# Air Traffic Controller and Management Attitudes Toward Automation: An Empirical Investigation

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**Summary**

In the context of EUROCONTROL's Conflict Resolution Assistant (CORA) project, a systematic assessment was made of ATC management and controller attitudes and beliefs, especially as they relate to potential future forms of automation. This was carried out through a series of seven site visits to ATC centres around western Europe. Focus groups and surveys were conducted at each site. Participants included both active controllers, and ATC managers. Quantitative and qualitative analysis was conducted, with an eye toward evaluating a set of fourteen research hypotheses. Finally, a qualitative descriptive model was constructed to help explain the factors influencing controller automation acceptance. Results challenge several of the commonly held notions about air traffic controller attitudes-- as well as the factors (e.g., age) underlying such attitudes-- and offer important lessons for those involved in ATM systems development.

## Background

### The CORA project

EUROCONTROL's ongoing Conflict Resolution Assistant (CORA) project aims to define and develop operational requirements and prototypes for conflict resolution concepts, based around the introduction of such computer-based Air Traffic Control (ATC) tools as Trajectory Planning, and Medium Term Conflict Detection. CORA is following a phased development, with CORA Phase 1 tools aimed at identifying conflicts or problems (and the aircraft involved), but stopping short of implementing a solution. CORA2, on the other hand, envisions a higher level of controller support with respect to conflict resolution and decision aiding.

One of the greatest challenges currently facing the development and implementation of advanced ATM automation (such as conflict resolution tools) is to foster acceptance among those who must ultimately come to use the tools, namely controllers. Given the nature of the ATC domain (in which technical and operational advances are typically made in an evolutionary and incremental way), it is reasonable for controller acceptance to have been identified as a key factor in how fully the controller community will embrace advanced new forms of ATC automation. By identifying at an early stage the prevalent automation-related attitudes among a representative sample of the European ATM community (both controllers and managers), such issues can be better addressed through controller/manager training and information.

### Controller attitudes

It is a widely-held belief, both in ATC operations and among the research community, that air traffic controllers (ATCos) are reluctant to change, and that any attempts to introduce new forms of ATC automation will be met with great resistance from the control room floor. Various survey results over the years have portrayed controller attitudes as very positive, at least toward the overall ATC job (Kennholt & Bergstedt, 1971; Crawley, 1982; Rajecki, 1990; Air Traffic Management, 1999). Nonetheless, survey and anecdotal evidence has suggested aspects of the job with which controllers are less satisfied. Hopkin (1995) portrayed the current day controller as someone who, although very happy with the ATC job itself, expresses reservations about management, equipment, the media (which is seen as presenting an overly negative image of ATC), and some of their conditions of employment. The research reviewed in this paper set out to ascertain the prevailing attitudes among operational controllers (and

management), especially as they relate to systems development, automation needs, and operations.

## Methods

As a first step in the current controller assessment project, a literature review was conducted, to survey past theoretical and empirical work on controller attitudes, and to establish what is currently known in this area. Literature were gathered on the subjects of controller attitudes toward advanced automation, controller attitudes generally (e.g. with respect to their job in general), and from other relevant domains.

Site visits were conducted during the summer of 2000 to seven ATC centres across Europe. Together, these seven captured a reasonable cross-section of current European ATC operations, in terms of systems, work cultures, and traffic patterns. At each site, the following data collections were conducted:

- Focus group- with a small group of controllers;
- Controller survey- a written survey of the same controllers;
- Control group ("cohort") survey- the identical survey, administered to a similar number of active controllers, who had not taken part in the focus group;
- Management survey- a written survey of centre managers;
- Management interview- face-to-face recorded interviews of one or more managers.

### Focus Groups

Focus Groups (FGs) are a common means of gathering qualitative information from a fairly homogenous group of participants. FGs have been used extensively in such areas as consumer product testing, marketing, political polling, and customer service (Morgan and Krueger, 1993). FGs have several inherent methodological strengths, which mainly derive from their social nature. It is important to note that FGs are not a form of group interview, in which numerous participants are asked to respond to the same questions, but rather a means of illuminating collective characteristics of the group. Unlike the one-way flow of information typical in survey research (e.g. interview), the FG method relies on the interaction natural in group discussions.

