Human-Human Interaction Modeling of Trainer

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Abstract. As the important way to achieve the trainer's teaching function, the design of human-human interaction, especially the interaction between instruct pilot and student pilot should be addressed. For trainers human-human interaction is rather the task itself now than designed for the task. The paper adopts the basic theory of Task Technology Fit (TTF) model to establish human-human interaction model. This model discusses the advantage and disadvantage of three traditional interaction ways and features of three tasks and match the interaction ways with tasks and then get the design requirements and methods to strengthen human-human interaction in trainers. Text message is proposed as a new interaction style for the trainer. The new style is an important complementary for the traditional methods. The new interaction style can give more information to ensure more comprehensive communication between instruct pilot and student pilot and then ensure the teaching function of trainer more effective.

Keywords: Trainer cockpit · Human-human interaction · Ergonomic · Task technology fit model

1 Introduction

Design of Human-human interaction is the key for the design of the trainer. To complete the task of the combat or safe navigation, interaction among the pilots is essential interaction. The basic function of trainer airplane is to help student pilots to learn how to fly the plane. The learning process itself is a form of human-human interaction. The very important task of the instructor pilot in the trainer is to show the student pilots how to fly planes in the context of flying safely. So for trainers human-human interaction is rather the task itself now than designed as the task. The design of the human-human interaction of trainers can't copy the method of fighters or commercial airplanes. We should put forward new design standards and methods for trainers.

2 Features of the Trainer Cockpit

There are always two basic layouts of trainer cockpit, which is tandem two-seat layout and parallel two-seat layout. Tandem two-seat layout trainers have advantages of decreasing the burden of the engine [1], addressing the concerns about observing the student's facial expressions, hand movements and body language [1]

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and the symmetrical field of vision [2] while side-by-side layout trainers are good at the arrangement of instruments, the weight and balance problems [2] and the field of vision [1]. Two pilots are always a student pilot and an instructor pilot (IP). Depending on the different functions, trainers can be also allocated a pilot or weapon operator. The interaction model is built to describe the human-human interaction of tandem two-seat layout trainer cockpit.

Trainers are always equipped with two different control systems for safe flight and effective learn. The relationship between two control systems is related or rejected, which is decided by the requirement of training. In general, control systems of primary trainers and intermediate trainers are related while two control systems of advanced trainers can only have one available in the meantime. The related control systems can help student pilots learn operations from the IP while the rejected control system can help the IP get the control right when dangers occur.

Due to the control system above, the pilot workload is not consistent with time. When student pilot (or IP) control trainers, although IP (or student pilots) has tasks of study or monitoring, the visual or auditory load is still less than driving. This feature leads to the human-human interaction is different from that of two-seat fighters or airlines, which makes it possible to delay interaction and more visual or auditory the interaction.

3 The Model to Describe the Human-Human Interaction of Trainer Cockpit

This chapter develops a matching model of task types-interaction styles to describe the human-human interaction. Basic structure is shown in Fig. 1.

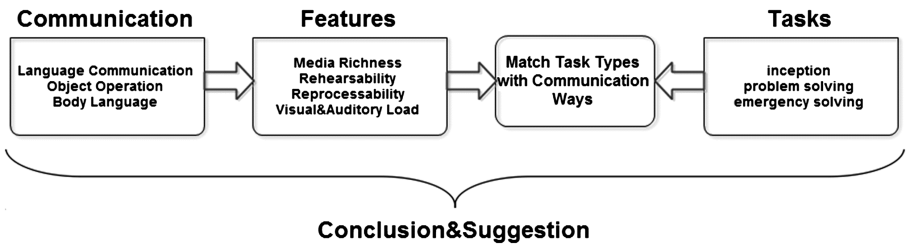

Fig. 1. Matching model of task types-interaction styles

This model firstly discusses three interaction styles of trainers. And then consider different task types from the mission profile and the most suitable interaction ways then can be gotten.

