3 Philosophy, policies, procedures and practices: The four ‘P’s of flight deck operations

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Introduction

Background

A complex human-machine system is more than merely one or more operators and a collection of hardware components. To operate a complex system successfully, the human-machine system must be supported by an organizational infrastructure of operating concepts, rules, guidelines, and documents. The reactivity, in terms of consistency and logic, of such operating concepts is vitally important for the efficiency and safety aspect of any complex system.

In high-risk endeavours such as aircraft operations, space flight, nuclear power, chemical production and military operations, it is essential that such support be flawless, as the price of deviations can be high. When operating rules are not adhered to, or the rules are inadequate for the task at hand, not only will the system’s goals be thwarted, but there may be tragic human and material consequences. Even a cursory examination of accident and incident reports from any domain of operations will confirm this.

To ensure safe and predictable operations, support to the operators often comes in the form of Standard Operating Procedures (SOP). These provide the crew with step-by-step guidance for carrying out their operations. SOPs do indeed promote uniformity, but they do it at the risk of reducing the role of the human operators to a lower level. Furthermore, an exhaustive set of procedures do not absolutely ensure flawless system behaviour; deviations from SOP have occurred even in highly proceduralized organizations.

The system designers and operational management must occupy a middle ground; operations of high-risk systems cannot be left to the whim of the individual. But they likewise must recognize the danger of over-procedurization, which fails to exploit one of the most valuable assets in the system, the operator who is close to the actual operation. Furthermore, the alert system designer and operations manager recognize that there cannot be a procedure for everything, and the time will come when the operators of a complex system face a unique situation for which there is no procedure. It is at this point that we recognize the reason for keeping humans in the system: since automation, with all its advantages, is merely a set of coded procedures executed by the machine. Procedures, whether executed by humans or machines have their place, but so does human cognition.

A dramatic example was provided by the Three City accident in which a United Airlines DC-10 suffered a total loss of hydraulic systems, and hence aircraft control, due to a disintegration of the centre engine fan disc (NTSB, 1990a). When he had sized up the situation, the captain turned to the flight engineer and asked what the procedure was for controlling the aircraft. The reply is worth remembering: ‘There is none! Human ingenuity and resource management were required: the crew used unorthodox methods to control the aircraft. This resulted in a crash landing, which left alive half of the passengers and crew survived.

This chapter is a continuation of our previous work on the human factors of aircraft checklists in air carrier operations (Degani and Wiener, 1990). Our work in this area was undertaken largely as a result of the discovery, during the investigation of the Northwest 255 crash, that checklists, for all their importance to safe operation, had somehow escaped the scrutiny of the human factors profession. The same, we found out, can be said of most flight deck procedures. We felt that our work in checklist design and usage would not be complete until we gave equal consideration to cockpit procedures.

Procedural deviation: Its influence on safety

Problems within the human-procedure context usually manifest themselves in procedural deviation. If all goes well, these deviations are not apparent to the operational management, and in most cases are left unresolved. They do become apparent, however, following an incident or an accident. Laurian and Gallimore (1980) conducted a study of jet transport aircraft accident reports to ‘better understand accident cause
As mentioned earlier, it is common in all high-risk systems that critical tasks that affect the objectives of the system are always accompanied with a set of procedures. Procedures, in turn, specify a set of sub-tasks or actions to be completed; that is, each procedure can be shown to lie between a higher level task and lower level sub-tasks. Figure 3.2 shows this structure. The structure, or pyramid, ends with the system goal, e.g. flying passengers from point A to point B.

The task-procedure hierarchy allows one to make the distinction between a checklist and a procedure (as the two are often confused). A checklist is a device (paper, mental, audio or electronic format), that exists to ensure that certain actions are carried out. A checklist is not, however, a procedure per se. The confusion may arise from the fact that conducting the checklist procedure is a task which is specified by a higher level procedure (e.g. 'the taxi checklist shall be conducted once the aircraft starts to move on its own power').

Philosophy and Policies

Philosophy

The cornerstone of our approach to the concepts of cockpit procedures is philosophy. By philosophy we mean that the airline management determines an over-arching view of how they will conduct the business of the airline, including flight operations. A company's philosophy is largely influenced by the individual philosophies of the top decision makers, but also by the company's culture, a term that has come into favour in recent years in explaining broad-scope differences between corporations. The corporate culture permeates the company, and a philosophy of flight operations emerges. (For a discussion of cultural differences between carriers, see various chapters in Wiener et al., 1991.)

Although most airline managers, when asked, cannot clearly state their philosophy, such philosophies of operation do indeed exist within airlines. They can be inferred from procedures, policies, training, positive actions, etc. For example, one company that we surveyed had a flight operations philosophy of granting considerable discretion (they called it 'wide latitude') to the individual pilot. Pilots are schooled under the concept that they are both qualified and trained to perform all tasks. Consistent with this philosophy, the company until recently allowed the first officer to call for as well as conduct the rejected take-off (RTO) maneuver (a maneuver which is only at the captain's discretion at most carriers).