A total of 38 active controllers participated in seven focus group sessions. Each FG session lasted roughly 2 hours. The same moderator and assistant moderator pair hosted each FG. Written notes were taken of each FG session, and were augmented with audio recordings of each session.

### Controller surveys

A total of 79 controllers, ranging in age from 24 to 57 (mean=37.6) completed a written survey. Thirty eight of these had participated in the focus group session, and the other 41 were "control group" members (other operational controllers at the same facility, who had not taken part in the focus group sessions). Demographics of the two groups were determined (post-hoc) to have been quite similar: focus group participants had a mean age of 38.2, with 14.7 years of total ATC experience, whereas control group members averaged 37.3 years and 13.2 years of experience. The aim of making a control group comparison, of course, was to verify that participation in the focus group sessions did not bias the attitudes later expressed in the written survey responses.

### Management surveys

Fourteen managers across the seven sites completed a written survey, the first part of which was a "projective" survey in which managers were asked to indicate how they felt controllers at their facility would respond to each survey item. This technique thus provided a proxy measure for the degree to which managers understood the attitudes of the controllers at their facility. In the second part of the manager survey, managers were asked to indicate their own attitudes regarding, for instance, criticality of various automation components (present or future), critical areas for controller improvement, and threats to successful ATC automation deployment.

## Results

The following section will now briefly review selected results, with an emphasis on high level results and implications. Those interested in reading the entire

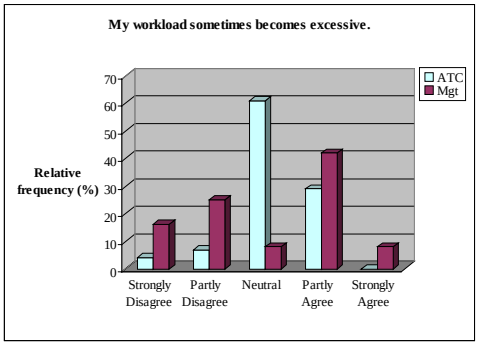
EUROCONTROL report should contact the second author.

Survey responses

Controllers tended to agree (either partly or strongly) with the statement that morale at their facility was high. This was not a surprising result, and is consistent with the results obtained by ATM magazine (1999) with another cohort of western European controllers. It is also consistent with other evidence (cf. Smith, 1973) that controllers generally enjoy their jobs.

A clear consensus emerged on three other issues: First, controllers generally reported being reluctant to cede authority for route selection to aircraft. Roughly three quarters of the surveyed controllers agreed (either partly or strongly) with the statement that "allowing pilots more freedom in planning routes will make airspace less organised." Secondly, clear opinions were expressed on the subject of technology in ATM. Over 70% of the controllers reported that they find new technology "easy to use," and over 60% reported not being mistrusting of technology. That is, over 60% disagreed with the statement that "I do not trust new ATC technology, even though it is designed to make my job easier." The final area of clear agreement relates to perceived training needs: over 70% of controllers reported needing more training in unusual situations, such as handling emergencies.

Managers tended to rate their controllers' self-reported stress higher than the controllers themselves did. Further, management tended to overestimate both the reluctance controllers would express toward approaching their supervisor with problems, as well as the degree to which controllers wanted anonymous reporting schemes. Although these results could have been coloured by *demand characteristics* (i.e. controller responses might have been biased by their understanding of the survey goals), they point up an interesting possible discrepancy between controller and management perspectives.




