



Mission Success Starts With Safety

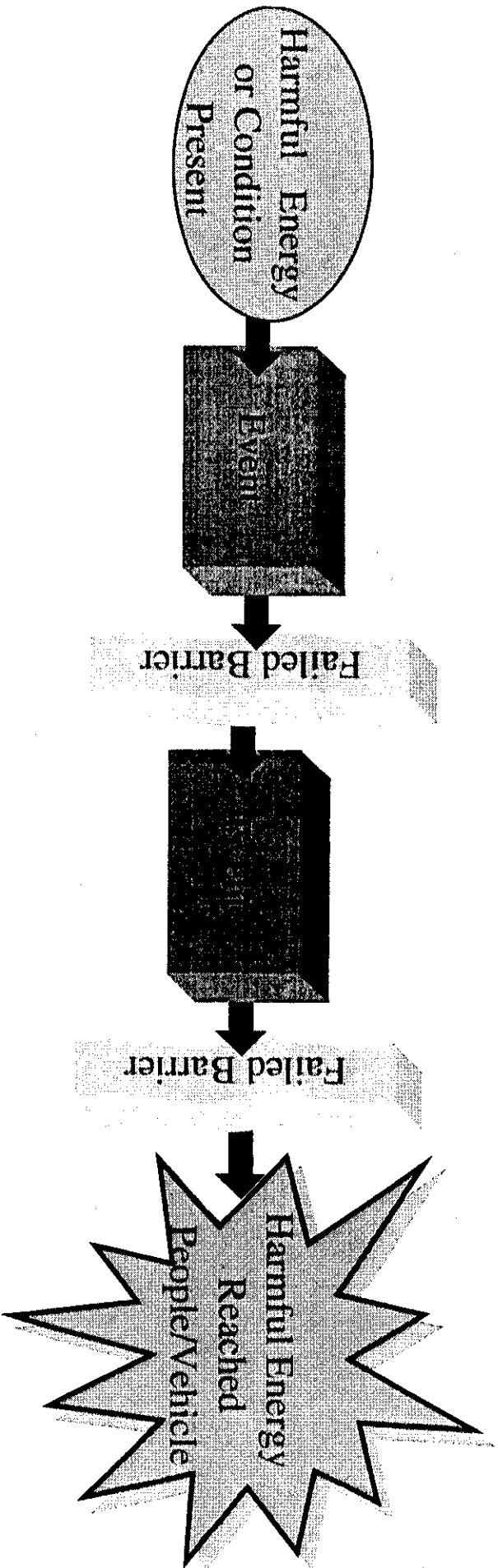
Data Collection – Some Sources of Data

- Audio (during accident, of meetings e.g., PAR, COFR)
- Video & photographs
- Computer aided design, 3-D simulation, flight simulation
- Telemetry & radar
- Hardware design drawings, as-built configuration & debris
- Quality records on materials & processes (manufacturers, suppliers, operations, engineering)
- Maintenance & inspection records
- Info. on chemical, radiation, thermal, structural, mechanical, electrical and biological changes in system or processes
- Existing fault trees & FMEAs
- Hazard analysis & safety analysis
- Risk assessment and PRA
- Policies and procedures (including stamped job cards/procedures)
- Problem reports, corrective action reports, anomaly reports and/or mishap reports
- Interviews & initial witness statements
- Time cards, training records, certification records
- Medical evidence
- Company records (budget, layoffs, past reports, hiring practices)
- Weather data



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Create Time Line of Events

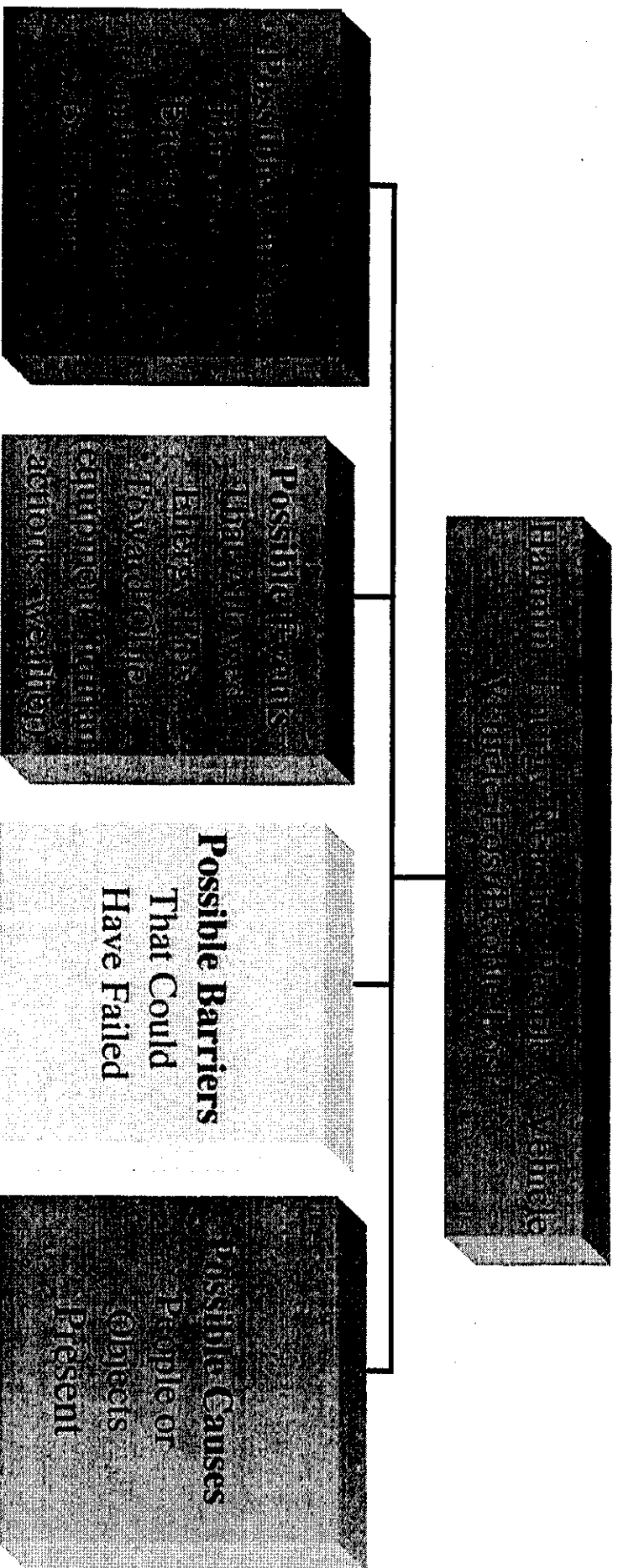


- Documents mishap scenario in chronological order.
- Begin well before the accident – e.g., Shuttle Processing or Launch.