4 Interaction Ways and Media

1. Language Communication
   The media of language communications is radio. Trainer cockpits have two sets. One is for internal communications between the IP and the student pilot while the

other one is for external communications between pilots and ground services [3, 4]. The language communication here refers to internal communications.

2. Object Operation
   The media of object operation is control systems. If a trainer is equipped with related control systems, the IP behind can observe the operation from the student pilot in front and vice versa. If a trainer has a rejected control system, there is no such interaction.
3. Body Language
   Because of the feature of the tandem trainer, the IP behind can observe the operation of the student pilot in front while the student pilot in front can't see IP's operation behind. As above, tandem trainers have advantages of addressing the concerns about observing the student's facial expressions, hand movements and body language. Body language is single-track, which can only transfer from the student pilot to IP in tandem trainers.

5 Features of Interaction Styles

1. Media richness
   Media richness refers to media's ability to enable users to communicate [5]. Better media has immediate feedback, more multiplicity cues, various communication languages, and attracting attention. MRT proposes that if a media is capable of sending "rich" messages which decided by the technology to ensure immediate feedback it is richness [6].
   According to the four indexes above, the evaluation of the three interaction media richness is as follows [7] (Table 1):

Table 1. The media richness of three communication ways of trainers

Interaction style	Richness	Features
Language interaction	High	• Synch • Low Symbol Variety • Acoustics Information • Immediacy Feedback
Object operation	Low	• Synch • Single Symbol Variety • Operation Information • No/Delayed Feedback
Body language	Medium	• Synch • Single Symbol Variety • Body Information • No Feedback

2. Information processing ability
   Information processing ability includes information edit ability and information storage ability. Information edit ability is the ability that the media enables the sender to rehearse or fine-tune a message before sending [8]. The media with edit ability can urge senders to consider seriously before sending messages to make sure that the message is accurate, and improve the information effectiveness and reduce the error probability. Three interaction styles available in the present trainers all lack the edit ability.
   Information storage capability is the ability that a message can be reexamined or processed again within the context of the interaction event [8]. The media with storage capability can make it possible for receivers to have sufficient time to consider and quote past messages. Also three interaction styles available in the trainers all lack the storage capability.
3. The visual and auditory interaction features
   The sensory channel of the pilot can be divided into visual channel, auditory channel, and tactile channel. Visual channel and auditory channel is used widely by pilot. For three interaction styles, language interaction have more auditory load while object operation and body language have more visual load. Compared with the auditory load, visual load is heavier when pilot is flying. So while flying the visual interaction should be avoided. However, auditory interaction may have a problem of noises.

6 Features of the Tasks and Matching with Interaction Styles

1. Inception Tasks
   In the trainer mission profile, many tasks, such as taking off, is familiar both to student pilots and IPs, and has been implemented many times. For these tasks, which called inception tasks, receivers will know senders' meanings with short messages and also know subsequent operations.
   For inception tasks, interaction with low richness is efficient. Object operation and body language should be avoided, because the sender should express and transfer messages clearly. If there is only one inception task, there is no demand of edit capability and storage capability, while if there are several inceptions, edit capability and storage capability is essential for the interaction.
   For three interaction styles available now, language interaction is the most suitable style for inception. But three interactions all lack edit capability and storage capability. So trainers need an interaction style that can edit and save like 'short message' and 'email'.
2. Problem Solving
   The aim of problem solving is to take a most suitable method to complete tasks or behave the student. Problem solving emphasizes the selection of methods.
   For problem solving tasks, interaction ways with immediacy feedback will be most suitable. The complex problem solving tasks should match an interaction way that have high media richness while the simple task only need low media richness.

Almost all tasks only have one correct solution because piloting trainers have strict standards. After solving problems there will be no need to reexamine the interaction, so there is no demand of editing for problem solving tasks.
Depending on different tasks, problem solving should match language interaction or object operation. Tasks that can be communicated clearly without the related control system should match the language interaction to release the visual load while tasks that should be communicated using the related control system should match the object operation or both.

