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TITLE

CRM: MORE THAN JUST TALK, TALK, TALK, TALK.....

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CRM: MORE THAN JUST TALK, TALK, TALK, TALK...

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INTRODUCTION

Traditional CRM training has placed great emphasis on how crews communicate. But what is the role of communication between crewmembers? The following piece was originally written in a brain storming attempt to put the role of communication into perspective within the often elusive concept called crew resource management (CRM). The concepts that are discussed apply to single-seaters as well as multi-place crews.

In 1994 our laboratory (the Toronto-based Defence and Civil Institute of Environmental Medicine or DCIEM) was tasked by the Canadian Forces Air Transport Group to investigate human factors issues in CC-130 *Hercules* operations. Our recommendations for improving safe flight performance in this fleet focused on two areas:

- knowledge of aircraft systems, and
- leadership/captaincy/decision making.

In looking at captaincy, we turned to the Aircrew Co-ordination Training course (a.k.a. CRM) as the most likely area for addressing this issue. The approach we have taken focuses on decision making, and by implication workload/situation awareness management. Therefore the basic concepts apply equally to single seat and multi-place aircraft. Remember that your crew includes, as appropriate to the platform you fly, those warm bodies in the aircraft with you, your wingmen, the AWACS crew etc., plus the automation you have available to you (the electronic crew). The *other* crew member may well be a silicon chip.

In the following discussion, three hypothetical types of aircrew are defined. They are *SuperPilot*, *DreamTeam* and *SuperbPilot* (you?). Many of the concepts for *SuperPilot*, *DreamTeam* and *SuperbPilot* came from theoretical work we have been involved with at DCIEM. For example.

The Information Processing (IP) Model. The IP model claims that all factors that determine operator workload can be reduced to their effect on the amount of information that has to be processed, or their effect on the time available before a decision has to be implemented. Under the assertion that humans are limited in the rate at which they can process information, operator workload, performance and error production can all be shown to be functions of the *time pressure* or the ratio of *time to process* the information to the *time available*.

The Perceptual Control Theory (PCT) Model. The PCT model is based on the assertion that all living organisms operate as a multi-layered closed loop control system. The set points for the control loops are the organism's goals (or how one wants to see the state of the world). PCT asserts that all observable behaviours are intended to operate on the external world so that the perceived world state matches a desired state (the goal). This model provides a coherent framework for integrating the concepts of workload, situation awareness, mental models and decision making performance. It establishes the absolute necessity of feedback in goal directed activity (that really is everything we do).

SUPERPILOT, DREAMTEAM AND YOU

Imagine an ideal flight deck that is run by a single individual — the *SuperPilot*. What does this *SuperPilot* do?