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Create Fault Tree of Events

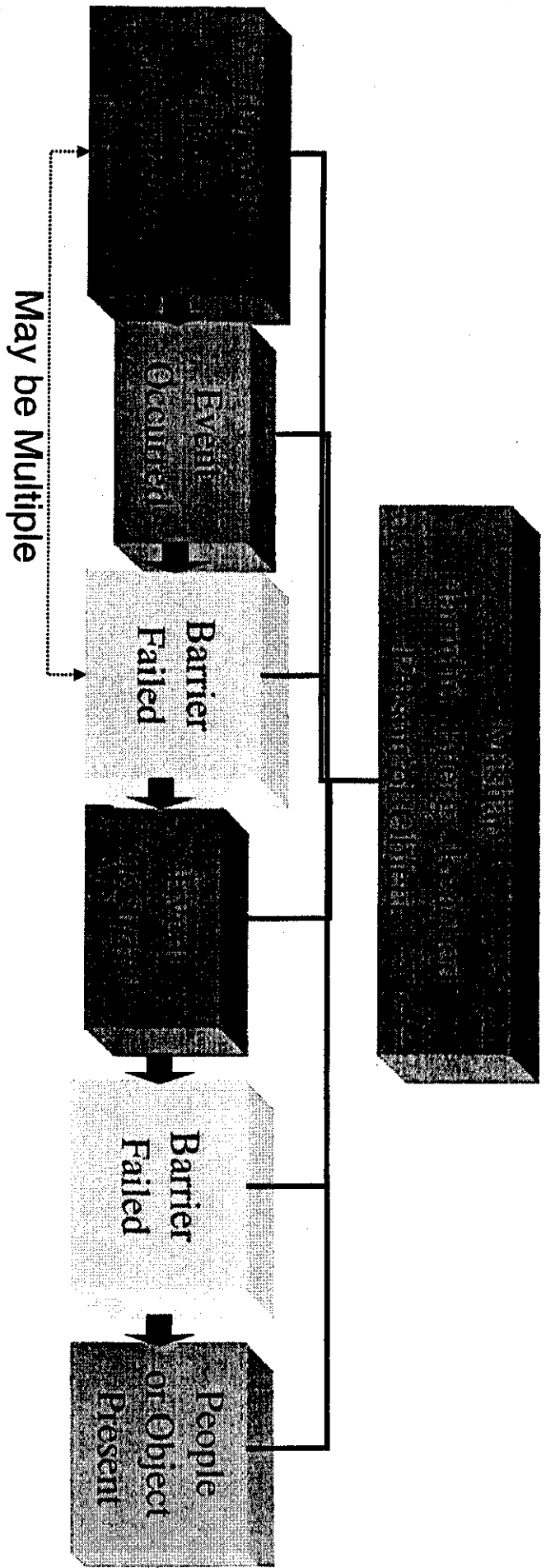


- The resultant tree should lead to a comprehensive picture of all **POTENTIAL** causes of the accident (including conditions and events).



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Form Event & Causal Factor Tree



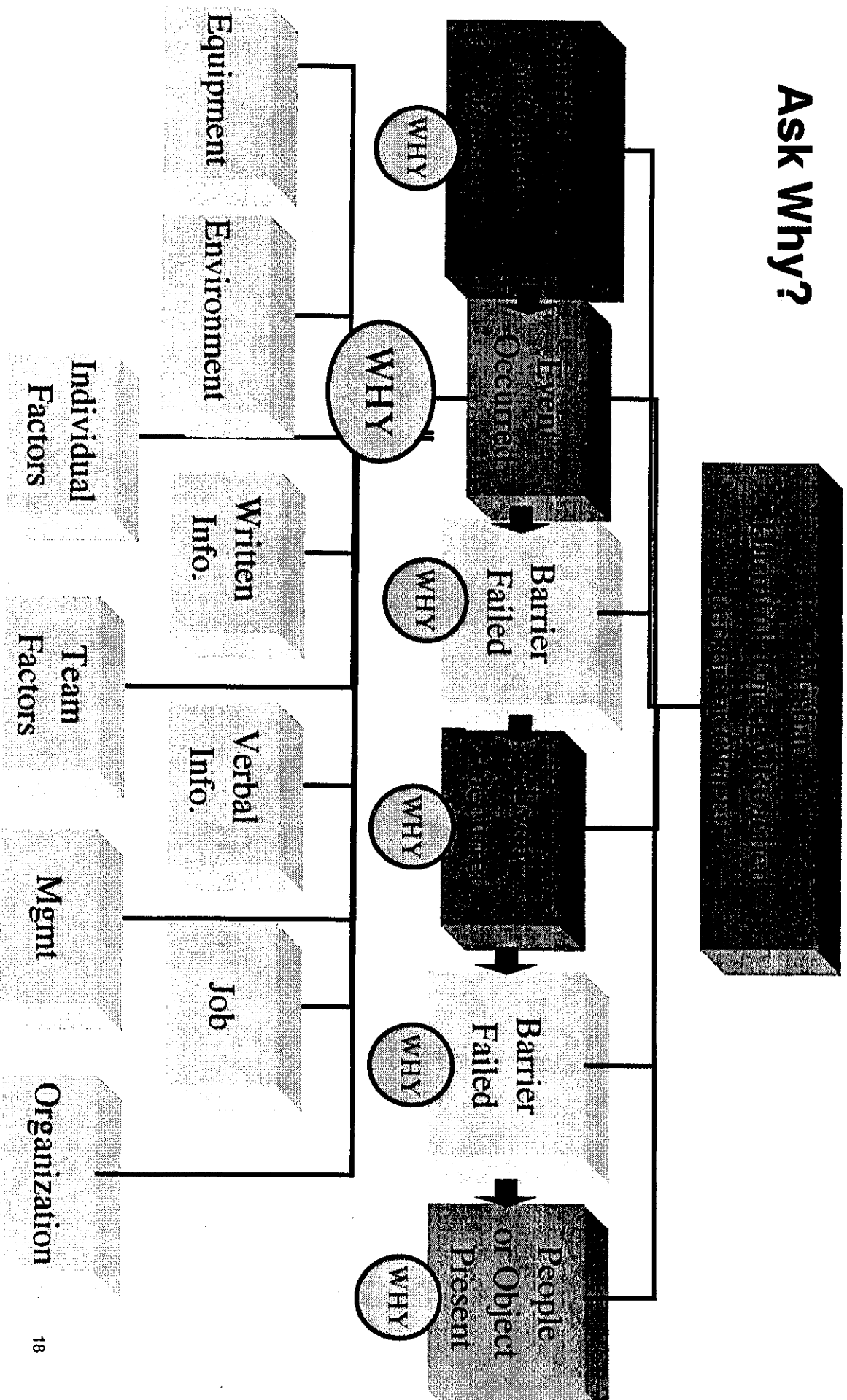
- Merge fault tree and event data to document actual events of and failed barriers.
- If possible, show events in chronological order.