The emergence of flight deck automation as an operational problem has recently generated an interest in the philosophy of operations, partly due to lack of agreement about how and when automatic features are to be used, and who may make that decision (Wiener, 1989). This led one carrier, Delta Air Lines, to develop a one-page formal statement of
Figure 3. The figure shows a diagram with various components and labels related to a scientific concept. The labels indicate different parts and functions within the system depicted. The diagram is complex and requires careful examination to understand the relationships and processes illustrated.
The fourth ‘P’: Practices

An extension of the three ‘P’s

In the first two sections of this chapter we focused on the global aspects of flight operations: the philosophy, policies and procedures (Degani and Wiener, 1991). As we progressed in this research, it appeared to us that something was missing. We neglected and ignored the ultimate consumer of the procedure – the pilot – whose decisions and actions determine the ‘system outcome’.

To correct this, we have added an additional component – practices. A practice is the activity actually conducted on the flight deck. While procedures must be part of a structured framework, it is the crew members who must carry them out. It is the pilot who will either conform to a procedure or deviate from it. The procedure is specified by management – the practice is conducted by the crew. Ideally they should be the same. The high prevalence of the ‘pilot deviation from SOP’ classification (Lauman and Gallimore, 1988) indicates that no one can assume that operations will always follow any given procedure dictated by flight management.

The goal of flight management is to promote ‘good’ practices by specifying coherent procedures. But we must also recognize that this is not always the case – procedures may be designed poorly. The crew can either conform to a procedure or deviate from it. The deviation may be trivial (e.g. superimposing some non-standard language on a procedural callout), or it may be significant (e.g. not setting the auto-brakes according to the take-off procedures). The alternatives of conformity versus deviation can be visualized as a switch (Figure 3.4). This may be somewhat of an oversimplification, but it expresses the choice that the crew member must make: to conform or to deviate. The reasons for and consequences of ‘placing the switch’ in the ‘deviate’ position will be explored later in this chapter.

We envision a term ‘\( \Delta \)’ – delta, or the degree of difference between procedures and practices (Figure 3.5). This ‘\( \Delta \)’ (not to be interpreted as a quantitative value by any means) expresses the amount of deviation from a specified procedure. This term has two components: (1) the magnitude of deviation from the procedure, and (2) the frequency of such deviations during actual line operations. The goal of flight management is to minimize \( \Delta \). When \( \Delta \) is large (flight crews constantly deviate from SOP and/or deviate in a gross manner) there is a problem. It may be due to a culpable crew, or in the case where there are frequent violations by many flight crews, a problem in the procedure itself.

The pilot, in this situation, is analogous to a ‘filter’. From the above, standards and training departments dictate and teach the way procedures...
Features of the four ‘P’ framework

Our four ‘P’ framework is an extension of the three ‘P’ framework, taking into account the following: tasks, crews, practices, quality assurance and the system outcome. Figure 3.6 is a graphical depiction of the inter-relationship of these elements. The top half of the chart is essentially the same as Figure 3.3. But when we get to the circle ‘crew’ we open the door to practices (and A).

Deviant behaviour In this section we shall examine several reasons why A exists. Why would a well-trained, and presumably well-motivated pilot, purposefully deviate from the company’s published procedures? Listed below are a few of the reasons:

- Individualism. A arises primarily due to the fact that pilots are individuals, and in spite of training, loyalty and generally a devotion to safe practices, they will impose their individuality on a procedure. This may or may not adversely affect the system. We also recognize that there is a positive side to individualism: it is one of the differences between humans and computers. Individualism makes life interesting and provides us with an incentive to achieve. Pilots are not ‘procedures executors’; they are individuals who bring to their job certain biases, prejudices, opinions and self-concepts. Furthermore, humans possess brains that allow great flexibility, and this can become critically important in extreme cases where no procedure is available, e.g. United’s Sioux City accident, previously mentioned (NTSB, 1990a). The problem is the potential conflict between individualism and standardization in high-risk enterprises.

We once observed a captain making a altitude change (FL370 to FL260). He abandoned the already programmed VNAV mode in favour of the V/S mode. Asked why he preferred to disengage VNAV he said: ‘just because its fun to have “manual” control over the aircraft.’

- Conspicuity. It is well established in aviation that a pilot’s vigilance may not always remain at its highest, or even an acceptable level at all time. This phenomenon, of dropping one’s guard, is generally labelled ‘conspicuity’. Wiener (1881) has questioned whether the term has any real meaning, and whether its use makes any real contribution to understanding safety. Pending an answer to this question, it seems safe to say that conspicuity, as the term is used, may be responsible for many departures from SOP.

