# HUMAN FACTORS PROGRAMS:

# FACT OR FANTASY?

*William B. Johnson, Ph.D.*
*Chief Technology Officer*
*Galaxy Scientific Corporation*
*Atlanta, Georgia*
*770.491.1100*
*drbillj@drbillj.com*

## EXECUTIVE SUMMARY

Airlines, repair stations, manufactures, and regulators have paid attention to human factors in aviation maintenance for a long time. However, the formal programs, named "human factors" or "maintenance resource management", emerged during the mid-nineties. Now, in 2001, international regulations are formalizing the requirement for human factors knowledge by the licensed engineer/maintenance technician. Regulators are now encouraging operators to establish human factors programs for maintenance. Many maintenance organizations have programs in place and nearly all maintenance organizations can "talk a good game" about what they are doing in maintenance human factors. This paper and questionnaire attempts to separate talk from action, or "fact" from "fantasy", regarding the human factors programs.

## WHAT IS A HUMAN FACTORS PROGRAM

This is the 15th Annual Symposium for Human Factors in Aviation Maintenance. Therefore, this is hardly the venue to offer a Primer on Maintenance Human Factors. Instead, the meeting should be an opportunity to take stock of your current human factors initiatives and find ways not only to sustain but also to improve your existing programs. The meeting should also help you project into the future as you evolve your human factors programs for the first decade of the millennium.

Speaking realistically, this meeting can also help maintenance managers ask themselves the introspective question: "Do we really have a Maintenance Human Factors program, or is it a fantasy?"

A human factors program, for a maintenance organization, is a means to identify, understand, and mitigate the characteristics of the human to system interaction that may lead to sub optimal performance. In some cases the program may fix the maintenance system by improving the physical workplace, the tools, the procedures, or the social environment that contribute to maintenance error. The other alternative is to make a change to the human condition by changing the requirements and experience of the worker or by training the worker to compensate for other system deficiencies. Ideally, a human factors program "tunes" the system to capitalize on the complementary respective strengths and limitations of the human and of the machine. An excellent human factors program strives for the continuous improvement and optimization of the human-machine combination. Succinctly, human factors programs reduce the likelihood of error, contribute to worker and product safety, and ensure continuing efficient and effective maintenance work.

The definition in the paragraph above is very general, difficult to measure, and hard to argue whether an organization has such a program in place. With or without a human factors program, most maintenance organizations would say "Yes, that is what we try to do." There are many high value human factor interventions (Johnson, 1999). It is merely a matter of choosing the ones that work best for your requirements, your resources, and the level of corporate commitment. The next section of this paper offers a few of the critical components of a human factors program. An organization must take certain action to ensure that their human factors program is fact and not fantasy. The sections below describe components of a "real" human factors program and ask a set of questions that are also included as an appendix to this paper.

## Identify Your Opportunities to Improve Performance

An error investigation system helps an organization identify the opportunities for improvement (Johnson and Watson, 2001). A human factors program must have an error investigation component. The error investigation program relies on trained investigators, who have a reasonable portion of their time dedicated to investigations. The error investigation system must identify human factors that contribute to an error by providing an organized method to openly report and then thoroughly investigate an incident. Boeing's Maintenance Error Decision Aid (MEDA) is the most popular industry examples of an investigation system. The MEDA system has been described elsewhere (Rankin et al., 1998, Allen and Rankin, 1997). This report assumes that the reader has knowledge of MEDA.

Another way to identify the opportunities to improve performance is to conduct a formal human factors audit. The FAA Office of Aviation Medicine has conducted research, published reports, and provided tools to conduct human factors audits (Maddox, 1998, Drury, 1998.) There are a number of consulting companies that are available to conduct a human factors audit within a maintenance organization. An audit reviews issues like the following: development and support of technical documentation; corporate and local technical communication; scheduling and workflow; physiological environment conditions; training; error investigation systems; process and procedures; and more. Companies design each audit for the perceived and observed requirements of the specific maintenance organization. A thorough audit will identify weakness and present a plan to address the challenges.