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Event & Causal Factor Tree (Root Cause)

Ask Why?





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Root Cause Analysis

- Each lower box should answer the question “why” from the box above. (Logic should remain – questions should be in line with the original issue.)
- Should continue asking “why” until the analysis identifies “organizational” root causes.
- Tools such as the Incident Analysis Tool – Modified (IAT-M) can be used to ensure that all possible areas of cause are considered.



Analysis – Human Factors

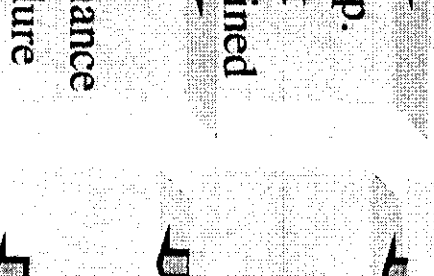
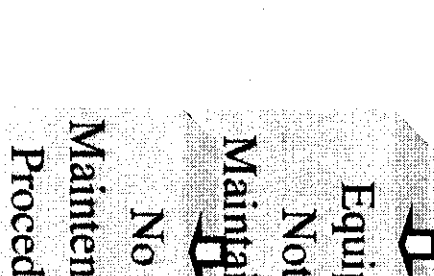
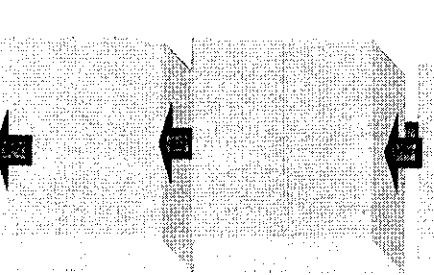
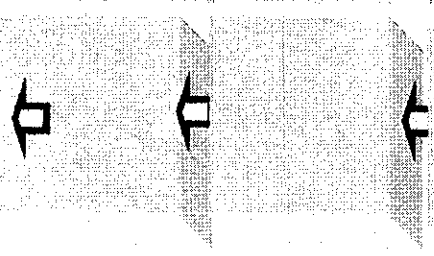
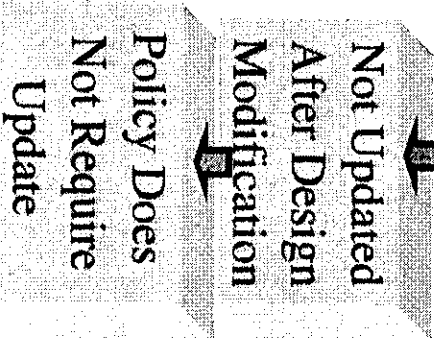
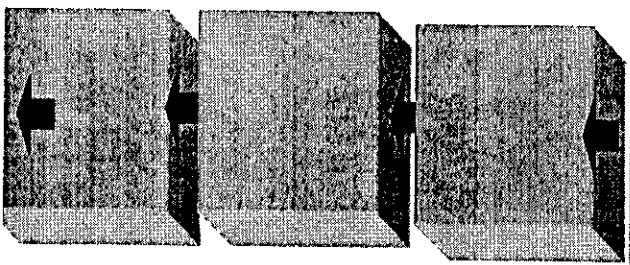
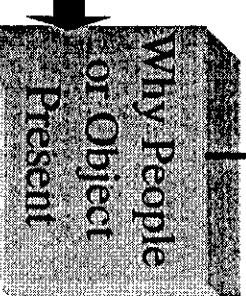
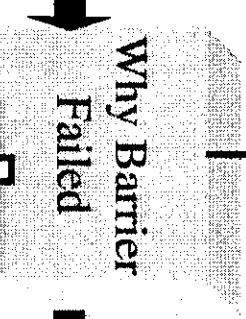
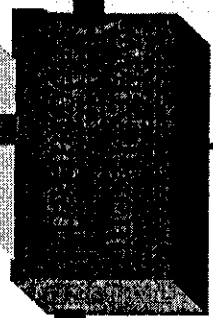
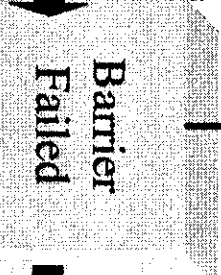
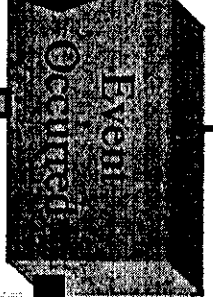
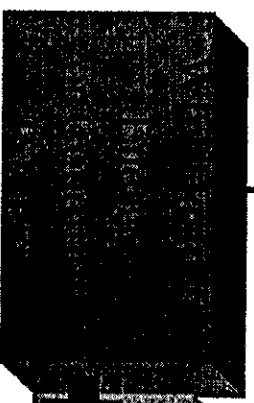
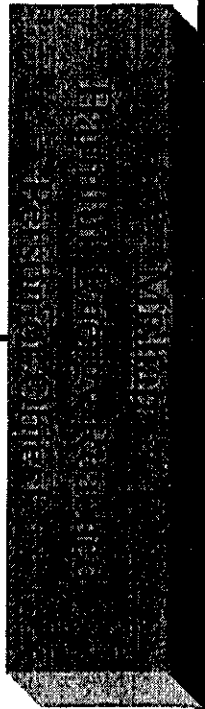
- Cause of human error(s) should be analyzed.
- Cause of of unsafe act(s), violations and/or undesired action(s) should be analyzed.
- Can be done through many analysis techniques (e.g., root cause, MORT, barrier analysis, Incident Analysis Tool – Modified, etc).
 - Must define the type of human action before cause is identified.
For example:
 - perceptual error
 - interpretation error
 - decision making error
 - action execution error, violation
 - Once the type of action has been identified, then the cause should be identified.