3. Emergency Solving
When an emergency occurs during flying, IP and student pilot should cooperate to solve problem. In the emergency situation all interaction styles should be used to ensure the communication between IP and student pilot. Interaction styles with high media richness and less edit time should be adopted. Finally, with high visual load interaction should be avoided because when an emergency occurs, IP and student pilot need visual interaction to solve problem. Language interaction is the most important way during emergency.

7 Improvement of Interaction Styles

1. Text message interaction
Three interaction ways available now all lack edit capability and storage capability. For messages that should be considered seriously, reexamined or processed, trainers now can't provide an appropriate interaction way to match. The new interaction style like 'short message' and 'email' should be developed. Such interaction way is called 'text messages interaction' in this paper.
When the student is piloting, IP can edit a message to conclude the behavior of the student and arrange the command of inception tasks. Because the student is piloting, the visual and auditory load of IP is less than that the situation that IP is driving. IP is possible to divert attention from tasks to edit text messages interaction. In the meantime, When the IP is piloting, the student is possible to read the message of conclusion and reply because of less visual and auditory workload. These situations

Table 2. Features of text messages interaction

Media richness	Low
Features	• Asynch • Single symbol variety • Text information • Delayed feedback
Edit capability	• High
Storage capability	• High
Visual&auditory load	• High visual load

fit with the feature that the pilot workload is not equality with time.
Features of text messages interaction are as follows (Table 2):
Text messages interaction is good at edit and storage. But the media richness is low and visual load is high. So text messages interaction and language interaction is complementary.
The set of text messages interaction include a control and a display. The function of the control is to edit messages while the function of the display is to read messages. The control needs an equipment to input text. The display doesn't need independent equipment. It can be integrated in a multi-function display. Considering that we use text messages interaction to send complex inception, the arrangement of the multi-function display should avoid flight and navigation information.

2. Matching task types with interaction ways
For inception tasks, if messages are easy, we should take language interaction while if messages are complex, we should take text messages interaction.
For problem solving tasks, we should take language interaction or object operation. Tasks that can be communicated clearly without the related control system should match the language interaction to release the visual load while tasks that should be communicated using the related control system should match the object operation or both.
For emergency solving, all ways should be made to ensure the interaction between IP and student pilot while language interaction is the most important ways during emergency.
The matching of task types and interaction ways are as follows (Table 3):

Table 3. Matching of task types and communication ways

Interaction ways	Language interaction	Text-messages interaction	Object operation	Body language
Media richness	High	Low	Low	Medium
Edit capability	Low	High	Low	Low
Storage capability	Low	High	Low	Low
Visual & auditory load	High auditory load	High visual load	High visual load	High visual load
Main matching tasks	1. Easy inception 2. Easy problem solving 3. Emergency solving	Complex inception	Complex problem solving	Single track feedback from student pilot to IP

8 Conclusions

In the design of the trainer, human-human interaction should be addressed. For trainers human-human interaction is rather the task itself now than designed for the task. The design of the human-human interaction of trainers can't copy the method of fighters or commercial airplanes. We should put forward new design standards and methods for trainers. Only adjusting the position of human-human interaction in the design of trainers can we design a better trainer.

Before the design of human-human interaction of trainers, we should be clear about the feature of trainers. The specific operating system makes it possible for delay interaction and the interaction that have much visual or auditory load, which are not available for fighters. We should find out the specific of trainers to find the most suitable human-human interaction ways for trainers.

The paper adopts the basic theory of Task Technology Fit (TTF) model to establish human-human interaction model. This model discusses the advantage and disadvantage of three traditional interaction ways and features of three tasks and match the interaction ways with tasks and then get the design requirements and methods to strengthen human-human interaction in trainers. Text message is proposed as a new interaction style for the trainer. The new style is an important complementary for the traditional methods. The new interaction style can give more information to ensure more comprehensive communication between instruct pilot and student pilot and then ensure the teaching function of trainer more effective.

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