**Fact or Fantasy Questions About Identifying Opportunities to Improve Performance (Answer Yes or No to each of the questions)**

| #. | Question | Yes | No |
|---|---|---|---|
| 1. | We use a MEDA-like system. | | |
| 2. | In Year 2000, we conducted over 25 MEDA-like investigations. | | |
| 3. | In Year 2000, we conducted over 100 MEDA-like investigations. | | |
| 4. | Our MEDA-like data (from questions 2 &3 above) are in a database. | | |
| 5. | We could demonstrate this fully operating MEDA-like database tomorrow. | | |
| 6. | From 1998-2001 we trained over 5 investigators for the MEDA-like system. | | |
| 7. | Boeing delivered MEDA training at our site. | | |

| | | | |
|---|---|---|---|
| 8. | We have conducted a formal human factors audit in our maintenance organization. | | |
| 9. | We have a written report on the HF audit (from Question 8 above). | | |
| 10. | We have a formal disciple policy that encourages error reporting. | | |

## Understand the Fundamentals

Human factors disciplines are many and varied, a fact demonstrated repeatedly with the "Disciplines of Human Factors" diagram (Johnson, 1998). Human factors fundamentals include such disciplines as the following: organizational, educational, cognitive, experimental, and clinical psychology; physiology, industrial engineering, and industrial safety. It is unlikely that anyone has formal training and experience in all of these disciplines. And it is not necessary to have expertise in all of these areas. However, the organization's maintenance human factors specialist should, at least, be able to identify and define the human factors disciplines germane to the organizational requirements.

The industry has demonstrated that the preference is to train an aviation maintenance person in human factors rather than train a human factors person to understand aviation maintenance. While the exact time frame can be debated, one might say that it takes at least four years to begin to understand the aviation maintenance system. And generally, the more experience the greater the knowledge. The same is true with understanding and proper application of the fundamentals of human factors. It takes a combination of formal training and experience to build the relevant expertise. An organization would hardly want an untrained and inexperienced person to diagnose and repair a constant speed drive. The same concept can apply to assigning untrained personnel to duties as the internal human factors specialist. Despite the myth, mere long experience as a human does not necessarily qualify one as a human factors expert.

There are many ways for aviation maintenance personnel to learn about the fundamentals of human factors. Over the past decade many industry maintenance experts have taken advantage of formal graduate programs, short courses, conferences and workshops, and participation in human factors research projects as a means to enhance their human factors credentials. With this new knowledge they have provided their companies and the industry with many exemplary techniques and programs. The workshops of this symposium offer many examples of such techniques and programs.

Formal education and training is required to grasp some of the fundamentals. There are many undergraduate and graduate programs offered worldwide. At least one university (Embry-Riddle Aeronautical University) offers a human factors program through its extended campus. Such programs cater to working professionals. Thus, one can continue daily work in airline maintenance while also building knowledge of the human factors fundamentals. Closely related to the formal university programs are the private short courses and conferences on human factors. These short courses are usually designed for the experienced aviation maintenance professional.

The FAA Office of Aviation Medicine, starting in 1988, created a research and development program that had a goal to bring the human factors education and practices to the industry. Through its many projects, publications, and website this program has become an important means of industry education. Through this program the human factors consultants brought their expertise to the industry (See Watson and Johnson, 2001). At the same time, the industry taught the consultants a great deal about aviation maintenance. Many graduate students learned about psychology and engineering at the university while participating in industry-centered research

projects. The result is many outstanding new graduates that understand not only human factors but also airline maintenance.

Many maintenance organizations have either hired human factors consultants or actively participated in the FAA research projects. Interaction with the consultants and/or the researchers has also helped many airline maintenance personnel gain very credible understanding of human factors fundamentals.

Other regulatory agencies provide excellent human factors assistance. Transport Canada offers a maintenance human factors program and has provided international leadership in course development for a long time. The CAA of the United Kingdom has strongly encouraged their maintenance organizations to use a formal error investigation process. The CAA provides guidance and software to assist with investigations.

**Fact or Fantasy Questions About Understanding the Fundamentals**

| #. | Question | Yes | No |
|---|---|---|---|
| 11. | Our company maintenance human factors specialist has an academic degree in a human factors-related discipline. | | |
| 12. | Our human factors specialist has taken 1 special human factors course. | | |
| 13. | Our human factors specialist has taken 2 or more special human factors courses. | | |
| 14. | Our human factors specialist has helped prepared a curriculum and currently teaches a maintenance human factors course. | | |
| 15. | Our human factors specialist has attended more than 2 human factors conferences. | | |
| 16. | Our human factors specialist has attended more than 5 human factors conferences. | | |
| 17. | Our company has presented papers at the FAA-CAA-Transport Canada human factors meetings. | | |
| 18. | Fifty percent of our managers have received over 4 hours of human factors training. | | |
| 19. | Fifty percent of our engineers(Non-US)/mechanics have received at least 8 hours of human factors training. | | |
| 20. | We are currently offering a HF refresher course to maintenance personnel. | | |
| 21. | We have delivered Human Factors training in 2001. | | |
| 22. | Human factors is introduced as part of our new employee training for maintenance personnel. | | |
| 23. | Our Chief Executive Officer actively supports maintenance human factors with words and actions. | | |