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Root Cause Analysis

Ask Why?





Root Cause Analysis

Apply the cause test

- If the deficiency or decision in question were corrected, eliminated or avoided, would the problem be prevented or avoided?

If yes, then it is a cause.

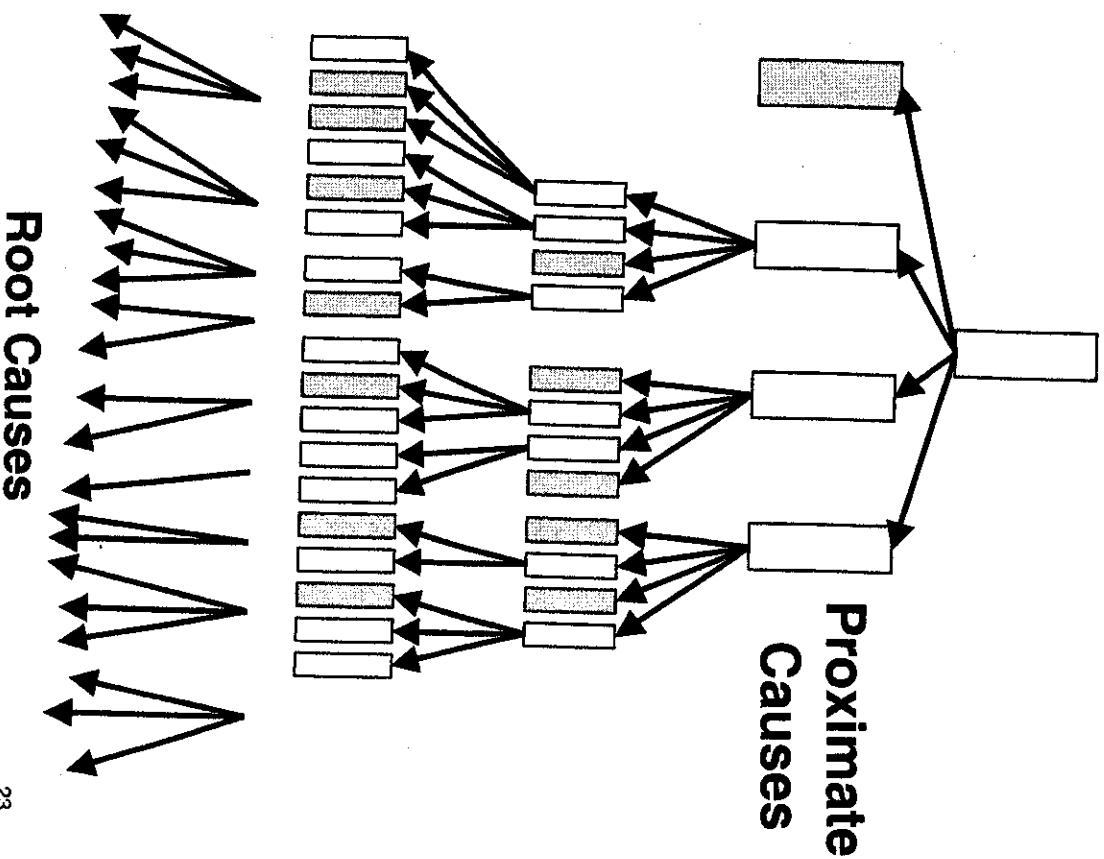
If no, then eliminate from the tree.

- Some choose to leave contributing factors on the tree... if done, they should be illustrated differently (e.g., different shape).



Root Cause Analysis

- There may be more than one root cause and many contributing factors.
- Don't be surprised if more than one paths leads to similar causes.
- Once the tree is complete, a detailed review of each cause is performed to verify the logic and that facts support causes.





Summary

- **NASA philosophy:**
 - **Identify root cause and contributing factors to prevent mishap recurrence using structured and proven investigation methodology.**
 - **Non-punitive system.**
- **NASA needs quick and thorough investigation to ensure safety of process and return to flight to support Agency mission objectives.**
- **Policy and guidelines:**
 - **Ensures an unbiased, independent, and thorough investigation of the facts.**
 - **Provides description of data collection, analysis, and reporting methods.**

To: Tina Panontin
From: Faith Chandler <fchandler@hq.nasa.gov>
Subject: Fwd: crew escape system studies list.ppt
Cc:
Bcc:
Attached:

Tina,

Do you or your personnel have any of these studies?

Thanks for your support.