It is the very safety of the system that may generate conspicuousness and non-adherence to SOPs. If day after day, year after year, pilots encounter few threats, and few genuine emergency situations, the temptation to ease up and accept less than standard performance is understandable. Recent work by Parasuraman and his collaborators have examined what they call ‘automation complacency’, the tendency to become overly trustful and over-dependent on various automatic devices in the cockpit (Parasuraman et al., 1991). Again, it is the unerring quality, the high reliability of these devices, that may induce pilot complacency.

- Humour. Humour is closely related to individualism, while its negative consequence may be related to complacency. Humour in the cockpit represents the desire to inject some variety and stimulation into an otherwise humourless situation. Humour, like individualism, has its place. It makes life enjoyable, overcomes the tedium of a highly precise job, and establishes a form of communication between crew members. It also carries potential hazards – it can be at odds with standardization.

We have observed in checklist reading behaviour, for example, when the pilot reads ‘gasoline’ where the checklist requires a challenge of ‘fuel’, or the use of the Spanish term ‘unomas’ instead of 1000 ft to level-off callout. These departures are inevitable, as they break the monotony of a highly standardized and procedured situation. The meanings are assumed to be clear, so the departure from SOP is in most cases harmless. However, that is exactly what cockpit standardization is all about – trying to eliminate the need to make unnecessary assumptions during high-risk operations. The difficult question, of course, is where to draw the line. Unfortunately, the absolute distinction between what is humour and what is a deviation from SOP depends on the outcome. If this humour caused a breakdown in communication that led to an incident, then it would be labelled ‘deviation from SOP’. If it did not result in an untoward consequence, it could be regarded as humour.

Noneetheless, we take the position that there are still breaches in cockpit discipline that should not be taken lightly, as the following example illustrates. We once observed a take-off in which the captain was the pilot flying. The first officer was supposed to make standard airspeed calls of V-1, V-2 and V-2. Instead, he combined the first two into a non-standard call of ‘V-one-dot’, and at V-2 said ‘two of em’. Obviously, the captain knew what was meant by these strange calls, and while one cannot say that this was a dangerous compromise with safety, it did represent a serious
has brought a plethora of techniques, largely consisting of ways in which pilots chose to employ the automatic devices and modes. These techniques are the result of the great variety of ways in which a task can be accomplished in a high-technology aircraft, due to its many modes and options.

A common example is the automatic level-off manoeuvre. Many pilots feel that left to its own, the auto-leveling produces flight maneuvers that are safe and satisfactory, but could be smoother and more comfortable for the passengers. Pilots also believe that in the auto-level-off maneuver the authorities are too aggressive. As a result of this, many have developed techniques to smooth these actions; most of these techniques involve switching autopilot modes during the level-off. We emphasize that these are techniques and not procedures. They represent the superimposition of the pilot's own way of doing things upon a standard procedure, and as long as the SOP is not violated, it may be all to the good.

Pilot technique is actually accommodated by some modern flight guidance systems. The bank angle limiter, for example, invites the crew to express their preference for maximum bank angles and rates of turn, consistent with the demands of ATC, and the comfort of their passengers.

Other techniques have been developed to 'trick the computer', as Wiener discussed in his 1985 report on glass cockpit human factors. For example, the pilots of a glass cockpit aircraft, wishing to start a descent on VNAV path earlier than the displayed Top of Descent (TOD) point, could either enter a fictitious tailwind into the flight guidance computer, or could enter an altitude for turning on thermal anti-ice protection (which he had no intention of actually doing). Both methods would result in a recomputation of the TOD and VNAV path, with an earlier descent. Why would the pilots do it? Because experience had taught them that the correctness of the VNAV path would result in speeds that would require the use of spoilers, which pilots consider as unprofessional, as well as creating vibration that would discomfort the passengers.

Perhaps the most unusual technique we have observed was demonstrated by a captain of a B-737. Acting as Pilot Not Flying (PNF), he tuned the arrival ATIS on the VHF radio, listened to it, and then rather than writing it on a pad or in a form, he proceeded to etch it into the scratch line of the Control Display Unit (CDU). He then read it from the CDU to the pilot flying. This was a captain who obviously wanted to make maximum use of his automated devices. Of course, this method of recording the ATIS has its limitations, the most severe being that only one person in the world could decode the message as recorded. Still we must presume that this was a technique and not a procedural deviation, unless the company's manual said that the ATIS was to be written out by 'pen and paper'.

Regardless of whether this was or was not a technical violation of company policy, it did seem to violate common sense, that ATIS information should be available to all pilots. What would we have thought if the captain had scribbled the ATIS on a form so illegibly that the first officer could not read it? Furthermore, had a message come into the scratch line, the ATIS message would have been lost. As we have previously said about individuality and humour, technique has its place. It may also have its price.