**Controller versus manager survey response**

Interestingly, managers and controllers tended to disagree on the issue of potential future threats to ATC safety. Whereas controllers identified excessive traffic levels as the single greatest threat, ATC management tended to rate excessive ATC automation the single greatest threat (interestingly, management overwhelmingly identified the presence of old equipment as the single largest problem facing their centre). The specific automation and HMI advances they felt would most benefit their facility were, in descending order: High-resolution (2000x2000 pixel) displays; Multi-radar tracking; Minimum Safe Altitude Warning (MSAW); Electronic Flight Strips; and Area Proximity Warning. In terms of potential operational improvements, the following changes were mentioned, in descending order of benefit: Reduced vertical separation Minima (RVSM); Collaborative civil-military airspace planning; Free routing in upper airspace; and flexible use of airspace.

Unlike controllers, who generally cited traffic levels as the greatest future problem to ATC, managers rated "too much ATC automation" as the greatest single threat to air safety in the future. Median rankings of each of the five future threats are shown below.

| | |
|---|---|
| Excessive ATC automation | 5 |
| Higher traffic levels | 3 |
| Inadequate ATC systems | 2 |
| Poor controller training | 2 |
| Inadequate number of ATCOs | 1 |

**Managers' perceived threats to future ATC, and their median rated criticality**

One aim of the survey data analysis was to assess whether there were systematic differences in controller attitudes—that is, whether some other factor (such as age, or experience) might be related to attitude differences. The following discusses the results based on age differences.

Controllers were assigned to one of two age groups, on the basis of a median split. Overall, responses across the age groups were remarkably similar. Median responses were identical for the two age groups, for all but three of the survey items. First, older controllers tended to agree more strongly with the statement that

> *"I suffer a high level of stress because of my ATC workload."*

Median responses were "Partly Agree" and "Neutral" for the older and younger controllers, respectively. Second, younger controllers tended to disagree more strongly with the statement that

> *"The controller's job in the future will be less interesting."*

Finally, and perhaps most interestingly, older controllers tended to disagree more strongly than younger controllers with the statement that

> *"I do not trust new ATC technology, even though it is designed to make my job easier."*

Focus Group results

Excerpted transcripts were supplemented with field notes, as well as summary comments from debriefings. Additional analysis of the focus group transcripts relied on content analysis—that is, computerised classification of textual material into relevant information (Weber, 1990). Computerised text analysis software was used to identify key words in context. Some of the major themes to emerge from the focus group sessions include the following:

- *Staff shortages*— and the variety of reasons behind them;
- *Traffic increases*— were recognised as driving new systems development and new working procedures.
- *Failure to capture specifications*— failed past attempts to implement new systems had encountered "spec creep," in which system design specs were not clearly agreed in advance;
- *Involvement of controllers in system developments*
- *Need to balance safety and commercial needs*—and how this relates to perceived management priorities;
- *Credibility of management*— in terms of both domain knowledge, and system development experience;
- *Opacity of management relations*— reasons and background of which differed greatly across sites;
- *Need to demonstrate benefits of new automation*. Controllers reported that they would hold CORA-like automation to a high standard of reliability, despite the fact that they are currently relying on systems (e.g. STCA) and human colleagues of less than 100% reliability
- *Retraining for new skills and tools*—
- *Automation-related human performance concerns*--
- *Job security / satisfaction concerns*—
- *Potential for automation to change role of Planner and Executive controllers*
- *Military-Civil ATC co-operation*

**Discussion**

Perhaps most striking among the focus group discussions was the degree of general agreement controllers displayed with regard to the ATC job, management, and perceived controller attitudes. Not only was agreement high within groups, but there was surprisingly high agreement between sites on the higher level aspects of the ATC job, and the way in which controllers interact with management. Some of the high level findings can be summarised as follows:

First, experiences with "lower level" automation (e.g. STCA) was generally positive. Despite various problems (e.g. false alerts, and inherent algorithmic

shortcomings), controllers were satisfied with the operation of STCA.

Second, it appears that the issue of verifiability is more critical than absolute reliability to controllers. Results suggest that a tool (as indeed a human partner) need not be 100% reliable, but that the costs (e.g. time) of verifying its performance should be minimal.

Third, opinion was split over the presence of (and factors underlying) controller conservativeness. Interestingly, it was suggested by several respondents that older controllers, who were trained in the "old world" traffic handling skills, might paradoxically be more willing to accept new automation, because of the greater comfort they feel (compared to younger controllers) with "failure mode" (manual) operations.