X-Authentication-Warning: spinoza.public.hq.nasa.gov: majordom set sender to owner-code-qe using -f

X-Sender: mkowales@mail.hq.nasa.gov
X-Mailer: QUALCOMM Windows Eudora Version 4.3.2
Date: Thu, 06 Feb 2003 11:31:24 -0500

To: code-qe@lists.hq.nasa.gov, code-qe@lists.hq.nasa.gov
From: Mark Kowaleski <mkowales@hq.nasa.gov>

Subject: Fwd: crew escape system studies list.ppt

Cc: Charles.M.Chesser@mstc.nasa.gov, Thomas.W.Hartline@mstc.nasa.gov
Sender: owner-code-qe@lists.hq.nasa.gov

Hi Folks,

This is a question from HCAT:

Does anyone have any of the following:

- Crew Escape Module Study, Rockwell, 1989
- Shuttle Evolution Crew Escape Study, Rockwell, 1991
- Access to Space Study, NASA, 1994
- Space Transportation Architecture Study, NASA, 1999

To: "Alan H. Phillips" <a.h.phillips@larc.nasa.gov>
From: Faith Chandler <fchandler@hq.nasa.gov>
Subject: Re: Analysis for the CAIB's Consideration
Cc:
Bcc:
Attached:

Thank you.

At 11:06 AM 2/7/2003 -0500, you wrote:

Enclosed is an observational analysis that one of our employees has offered for consideration. Please forward to the responsible parties for their use.

Thanks.

Alan

Alan H. Phillips
Director, Office of Safety and Mission Assurance
NASA Langley Research Center
5A Hunsaker Loop
Building 1162, Room 112C
Mail Stop 421
Hampton, VA 23681
(757)864-3361 Voice
(757)864-6327 Fax

To: Mkwales@hq.nasa.gov
From: Faith Chandler <fchandle@hq.nasa.gov>
Subject: CAC

Cc:
Bcc:
Attached:

Mark,

Please forward the email that you received from Ashley Stockinger concerning the CAC RTQs and the material that they are putting together ...to Jim Lloyd.

Please cc me so that I may verify that you received this note.
Thank you.

To: boconnor@mail.hq.nasa.gov
From: Faith Chandler <fchandle@hq.nasa.gov>
Subject: Mishap Investigation Website Info.
Cc: prutledg@hq.nasa.gov, prichard@hq.nasa.gov
Bcc:
Attached:

Bryan,

I sent you an invitation to join the PBMA Mishap Investigation site.

This website is maintained by the NASA Headquarters Office of Safety and Mission Assurance to provide a collaborative environment between government agencies, academia, and the commercial sector to promote the exchange of knowledge and advance the development of accident investigation methodology and tools.

The site includes checklists, methods, tools, implementation guides, policies and more from many different government Agencies.

There is a link to a very good **Root Cause Analysis Literature Review** that provides a concise overview of a number of methods currently being used to perform root cause analysis. It can be found by using the link to the "Investigation Process Research Library", selecting "projects" from the top menu bar and then select the pdf file under item 4) Root Cause Analysis Literature Review.

I hope this site serves as a valuable resource for your team.

To: Richardson_Pamela
From: Faith Chandler <fchandle@hq.nasa.gov>
Subject: Fwd: Analysis for the CAIB's Consideration
Cc:
Bcc:
Attached: C:\Documents and Settings\fchandle\My Documents\attach\MazanekMemo.pdf;

Pam,

Please include in your notebooks.

X-Sender: a.h.phillips@pop.larc.nasa.gov
Date: Fri, 7 Feb 2003 11:06:30 -0500
To: Pete Rutledge <prutledg@hq.nasa.gov>
From: "Alan H. Phillips" <a.h.phillips@larc.nasa.gov>
Subject: Analysis for the CAIB's Consideration
Cc: Jim Lloyd <Jlloyd@hq.nasa.gov>, Faith Chandler <fchandle@hq.nasa.gov>

Enclosed is an observational analysis that one of our employees has offered for consideration. Please forward to the responsible parties for their use.

Thanks.

Alan

--

Alan H. Phillips
Director, Office of Safety and Mission Assurance
NASA Langley Research Center
5A Hunsaker Loop
Building 1162, Room 112C
Mail Stop 421
Hampton, VA 23681

(757)864-3361 Voice
(757)864-6327 Fax

From: "Daniel D. Mazanek" <d.d.mazanek@larc.nasa.gov>

7:38 AM

Subject: Columbia Accident - Launch Debris Observations

To: Cindy Lee <C.C.LEE@larc.nasa.gov>

Hi Cindy,

I would like to offer several observations regarding the theory that debris damaged Columbia's left wing during launch on January 16, 2003. I would like to be able to discuss these ideas during an appropriate Columbia accident investigation meeting here at LaRC.

1. The video footage (apparently provided by the KSC Ice & Debris Team) appears to show that the debris, assumed to be polyisocyanurate foam from the external tank (ET), may not have originated from the ET. In the first few frames of the video sequence, the debris appears to come from a location obscured by the orbiter and ricochets off the ET. The origin of debris still could be from the ET, or possibly the underside of the orbiter. After contacting the ET, the debris fragments into two visible pieces. The first, apparently smaller, debris fragment produces a small shower of particles that can be seen at the trailing edge of the left wing. The second, larger piece of debris appears to result in a much larger impact on the trailing edge of the left wing. The debris may have been made of ice or some other material(s) and could be much more massive than the calculated 1.211 kg (2.67 lb.). If the photogrammetric measurements accurately measured the debris to be 0.508 x 0.406 x 0.152 meters (20 x 16 x 6 inches), and it was made of solid ice, the mass could be approximately 28.7 kg (63.4 lb). The energy released from this impact could be almost 25 times greater than estimated. Other dense materials, such as aluminum, would make this impact even more damaging. I would like to suggest a re-examination of the debris impact video footage to determine if the fragment(s) could have originated from another location, possibly an ice buildup somewhere under the orbiter. As a reference, if the debris was 1.211 kg. and assuming a conservative relative impact velocity of 457.2 m/s (2 x 750 fps used in the JSC analysis), the kinetic energy would have equivalent to a 500 lb safe impacting at 75 mph. If the debris was 28.7 kg, that would be the equivalent of a 500 lb safe hitting the wing at 365 mph.