## Fix What is Broken

This paper has discussed means of identifying opportunities to improve the maintenance system to reduce the probability of human error. Error investigation systems and human factors audits are two obvious ways. Sometimes personnel return from training, or from a conference like this one, and implement immediate "Fixes." The least desirable way to identify a necessary "Fix" is a job injury, an error, an incident, or even an accident. Whatever the motivation, the organization must improve the system and move on. If related to the human factors program it is likely that your organization keeps a list of the fixes and observes the impact. The cost analysis of such programs is discussed in another section.

When human factors programs are discussed there is often discussion about the commitment from senior management. Such commitment is important, especially with respect to allocation of resources for programs. However, when human factors initiatives fail it is seldom the fault of senior management. In many cases it is the middle management, or the maintenance personnel, who have not "bought in" to the key principles of maintenance human factors. Such personnel, by their very nature of their jobs, are driven by schedules and aircraft readiness. This level of the organization is important because they control such activities as scheduling, shift turnover, procedure compliance, workplace environmental conditions, and more. This challenge of sensitizing the middle managers must be "fixed" by creating programs that train them and reinforce human factors and error prevention. There is unanimous agreement that this is a critical challenge for maintenance human factors.

**Fact or Fantasy Questions About Fixing What is Broken**

| #. | Question | Yes | No |
|---|---|---|---|
| 24. | We have a formal listing of our added human factors interventions since 1999. | | |
| 25. | We assess and report the impact of human factors interventions. | | |
| 26. | We could show these assessment reports tomorrow. | | |
| 27. | We have specific methods to reinforce maintenance human factors to our middle managers in the maintenance organization. | | |

## Take Proactive Steps

Human factors programs can be motivated by the recognition that such activity can reduce error, promote safety of work, ensure continuing product safety, and contribute to cost effectiveness. Job injuries, maintenance error, incidents, and accidents also motivate development and implementation of human factors programs. Of course, taking the proactive steps to develop and implement human factors programs is the more desirable course of action. Many of the sections of this report describe various proactive steps toward a "real" human factors program.

This section is an ideal place to emphasize that there are many, many components to a maintenance human factors program. Many represent that a training program, called Maintenance Resource Management or Maintenance Human Factors, is the first and most important activity. That may be true for some organizations, but in the case of human factors "One size does not fit all." Error investigations, audits, suggestion boxes, quality programs, shift changeover safety discussions, ergonomic design of work stations, selection of new tools,

redesign of work procedures, and so many more activities are components of a proactive system to improve human work performance.

It is important to document the activities, challenges, and successes of your company's human factors program. Such documentation creates a corporate history and provides critical guidance as personnel retire or transition to other opportunities. The company's maintenance human factors expertise must not reside only in the head of the current maintenance human factors specialist. Ideally, the activities of the Maintenance Human Factors Specialist should be documented within written operating procedures. Human factors activities should be part of the documentation for ISO 9000 or other similar quality programs.

Here are a few questions to assess your proactivity.

**Fact or Fantasy Questions About Taking Proactive Steps**

| #. | Question | Yes | No |
|---|---|---|---|
| 28. | Our human factors courses change with each offering, to address new issues identified by workers and supervisors. | | |
| 29. | I can list specific examples of #28 above. | | |
| 30. | We have formal means for workers to provide suggestions to the human factors specialist. | | |
| 31. | We have a formal method for the human factors specialist to provide regular briefings to senior maintenance management. | | |
| 32. | We work very closely with our regulator to monitor our human factors program. | | |
| 33. | We employ a trained human factors specialist who spends over 75% of his/her time as an advocate for human factors in maintenance. | | |
| 34. | We have formal maintenance human factors campaign ongoing at this time. | | |
| 35. | We are active participants in ATA or our International Human Factors Working Group. | | |
| 36. | We have a formal quality program like ISO9000 or High Performance Workplace. | | |
| 37. | Our quality program explicitly addresses human factors. | | |
| 38. | In the past year, we changed a process or a procedure because of a human factors issue. | | |
| 39. | In the past year we bought new tooling because of a human factors issue. | | |
| 40. | We have an explicit line item in the budget for human factors interventions. | | |

## Measure the Outputs

Cost-Benefit analysis is a popular topic for airlines and maintenance organizations these days. Johnson, et al., (2000), Taylor (2000), and Stelly (2000) have offered ways to conduct straightforward calculations for Return on Investment. Essentially, they proposed calculations for the human factors investments versus the likely return on those investments. The examples are very straightforward and demonstrate a quick rate of return in most cases.

