gets. This will result in a worse performance when the efforts of the human operator are required. So, when trying to reduce errors, we should always check if our actions have the desired effect.

When we cannot prevent errors, we can at least try to predict them. An example of a technique which does this is the **technique for human error rate prediction** (THERP). In a so-called **probability risk assessment** (PRA), we model the system and its failures. Using this model, we can then calculate the probability of success of a mission. Of course, the downside is that we have to make several assumptions while developing our model. Do the events that turn up in incident analyses actually cause accidents? And aren't there other unknown events which might cause accidents as well?

Once an error has occurred, you should of course try to find the cause. But more importantly, you should make sure that the error cannot be made again. A very tempting but generally bad solution is to fire the error maker. Instead, you should take the point of view of the error maker at the point where he made the error. Were his decisions necessarily wrong? Or is the error caused by some underlying anomaly? If that is the case, then you should fix the anomaly, instead of firing the error maker.

# 3 Cognition

**Cognition** is the scientific term for the process of thought. Classic **cognitive psychology** focusses on processes inside the head, like memory, matching, pattern recognition and such. **Ecological psychology** focusses on the environment. What happens in the environment determines for a large part the reactions of human beings. An extension to this is **naturally situated cognition**. This is the view that our cognition doesn't only depend on the environment, but also on culture, upbringing and more. So cognition is best studied in an as big as possible picture.

When studying cognition, what should we look at? There are several important fields.

- **Anthropology** – By understanding humanity across the ages, we will also be able to better understand the influences of culture and knowledge on cognition.
- **Linguistics** – By understanding the languages which humans use, and how they use them, we will know better how language influences cognition.
- **Semiotics** – This is the study of signs and symbols. It allows us to understand how meaning is constructed and understood.
- **Sociology** – How do people influence eachother? What effects does this have on how people think?
- **Philosophy** – How do people consider their own existence? And how do they consider their own knowledge and beliefs?

There is a reason why cognition is so important. We have to understand how a pilot uses his flight deck, and how it influences his thoughts and believes. Only then will we be able to really improve it.