2. If the observation in #1 above can proven to be incorrect, and it can be definitively determined that the debris was foam insulation from the ET, there still appears to be an issue regarding its thickness. It has been estimated that the debris was 0.152 meters (6 inches) thick. Several sources that I have found indicate that the insulation is sprayed on the ET to a thickness of 1-2 inches. It is certainly possible that certain locations on the ET may have insulation that is 6 inches in depth, but how thick was the insulation at the point where it is believed to have separated? How accurately is this location known? I assumed that the volume of ET insulation can be approximated by a thin walled cylindrical body with flat, circular plates on each end. I assumed that the ET was 46.8 meters (153.8 ft) in length, 8.412 meter (27.6 ft) in diameter. I used a density of 38.63 kg/m³ (calculated from the mass and size of the foam debris assumed in #1 above).

Using a uniform thickness of 0.152 meters (6 inches), I estimate the total mass of the insulation to be 8080 kg (17,813 lb). This is 3.7 times greater than the 2187 kg (4823 lb) that is stated on the NASA Human Space Flight Shuttle Reference web page. A 0.0254 meter (1 inch) thickness results in a total mass of 1328 kg (2928 lb), and a 0.0508 meter (2 inch) thickness results in a total mass of 2664 kg (5873 lb). These totals are consistent with a thickness of 1-2 inches. It is possible that the numbers stated on the Space Flight web page are not very accurate, but I would not expect them to be that much off. I have not heard any discussion about variations in the insulation thickness, and I would like to understand how certain we can be that the debris was entirely made of foam.

3. Even if the damage to the tiles was not obviously visible, could this type of impact carve out a significant channel in the protective tiles? This channel

would then allow extreme heating to occur down the length of the wing. How many re-entries had the tiles in the area of the suspected damage been through? Is it possible that this area could have had "older" tiles that could be more easily loosened from the wing during impact, but only separated during re-entry or later during ascent? Could the impact result in a significant increase in the surface roughness of the tiles around the impact area, and could this result in a high turbulent heating that caused tiles to be shed during re-entry? Finally, it is reasonable that the impact could have multiple effects on the orbiter, such as damage to control surfaces.

Thanks very much for your attention to these observations. I hope that they are helpful in the investigation of this terrible loss for the astronauts and their families, NASA, and our country.

Dan

--

Daniel D. Mazanek

Spacecraft and Sensors Branch, ASCAC
8 Langley Boulevard
NASA Langley Research Center Phone: (757) 864-1739
Mail Stop 328 Fax: (757) 864-1975
Hampton, VA 23681-2199 E-mail: d.d.mazanek@larc.nasa.gov

X-Authentication-Warning: spinoza.public.hq.nasa.gov: majordom set sender to owner-code-q using -f

X-Sender: jlloyd@mail.hq.nasa.gov

X-Mailer: QUALCOMM Windows Eudora Version 4.3.2

Date: Fri, 07 Feb 2003 08:18:10 -0500

To: code-q@lists.hq.nasa.gov, smadir@hq.nasa.gov

From: James Lloyd <jlloyd@hq.nasa.gov>

Subject: Fwd: Re: Questions

Sender: owner-code-q@lists.hq.nasa.gov

Dear All,

I started to write a note to tell you that Bryan is proud of the SMA team and its selfless effort to support the Agency but I thought it better to let Bryan's words speak for him. I add my thanks to your untiring efforts... too bad it had to snow 7 inches here in Washington last evening (I bet it snowed in Cleveland also!), it has complicated an already complex operation. Continue to keep your minds open to all possibilities as causes for this catastrophic loss of crew and vehicle.

Keep your chins high and once in a while pause and take a deep breath to collect your perspective. We've got many days of tough work ahead so meter yourself accordingly. No one person is going to solve this accident in the first week as much as we would like to all do that.

Regards,

X-Sender: boconnor@mail.hq.nasa.gov

X-Mailer: QUALCOMM Windows Eudora Version 4.3.2

Date: Fri, 07 Feb 2003 08:05:37 -0500

To: James Lloyd <jlloyd@hq.nasa.gov>

From: boconnor <boconnor@hq.nasa.gov>

Subject: Re: Questions

Jim,

Good show...pass my thanks on to the team.

We were in the debris field 2 days ago.....I'm getting choked up just trying to type this.....the people all over the area are stopping their cars and getting out and putting flowers and small American flags all around pieces of tile and metal and other debris. And the volunteers and police and forest service and FEMA and national guard troops who have all been quickly trained and deputized to record and recover the debris are taking their pictures without removing the flowers and flags out of respect...we had to tell them it was OK!

Again, tell the gang I'm proud of them.

Best,

At 05:46 PM 2/6/2003 -0500, you wrote:

Bryan,

We have decided to provide you the entire list of questions in order to establish a new baseline. Please discard previous list as this contains all up to 2 PM on Thursday (I hope it doesn't upset

any system you have set up). We can assemble a package that has paper copies of everything (questions, offer of assistance, and Q internal actions) through the end of the week if you think you may stop by the office over the week end. Let me know.

Things are progressing well under the circumstances; we are preparing a Q&A batch of topics for Sean O'Keefe for review on the week-end. We have a 9 PM deadline on Friday so people have been assigned chunks of this to work. Paul Pastorak is pulling all the inputs together for the global effort of which we are a part. Michael seems very satisfied with how we have set this process up to assure that we cover the entire spectrum of topical areas for safety and mission success activity for NASA.