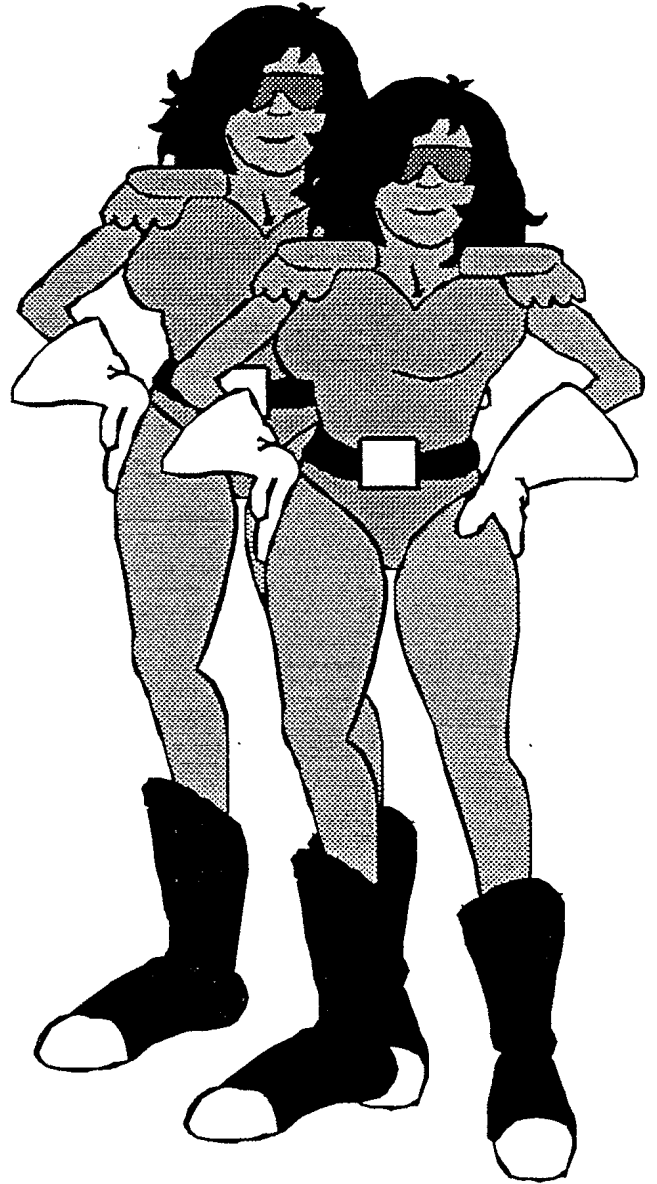
SuperPilots are decision makers, establishing goals, forming perceptions about the world, comparing these perceptions with their goals and acting to correct discrepancies. *SuperPilots* ensure that the most important information processing loops are always controlled by prioritising. Results from lower level loops are fed to higher level loops by relatively high speed neural communication. These pilots are super proficient, so their mental models always contain the knowledge required to form the appropriate actions. Actions are always consistent with *SuperPilot's* overall state of knowledge (what we might call their mental models and situation awareness) and are goal driven with no slips, lapses, omissions etc.. The only resource managed is *SuperPilot's* attentional resources — that is, what loops are to be controlled, at what level of precision, at any point of time. Resource management is entirely internal.

But we only have a few *SuperPilots* around, not enough to staff the Air Force, so the next best thing is the *DreamTeam*. *DreamTeam* crews have exactly the same life experiences and share common mental models and goals. Because each individual takes a little longer to process information and make the mechanical actions needed to operate all the systems on board, two team members are required on the flight deck.

So what does the *DreamTeam* do? The functions are exactly the same as for *SuperPilot*, but now there is a requirement for communication between the flight crew. What might this communication be about?

Because these team members share the same goals, priorities and mental models, anything attended to in the external environment will be perceived identically by the members of the *DreamTeam* — their actions in all circumstances will be identical and indistinguishable. Therefore the *DreamTeam* would communicate in order to:

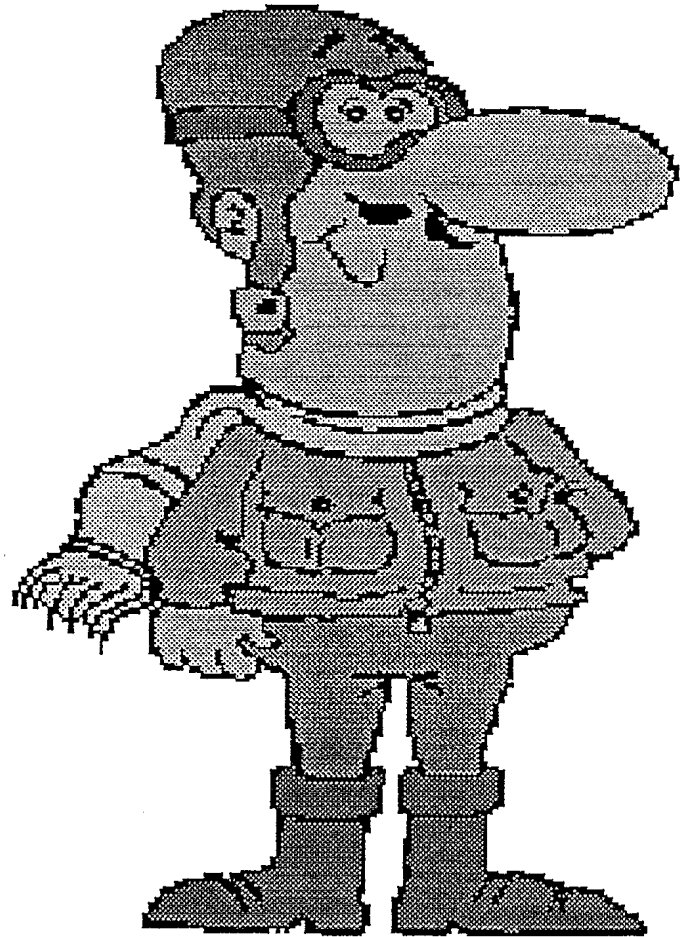
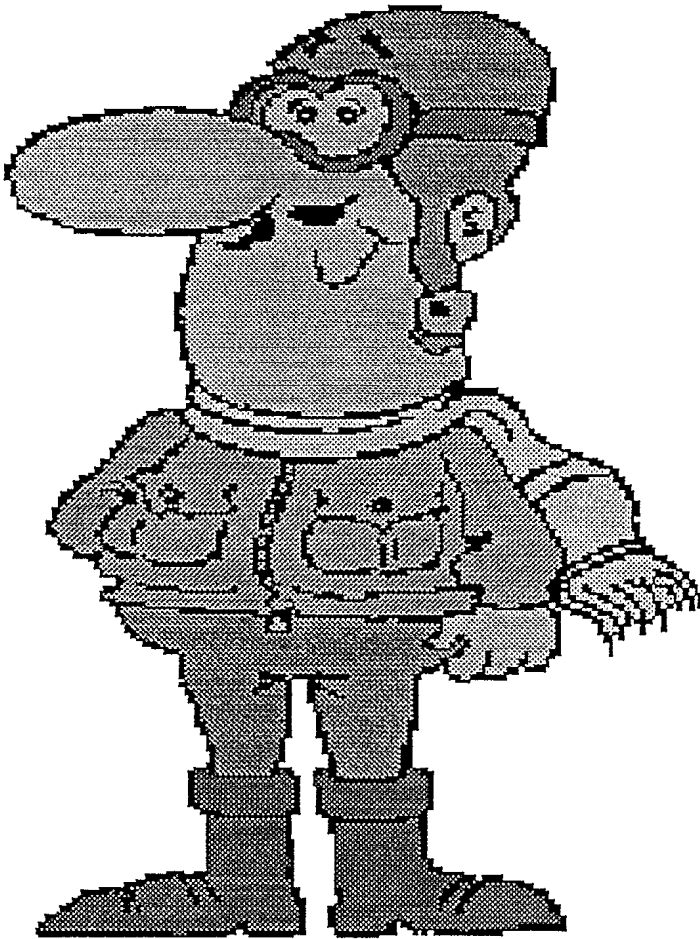
- Allocate responsibilities (otherwise both members of the *DreamTeam* will be reaching for the same controls at the same time in response to changes in the external environment). The only way the *DreamTeam* can approach the performance of *SuperPilot* is by dividing the task load and not competing for control.
- Pass the results of internal processes (i.e., thinking without observable action) so that the internal mental models of both team members remain the same.
- Provide feedback on system states that are not within the common locus of attention (because of the division of duties, each member of the *DreamTeam* might be attending to different things).
- Direct attention i.e., inviting direct observation rather than using verbal descriptions to convey information.



The *DreamTeam* will operate at a slightly lower level of precision than *SuperPilot*. This is a direct function of the time lost in external versus internal communication speeds. The only new functions for *DreamTeam* are the requirements to allocate responsibilities and to replicate the complete

mental model in the other crew member at all times. This suggests a Captaincy or Leadership role for one of the *DreamTeam* members (because the *DreamTeam* are entirely in tune with each other, each will come up with the same division of duties for the other — this needs to be resolved!). There is no need to assign a principle decision maker or leader as each member will make the same decisions given a common state of situational knowledge. In essence each knows what the other will do in a given situation. However, the role of splitting the load should be assigned to one of the *DreamTeam* crew in order to avoid the need for conflict resolution.

The last of our *DreamTeams* took an Early Retirement Package and now works for Air Canada, so most of our crews are made up by the *SuperbPilot* variety of aviators. These crews come to the job with different life experiences and some common training for the task. They have different levels of proficiency as measured by their state of knowledge (mental models) of the environment. Their decision and action times are such that they cannot accomplish all the



tasks to the same level of precision that *SuperPilot* and the *DreamTeam* can. Therefore they have to shed more tasks than their more proficient peers and prioritisation (what they choose to attend to) assumes greater importance.

