Basics of human-machine interaction

To start off our journey in the wondrous world of human-machine interaction, we first need to learn some basic principles. What is human-machine interaction, and how can we characterize it? That is discussed here.

1 Introduction to human-machine interaction

1.1 The history of human-machine interaction

Ever since humans started to build tools, there was interaction between the humans and the machines. This interaction has evolved over time.

Initially, before the second world war, people were adjusted to fit to machines. In other words, humans were **trained** to use the machines. However, in the second world war, new equipment was developed so quickly that it was hard to sufficiently train humans. So the need for a systematic analysis and synthesis of the interaction between humans and machines arose.

The history of human-machine interaction can be split up into four time zones. First, in the years 1940 to 1955, developers tried to find the **limits** of human possibilities. New equipment was designed such that human controllers would just be able to deal with it. From 1955 to 1970, things advanced. In this time, researches tried to model the humans like **machines** and design products accordingly.

Around 1970, electronics were advancing. So from 1970 to 1985, this technology was used to automate a lot of tasks which normally required humans. The human stopped being the controller and started becoming the **supervisor**. This advanced much more since 1985. Now we take into account several complicated things, like **workload**, **cognitive process models**, **situational awareness** and more.

1.2 Eliminating human mistakes

Making mistakes is human. But the amount of mistakes needs to be minimized. The amount of mistakes highly depends on the workload. If the workload is too high, humans become tired (**fatigue**) and start to make errors. However, if the workload is too low, humans become bored and make mistakes as well. So, the amount of workload needs to be optimized.

To get rid of human mistakes, engineers initially tried to do this by eliminating the human as much as possible. However, a newer approach is to involve humans in the right way. By making a good joint-cognitive system, the workload is appropriate and the situational awareness is high.

1.3 Wickens' model of human information processing

A central topic in human-machine interaction is the way in which humans process information. One way to model this is by using **Wickens' model of human information processing**. This model consists of several parts.

- **Sensory processing** – The input (called **stimuli**) comes from all the human senses (also known as **sensory systems**).
- **Short-term sensory store** – Each sensory system has a mechanism which prolongs any stimulus for a short time after the stimulus has occurred.
- **Perceptual encoding** – The stimuli are assigned to a single perceptual category. This is also known as **detection**, **recognition**, **identification**, **categorization**, **pattern recognition**, etcetera.

- **Decision making** and **response selection** – After categorizing the stimulus, you must decide what to do with it.
- **Response execution** – The response (**action**) is executed.
- **Feedback** and **information flow** – You monitor the consequences of your action.
- **Attention** – You select information sources to be processed. (For example, when you hear a suspicious sound, you decide to pay more attention to your hearing than to your eyesight.)

2 Human behavior

2.1 Skill, rules and knowledge

Human behavior is often split up into three categories. There are skill-based, rule-based and knowledge-based behavior. (This is the **SRK model**.) Each of these behaviors works differently. Also, they are caused differently. Let's examine these three categories.

Skill-based behavior (SBB) concerns the basic motor performance of your body. You generally don't think about this kind of behavior: it's just something which you learn. An example is standing up straight. Without knowing it, your feet make sure that you continue to stand up straight. Skill-based behavior is caused by (continuous) **signals**. You then subconsciously use these signals to control something. Because this doesn't involve any conscious thought, SBB is a very fast type of behavior.

When applying **rule-based behavior** (RBB), you are using stored rules. These rules are often learned by experience or have been communicated by others. An example of rule-based behavior occurs when a child suddenly crosses the road in front of your car. When this happens, you have learned to break. Rule-based behavior is thus mostly caused by **signs/events**. The rules then imply which event cause which response. RBB is often confused with SBB. But the most important difference is that in RBB you can explain which rules you use, while with SBB you cannot.

Sometimes simple rules won't get you to your goal. In this case, **knowledge-based behavior** (KBB) is used. In this behavior, plans are developed and traded off, such that you remain with the plan which best reaches your goal. An example of knowledge-based behavior is planning a route to a place you haven't been before. KBB is caused by **symbols**. A symbol is a piece of information which can be used for reasoning.

2.2 Ergonomics

When designing human-machine interfaces, it is often wise to use ergonomics. **Ergonomics** is the application of scientific information concerning humans to the design of objects and systems for human use. Examples are ergonomic keyboards and displays. When these products were developed, scientific data about humans was used.

When applying ergonomics, you have to look at what kind of behavior is present. When influencing SBB, you need to make sure that the user has a clear and continuous feedback signal. On the other hand, when influencing RBB or KBB, the user needs a clear overview of all relevant data, and must know what it all means.