Regards,
Jim

O'C

Bryan O'Connor
Associate Administrator
Office of Safety and Mission Assurance

Jim

X-Authentication-Warning: spinoza.public.hq.nasa.gov: majordom set sender to owner-code-qe using -f

X-Sender: prutledg@mail.hq.nasa.gov

X-Mailer: QUALCOMM Windows Eudora Version 4.3.2

Date: Thu, 06 Feb 2003 12:52:24 -0500

To: code-qe@lists.hq.nasa.gov

From: Pete Rutledge <prutledg@hq.nasa.gov>

Subject: Fwd: Safety Reports--Shuttle safety studies needed

Sender: owner-code-qe@lists.hq.nasa.gov

Code QE staff members,

Here's a request we sent to SMA Directors. We're doing the same thing in house. Please look in your QE area for studies as described below and let Ron Moyer know what, if anything, you find. Mark sent out a request for some particular studies this morning--they are of the same nature as we are looking for here, so if you find any of those, give them to Mark, but let Ron know, as well.

Thanks,

Pete

Date: Thu, 06 Feb 2003 10:40:21 -0500

To: smadir@lists.hq.nasa.gov

From: Pete Rutledge <prutledg@hq.nasa.gov>

Subject: Safety Reports--Shuttle safety studies needed

Cc: rmoyer@hq.nasa.gov

SMA Directors,

Ref.: Jim Lloyd's message of last night, Feb. 5, 2003, 19:52 EST, subj: Safety Reports (the onslaught is starting)

This message expands on Jim's.

The General Counsel's office has asked for our help in identifying and collecting Shuttle-related safety studies that have been done since Challenger. So it's more than just those funded by Code Q RTOP money. You have seen examples of some of these studies held up by reporters on the TV news stories and in the newspapers (the one by Pate-Cornell and Fishbeck actually was funded by Code Q). Please have someone do a search (of your memory, of your office, etc.) for Shuttle-related safety studies, especially those that might be most related to the Columbia mishap and the circumstance surrounding it (Shuttle safety, tile, ET, insulation, escape, repair, control, avionics, hydraulics, tires, aerodynamics, debris damage, etc.). So what do we need?

1. Certainly we need bibliographical citations of any such reports you are able to locate and a little more, which will require some intellectual work (see entries in format below).
2. Ideally we'd like to have copies of the reports overnight mailed to us (it's OK if we end up getting multiple copies of studies found at multiple locations).

Here's a reporting format desired by General Counsel:

Name of Document:
Author(s) of Document:
Date (of document):
Brief Summary of Document:
Bad News:
Good News:
NASA Response: (how did NASA respond to the studies' recommendations?)
Tough Questions and Answers: (knowing about this report, what might a reasonable person ask NASA?)
Preparer (of the information in this format):

As with everything else, this information is needed as soon as possible, but the need won't end immediately, either. Partial responses are desirable; i.e., any studies you find, as they are located. And continuing responses are desirable, so if a study report can't be gotten until next week or the week after or the week after that, we still want it. Consider this to be an open request until we shut it down.

Please send your feedback to Ron Moyer in my office (see his e-mail address on the cc: line above).

And, as Jim said, we're doing the same search right here.

Thank you very much for your help,

Pete

Peter J. Rutledge, Ph.D.
Director, Enterprise Safety and Mission Assurance Division
Acting Director, Review and Assessment Division
Office of Safety and Mission Assurance
NASA Headquarters, Code QE, Washington, DC 20546

ph: 202-358-0579
FAX:202-358-2778
e-mail: pete.rutledge@hq.nasa.gov

Mission Success Starts with Safety!

To: Mark Kowaleski <mkowales@hq.nasa.gov>
From: Michael Stamatelatos <mstamate@hq.nasa.gov>
Subject: Re: Fwd: Clarify Answer for PRA question
Cc:
Bcc:
Attached:

You are welcome.

At 03:20 PM 2/28/2003 -0500, you wrote:
Michael, this is great. Thanks. I'll forward it to the CAC.

Thanks a bunch.

Mark

At 02:18 PM 2/28/2003 -0500, you wrote:

Mark:
Is this better?
Michael

At 03:43 PM 2/27/2003 -0500, you wrote:

Michael, can you take a shot at simplifying this answer? I understand it, but I guess they want baby talk.
This a Columbia Action Center (Greenfield) action.

Thanks,

Mark

X-Sender: smcgrath@mail.hq.nasa.gov
X-Mailer: QUALCOMM Windows Eudora Version 4.3.2
Date: Thu, 27 Feb 2003 15:13:56 -0500
To: mark.m.kowaleski@hq.nasa.gov
From: Sally McGrath <smcgrath@hq.nasa.gov>
Subject: Fwd: Clarify Answer

Date: Thu, 27 Feb 2003 15:11:55 -0500
To: mark.m.kowleski@hq.nasa.gov
From: Sally McGrath <smcgrath@hq.nasa.gov>

Subject: Clarify Answer

Mark, I failed to give this to you at the CAC meeting. Can you have someone re-word this so that it's understandable? Thanks.

Sally McGrath

Dr. Michael Stamatelatos
Manager, Agency Risk Assessment Program
NASA Headquarters - Mail Code QE
Office of Safety and Mission Assurance
300 E Street, SW
Washington, DC 20024
Phone: 202/358-1668 Fax: 202/358-2778
E-mail: Michael.G.Stamatelatos@nasa.gov
(Please note change in e-mail address)

"Mission success starts with safety"

X-Sender: mkowales@mail.hq.nasa.gov
X-Mailer: QUALCOMM Windows Eudora Version 4.3.2
Date: Thu, 27 Feb 2003 15:43:50 -0500
To: mstamate@mail.hq.nasa.gov
From: Mark Kowaleski <mkowales@hq.nasa.gov>
Subject: Fwd: Clarify Answer for PRA question

Michael, can you take a shot at simplifying this answer? I understand it, but I guess they want baby talk.

This a Columbia Action Center (Greenfield) action.