Fourth, the surveyed centres differed greatly in terms of available automation. Although survey and focus group results appeared to vary on the basis of centre automation level (as determined through an objective on-site inventory) it is not clear what other site differences (such as training opportunities, or salary levels) might have been at play.

Obviously, controller attitudes toward system development are coloured by the way in which they have seen other development efforts—such as STCA, OLDI, or various local system upgrades—handled. Regardless of the system(s) under discussion, controllers raised a number of potentially critical issues about the development process itself, and how such developments had been (mis)managed in the past. Most of these concerns focussed on management communication (e.g. the need for management to convey clear goals), systems engineering (e.g. the need for controllers to be involved early in the process, to have a good working relationships with engineers, and the need for ATC credibility in such engineers), and deployment strategy (e.g. the importance of safety cases, shadow mode pre-deployment, and clear error handling procedures).

Lessons Learnt

On the basis of the preceding, as well as the sum of data collected during this controller assessment, the following high-level guidelines can be offered to help guide the development and deployment of new ATC automation:

1. *Share information early*— both to assist the development cycle, and to foster acceptance, early and accurate sharing of information about system developments—including need for change, and likely outcomes—is seen as essential.
2. *Develop clear management policies*—Controllers reported that management sometimes sends mixed signals, or is unclear in sharing its goals. It is therefore recommended that management policies be developed with respect to how acquisition, development, procedures, safety and capacity are addressed. This applies especially to procedures for handling emergencies.
3. *Involve controllers in the development cycle*—the process cannot be seen as opaque by controllers. Word-of-mouth spreads quickly, and early controller input on preferences and working methods are essential for acceptance.
4. *Demonstrate benefits*—controller acceptance is likely to be much higher if justifications for change are accompanied by demonstrable benefits, preferably early in the design cycle (e.g. via prototypes). Controllers are generally aware of the need for new systems, if only to handle increasing traffic loads. By and large, the consensus view was simply that they wanted some assurance, in advance of operational use, that new tools would be useful and reliable.
5. *Ensure domain knowledge*— such knowledge and domain credibility, both in managers and engineers, are essential to controllers.
6. *Provide training opportunities*—if system change is accompanied by training opportunities, management should emphasise its desire to invest in controllers. Simulation opportunities seem to serve a dual purpose: they both educate the ultimate users of the system, but they also send a signal to staff that management is willing to invest in them.

7. *Create a culture of reward*—as was suggested several times, controllers can view training, and even the introduction of a new system itself, as an investment in the control room staff. One of the biggest challenges for management, it would seem, lies in making this message explicit to controllers.

Much of what emerged from these data does not agree with the stereotypical view of the air traffic controller as over-stressed recalcitrant neo-luddite. Indeed, the involved controllers all recognised and respected the need for new forms of ATC automation. Their concerns about how such systems should best be developed provided valuable lessons for the CORA project, and hopefully extend to ATC system development efforts more generally.

**References**


Air Traffic Management (1999). Attitude adjustment: controller survey. ATM Special Insert: ATC Issues from the Controller's Perspective, March-April, 5-9.

Crawley, R. (1982). Predicting air traffic controller reaction to computer assistance: a follow-up study. AP Report 105. Birmingham, UK: Applied Psychology Department, University of Aston in Birmingham.

Hopkin, V.D. (1995). Human Factors in Air Traffic Control. London: Taylor and Francis.

Kennholt, I. & Bergstedt, M. (1971). Attitudes toward the work and working conditions among air traffic control personnel in the aviation administration. Stockholm: Swedish Personnel Administration Council.

Morgan, D.L. & Krueger, R.A. (1993). When to use focus groups and why. In D.L. Morgan (Ed.) Successful Focus Groups: Advancing the State of the Art. London: Sage.

Rajecki, D.W. (1990). Attitudes. Oxford: W.H. Freeman

Weber, R.P. (1990). Basic Content Analysis (2nd edition). London: Sage.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