Time management is the critical issue at all levels of proficiency from *SuperPilot* down to *SuperbPilot*. It is a constant trade-off between speed and precision of performance. Therefore a

hub (principle decision maker or PDM — say the Aircraft Commander, Mission Commander etc.) and spoke (secondary decision makers, automation) arrangement of the team is called for.

Where there is the possibility of more than one outcome in a given situation someone has to choose. Pre-assignment of this responsibility resolves uncertainty and saves time. And time is the critical resource.

The mental models of the *SuperbTeam* members can not be assumed to be identical and therefore their decisions/actions will not be the same. The PDM must assume that certain assigned activities will be completed by the team members. This allows the PDM to delegate responsibility and switch attention to other tasks. Confirmation of final results may be all that is necessary. Only through this type of off-loading can the PDM free up time to control the high level loops that are essential to the executive role of the PDM, for example, strategic goal setting, risk management. This can not be done at the expense of overloading the secondary decision maker(s), however, as this can adversely effect the outcomes of the delegated tasks!

So now to the list of communication functions for the *DreamTeam* one could add:

- Establish common goals. If team members are trying to accomplish different goals the system will go unstable particularly if both are controlling the same elements in the environment. This is a fundamental property of multiple controller systems.
- Build common mental models of system states. This pertains only to the mental models that each member of the team might call on to control the loops they are responsible for. Not everyone needs to know everything, and in a time pressured environment this is an unaffordable luxury. However, as time permits, the alignment of mental models should be a goal.

When we are dealing with human-human interaction, rather than strictly human-machine interaction, a secondary communication role emerges related to:

- Establishing and maintaining effective external communications. This involves:
 - establishing leadership,
 - establishing the level of trust,
 - establishing the authority gradient,
 - establishing receptiveness, attentiveness, cooperativeness, assertiveness etc.

SUMMARY

The roles of communication in a flight deck of *SuperbPilots* can be summarised as follows.

- Allocation of responsibilities (AC, MC).
- Establishing common goals (AC, MC).

- Building common mental models of system states (All).
- Providing feedback on system states and directing attention (All).
- Establishing and maintaining communication channels in human-human interactions (All).

From this list of functions, and the theoretical framework provided by the IP and PCT Models, we can formulate a list of topics that might be included in a CRM course — or perhaps what might be more appropriately called a *Human Factors in Decision Making* course. From these topics a skill set can be derived that would also form the basis for an assessment system. A course structure might be.

- Introduction to the Decision Making Loop.
- Leadership and Followership.
- SuperPilot, DreamTeam and You.
- Sensation/Perception.
- Goal Setting.
- Action Selection.
- Resource Management.
 - Management of Control and Attention.
 - Management of Time Pressure.
 - Management of Knowledge.
- Communication.

This syllabus is just as relevant to single seaters as it is to multi-place crew, because it is all about making better and more timely decisions. The type of problems seen in human-human interactions, are also seen in human-machine interactions. The single-seater must manage control, attention, time pressure, and knowledge in exactly the same way that a multi-place crewmember does. It is just that the machine and human resources, that they both draw on, may differ.

CRM has been an idea borne of necessity but lacking a theoretical framework to provide focus. CRM programmes generally concentrate on the process (e.g., communication) rather than the product (e.g., to support better and more timely decision making). Our concern has been that traditional approaches to CRM training do not provide either the requisite skill, or the top level knowledge to guide behaviour, that will improve the safety and efficiency of our flight operations. The report of the Colombiana Aeronautica Civil into the 1995 accident to AA965, near the city of Cali, came to similar conclusions.

However theoretical positions exist, such as the one briefly described here, that focus much of what has been traditionally taught under the CRM rubric. These theoretical frameworks can provide a top level understanding of the subject which should aid in the retention of the material. What is more important, we might expect that this knowledge will be more readily used, to guide behaviour,

when it is really required — when things are going terribly wrong. Rather than trying to remember what some strange acronym, you learnt once in CRM school, stands for, you might start asking the following basic questions of yourself and your crew (including the automation).

- What are you trying to do (the goal)?
- Who's controlling what?
- What is the situation (the mental model)?
- What are the implications of the situation?
- What am I going to do about it?

Now your only problem is to manage your time pressure so that you can attend to this information (knowledge). Good luck, you have control..

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