Some have referred to Maintenance Resource Management or Maintenance Human Factors as "The flavor of the day." When there is a documented legacy of the financial success of the program, it is more likely to remain as a fully integrated component of the maintenance organization.

**Fact or Fantasy Questions About Measuring the Outputs**

| #. | Question | Yes | No |
|---|---|---|---|
| 41. | We perform a Cost-Benefit or Return-on-Investment calculation to justify our human factors interventions. | | |
| 42. | We can show, at this moment, success stories and positive examples of cost-benefit of our human factors interventions. | | |
| 43. | Our management demands ROI calculations in our proposed program plans. | | |

## Plan for the Future

In this discussion, good plans can also earn positive points. If an organization does not have a formal human factors program but has one in the near plans, then you shall earn your "Yes" answers here. In some cases the plans are emerging to respond to new Joint Aviation Regulations and Canadian Aviation Regulations. No matter the reason, this section assesses your plans.

There is one caveat to consider as you answer the questions below. Assume that the word "Plan" means that it is written down in a formal manner and, most likely, has a budget with the support of critical senior and participating personnel.

**Fact or Fantasy Questions About Planning for the Future**

(If your program already has this then check yes)

| #. | Question | Yes | No |
|---|---|---|---|
| 44. | We have, or plan to have a maintenance human factors specialist working 50% time during 2001. | | |
| 45. | We have, or plan to have one maintenance human factors specialist working, during 2001, for each 2500 personnel in maintenance jobs (Interpolate for smaller organizations). | | |
| 46. | We have a firm schedule to start/continue large-scale human factors training in 2001. | | |
| 47. | We shall conduct a maintenance human factors audit during 2001. | | |
| 48. | We shall comply with JAR 66 and CAR 66 and related regulations. | | |
| 49. | We plan to conduct MEDA-like Investigator training in 2001. | | |
| 50. | We shall attend the FAA-Transport Canada-CAA Maintenance Human Factors meeting in San Francisco in April 2002. | | |

# DO YOU REALLY HAVE A PROGRAM OR PIECES?

Through the years of these Regulator-Industry conferences, since 1988, speakers and attendees have generally agreed that a maintenance human factors program must have many components. Single point adjustments do not constitute a human factors program. The questions discussed above and during the conference presentation should clearly demonstrate that a good human factors program is multifaceted. There must be commitment and knowledge from the top to the depths of the maintenance organization, and cooperation from the regulator, to ensure an ongoing program.

The questions above require a multi-faceted approach to determine that you have a "real" human factors program. So let's begin the count:

| #. | Category | Yes | No |
|---|---|---|---|
| 1. - 10. | Opportunities to Improve Performance | | |
| 11. - 23. | Understand the Fundamentals | | |
| 24. - 27. | Fix What is Broken | | |
| 28. - 40. | Taking Proactive Steps | | |
| 41. - 44. | Measure the Output | | |
| 45. - 50. | Plan for the future | | |
| **Totals** | **Totals must add to 50.** | | |

# FACT OR FANTASY RATING

The table below offers guidance on the reality of your program. During the review cycle of this paper there were mixed comments. Some reviewers called to say that the questions were too tough. Others said that the grading scale below is too easy. Each organization must judge itself and decide what level of human factors activity is best for them.

This questionnaire and discussion has offered an opportunity for introspection. If you are proud of your score then congratulations are due to you and to your company. If your score falls below your fantasy then this activity offers a means for mid-course correction.

| # Of Yes | Fact-Fantasy Rating |
|---|---|
| 41 - 50 | You, in FACT, have a "real" human factors program. |
| 31 - 40 | You are well on your way with respect to a having a "real" program. |
| 21 - 30. | You are a prospect for a good consultant to help fulfill your human factors fantasy. |
| 20 or below. | You may want to take this list to senior management upon return. Avoid your regulator on the journey. |

***"Is not this something more than Fantasy?"***
**Hamlet - William Shakespeare**

## ACKNOWLEDGEMENTS

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# HUMAN FACTORS PROGRAMS:

# FACT OR FANTASY QUESTIONNAIRE

## Directions: Check Yes or No. Leave no blanks.

| #. | Questions on Identifying Opportunities to Improve Performance | Yes | No |
|---|---|---|---|
| 1. | We use a MEDA-like system. | | |
| 2. | In Year 2000, we conducted over 25 MEDA-like investigations. | | |
| 3. | In Year 2000, we conducted over 100 MEDA-like investigations. | | |
| 4. | Our MEDA-like data (from questions 2 &3 above) are in a database. | | |
| 5. | We could demonstrate this fully operating MEDA-like database tomorrow. | | |
| 6. | From 1998-2001 we trained over 5 investigators for the MEDA-like system. | | |
| 7. | Boeing delivered MEDA training at our site. | | |
| 8. | We have conducted a formal human factors audit in our maintenance organization. | | |
| 9. | We have a written report on the HF audit (from Question 8 above). | | |
| 10. | We have a formal disciple policy that encourages error reporting. | | |
| **#.** | **Questions on Understanding the Fundamentals** | **Yes** | **No** |
| 11. | Our company maintenance human factors specialist has an academic degree in a human factors-related discipline. | | |
| 12. | Our human factors specialist has taken 1 special human factors course. | | |
| 13. | Our human factors specialist has taken 2 or more special human factors courses. | | |
| 14. | Our human factors specialist has helped prepared a curriculum and currently teaches a maintenance human factors course. | | |
| 15. | Our human factors specialist has attended more than 2 human factors conferences. | | |
| 16. | Our human factors specialist has attended more than 5 human factors conferences. | | |

| | | | |
|---|---|---|---|
| 17. | Our company has presented papers at the FAA-CAA-Transport Canada human factors meetings. | | |
| 18. | Fifty percent of our managers have received over 4 hours of human factors training. | | |
| 19. | Fifty percent of our engineers/mechanics have received at least 8 hours of human factors training. | | |
| 20. | We are currently offering a HF refresher course to maintenance personnel. | | |
| 21. | We have delivered Human Factors training in 2001. | | |
| 22. | Human factors is introduced as part of our new employee training for maintenance personnel. | | |
| 23. | Our Chief Executive Officer actively supports maintenance human factors in his words and actions. | | |
| **#.** | **Questions about Fixing What is Broken** | **Yes** | **No** |
| 24. | We have a formal listing of our added human factors interventions since 1999. | | |
| 25. | We assess and report the impact of human factors interventions. | | |
| 26. | We could show these assessment reports tomorrow. | | |
| 27. | We have specific methods to reinforce maintenance human factors to our middle managers in the maintenance organization. | | |
| **#.** | **Questions about taking Proactive Steps** | **Yes** | **No** |
| 28. | Our human factors courses change with each offering, to address new issues identified by workers and supervisors. | | |
| 29. | I can list specific examples of #1 above. | | |
| 30. | We have formal means for workers to provide suggestions to the human factors specialist? | | |
| 31. | We have formal method for the human factors specialist to provide regular briefings to senior maintenance management. | | |
| 32. | We work very closely with our regulator to monitor our human factors program. | | |
| 33. | We employ a trained human factors specialist who spends over 75% of his/her time as an advocate for human factors in maintenance. | | |
| 34. | We have a formal maintenance human factors campaign ongoing at this time. | | |
| 35. | We are active participants in ATA or our International Human Factors Working Group. | | |

| | | | |
|---|---|---|---|
| 36. | We have a formal quality program like ISO9000 or High Performance Workplace. | | |
| 37. | Our quality program explicitly addresses human factors. | | |

| | | | |
|---|---|---|---|
| 38. | In the past year, we changed a process or a procedure because of a human factors issue. | | |
| 39. | In the past year we bought new tooling because of a human factors issue. | | |
| 40. | We have an explicit line item in the budget for human factors interventions. | | |
| **#.** | **Questions about Measuring the Outputs** | **Yes** | **No** |
| 41. | We perform a Cost-Benefit or Return-on-Investment calculation to justify our human factors interventions. | | |
| 42. | We can show, at this moment, success stories and positive examples of cost-benefit of our human factors interventions. | | |
| 43. | Our management demands ROI calculations in our proposed program plans. | | |
| **#.** | **Questions on Planning for the Future** | **Yes** | **No** |
| 44. | We have, or plan to have a maintenance human factors specialist working 50% time during 2001. | | |
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| 46. | We have a firm schedule to start/continue large-scale human factors training in 2001. | | |
| 47. | We shall conduct a maintenance human factors audit during 2001. | | |
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| 49. | We plan to conduct MEDA-like Investigator training in 2001. | | |
| 50. | We shall attend the FAA-Transport Canada-CAA Maintenance Human Factors meeting in San Francisco in April 2002. | | |