- Management's view of technique. What view should management take of pilots developing their own techniques? Does the superimposition of 'personal' technique on SOPs represent a compromise with standardization? Once again the answer is to be found in the four 'Ts'. Management must develop a philosophy that governs the freedom of the pilot to improvise, and from this philosophy will grow company policies that will state exactly what the company expects on the line. Our own view is, of course, to return to the definition of Δ. If the techniques employed on the line lead to practices that are consistent with the procedure and the policy, then Δ is zero and management should take little notice of the techniques employed.

If management discovers, through standardization and quality management techniques, or the feedback loop (to be discussed next) that certain techniques may have potential for procedural deviation, then this can be dealt with through the normal quality assurance processes. It is entirely possible that the opposite could occur, that the quality management or feedback processes could discover superior techniques that should become procedures. Check-airmen play a vital role here. While their job is generally quality assurance and standardization, they should be watchful for line-generated techniques that could and should be incorporated into the company's SOPs.

- Technique and CRM. Our discussion of technique has centered on the means of executing company-generated cockpit procedures. The same principles apply to the vast and ill-defined area known as cockpit resource management (Wiener et al., 1985). Pilots develop communication, team-building, stress management and
As we have noted, one of the reasons why pilots deviate from accepted procedures (create positive $\Delta$) is that they think they have a better way. In some cases they might. This view of $\Delta$ portrays it as a negative feedback signal in a closed-loop system. If a corrective path is available, ideally $\Delta$ will be a self-eliminating quantity.

One way of promoting conformity to procedures is by providing a formalized feedback between the operational world and flight management. Some may argue that this is not necessary and that flight management is part of the operational world. On the other hand, the performance of line pilots is the ultimate measure of the adequacy of procedures because of their daily interaction (and sometimes confrontation) with procedures. When written procedures are in conflict with the operational environment, or have technical deficiencies, or increase workload, or create conflicts in time management, etc., flight crews may react by resisting and deviating from SOP. This can be minimized by establishing a clear feedback path that will provide a channel of communication between the line and management. If the line pilot is resisting certain procedures, or if she feels that there is a better way, clearly this information should be brought to the attention of the procedure writers in management for reevaluation.

One value of a well managed feedback loop is to eliminate the difference between what is taught in the training centre and what is expected on the line. The oft-expressed instruction 'I don't care what you are teaching you in the simulator and ground school, it won't apply to the flight' reveals not a minor quirk, but a serious management and training failure.

We have used the word 'formal' to describe the desired feedback path. By the we mean that a clear mechanism be established for movement of information and suggestions from the line to management. Blank statements from management such as 'my door is always open,' or 'you can always go to your chief pilot' do not constitute a sufficient feedback path. The line pilot must feel that his input is desired, and will be taken seriously. Offhand comments given in passing in the corridors and coffee shops do not qualify as effective feedback mechanisms.

Discussing the feedback path from line to management forces us to consider briefly labour-management relations at airlines. To be successful, the feedback process must involve the participation of the appropriate pilots' representative group. At most carriers this would be the Air Line Pilots Association Safety Committee, or perhaps other committees such as Training or Professional Standards. The feedback path then would consist of a communication from the line to the representative group, and thence to management. This has some advantages over direct pilot-to-management communication, in that the pilot may wish for various reasons to be insulated from his managers. Also, by working through a committee, patterns can be noted by the committee members.

For this system to be effective, it is essential that a cooperative, non-adversarial relationship exist between management and the representative group. This is sometimes difficult when either contract negotiations are underway, or for whatever reason tensions exist between pilots and management. The feedback process can be effective only if management makes it clear that they are eager to receive input from the pilots' representative group on a non-adversarial basis, and the pilots' group in turn must resolve to stick to its safety mandate, and not be tempted to use such things as a smokescreen for contractual/industrial matters. It is a measure of the maturity of the management of both the company and the union if both sides can transcend 'politics as usual' for the sake of promoting safety.

We recommend that a clear, well-defined feedback loop be established and supported so as to provide an effective channel of communication between line and management. To be effective, the feedback process must be easy to use, non-threatening, and above all must regenerate at least the promise that the line pilot can affect something.

Conclusions

We believe that the four 'P's concept detailed in this chapter forms the foundation for writing and executing flight deck procedures in a professional and logical manner, within and across fleets. Consistent and technically correct procedures in turn ensure both the economical utilization of humans and equipment and the safe conduct of flight. Any procedure, even the best one, cannot be 'bullet-proof'. It can only be a baseline. The role of management should be to provide the best possible baseline for its crews, and then train and standardize this to baseline. No procedure is a substitute for an intelligent operator.

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