Thanks,

Mark

X-Sender: smcgrath@mail.hq.nasa.gov
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Date: Thu, 27 Feb 2003 15:13:56 -0500
To: mark.m.kowaleski@hq.nasa.gov
From: Sally McGrath <smcgrath@hq.nasa.gov>
Subject: Fwd: Clarify Answer

Date: Thu, 27 Feb 2003 15:11:55 -0500
To: mark.m.kowleski@hq.nasa.gov
From: Sally McGrath <smcgrath@hq.nasa.gov>
Subject: Clarify Answer

Mark, I failed to give this to you at the CAC meeting. Can you have someone re-word this so that it's understandable? Thanks.

Sally McGrath

 [PRA estimates vs. demonstrated estimates.doc](#)

QUESTION

Explain the discrepancy between the PRA-estimated probability of a catastrophic shuttle accident and the demonstrated probability of the same catastrophic accident.

ANSWER

The probability of a frequent event can be reasonably well estimated from available statistics as the number of outcomes of interest divided by the total number of trials. Thus, by flipping a coin 100 times, one can get 49 heads and 51 tails. The probability of either (which is $1/2$) can be calculated by the number of successes (49 for heads and 51 for tails) by the total number of tosses. These numbers, 0.49 and 0.51 approximate well the true 0.5 probability. For rare events such as the catastrophic failure of the Space Shuttle, this approach does not yield meaningful results. The catastrophic failure of the Space Shuttle cannot be accurately calculated by dividing the number of such accidents by the total number of flights because the total number of flights is small. Returning to the coin flipping example, if we flip a coin three times and we get 1 head and 2 tails, one can infer that the probability of heads is $1/3$ and that of tails is $2/3$. These are of course bad approximations of the true probability, which is $1/2$ or 0.5, because the total number of tosses (3) is small. In the case of the Shuttle, dividing experienced catastrophic failures to the total number of flights yields 0 for the first 24 flights, $1/25$ right after the Challenger accident, $1/112$ just before the Columbia accident and $2/113$, or $1/57$, right after the Columbia accident. These are obviously all different numbers neither one of which is a good estimate of the Shuttle catastrophic failure probability. Therefore, for rare events, i.e., those for which there is a small number of total trials, (i.e., total number of flights in the case of the Shuttle) one needs to construct a mathematical model based on a methodology called probabilistic risk assessment. This model will yield a probability distribution, which describes the uncertainty scatter of the sought quantity, i.e., the probability of interest. A parameter of this probability distribution, e.g., the mean, or average, is a good measure (or approximation) of the probability of interest. As more Shuttle flights occur and the experience database increases (the total number of flights is large), calculating the probability by dividing the number of experienced failures to the total number of flights will better approximate the "true" catastrophic failure probability.

To: Mark Kowaleski <mkowales@hq.nasa.gov>
From: Michael Stamatelatos <mstamate@hq.nasa.gov>
Subject: Scenario
Cc:
Bcc:
Attached: C:\Documents and Settings\mstamate\Desktop\Scenario.doc;

Mark:

This is a scenario I showed Pete on Monday AM and is being sent by Pam to Bryan. I also sent it to the JSC Shuttle PRA group who are now involved in developing possible scenarios for Columbia. I will keep in touch with them and let you know about their progress. I would also appreciate you keeping me informed of what deterministic or probabilistic analysis are being performed in support of the investigation.

Thanks,
Michael

X-Sender: mkowales@mail.hq.nasa.gov
X-Mailer: QUALCOMM Windows Eudora Version 4.3.2
Date: Wed, 05 Feb 2003 09:59:20 -0500
To: Michael Stamatelatos <mstamate@hq.nasa.gov>
From: Mark Kowaleski <mkowales@hq.nasa.gov>
Subject: Re: Scenario

Will do.
Mark

At 07:59 AM 2/5/2003 -0500, you wrote:

Mark:

This is a scenario I showed Pete on Monday AM and is being sent by Pam to Bryan. I also sent it to the JSC Shuttle PRA group who are now involved in developing possible scenarios for Columbia. I will keep in touch with them and let you know about their progress. I would also appreciate you keeping me informed of what deterministic or probabilistic analysis are being performed in support of the investigation.

Thanks,
Michael

Dr. Michael Stamatelatos
Manager, Agency Risk Assessment Program
NASA Headquarters - Mail Code QE
Office of Safety and Mission Assurance
300 E Street, SW
Washington, DC 20024
Phone: 202/358-1668 Fax: 202/358-2778
E-mail: Michael.G.Stamatelatos@nasa.gov
(Please note change in e-mail address)

"Mission success starts with safety"

X-Authentication-Warning: spinoza.public.hq.nasa.gov: majordom set sender to owner-code-q using -f
X-Sender: prutledg@mail.hq.nasa.gov
X-Mailer: QUALCOMM Windows Eudora Version 4.3.2
Date: Thu, 06 Feb 2003 09:20:22 -0500
To: code-q@lists.hq.nasa.gov
From: Pete Rutledge <prutledg@hq.nasa.gov>
Subject: Your help is needed: Qs and As for Congressional Testimony
Sender: owner-code-q@lists.hq.nasa.gov

Code Q staff members,

Michael Greenfield has been assigned, by the Administrator, the task of collecting anticipated questions (Qs) along with proposed answers (As) for Mr. O'Keefe's Congressional testimony, which will take place next Thursday, February 13. We have been tasked to collect safety and mission success (SMS) and safety and mission assurance (SMA) related Qs and As. We have to hand in our Qs and As by 9PM tomorrow, Friday, Feb. 7.

Note that by "SMS," we are referring to the Programs' implementation of our requirements (and perhaps other things) in order to achieve safe and successful missions. So some questions may be of this nature; i.e., not merely about what we do. "SMA" refers to those things that our SMA community does to assist NASA programs to achieve safety and mission success.

This task is something we can all help with. Please put your Congress-person hat on and think about what SMS/SMA-related questions pertaining to this mishap (directly or indirectly) might be asked of the Administrator. If you are the expert in the area of your question, please propose the right answer for it. If you are not, then just give us the question. We will keep your name associated with the question so that we can come back to you for more information, if needed.

Please send your Qs, with or without As to Juanita Sandin. She will create a running list of them. Later we will parse them into categories for inclusion in the master list of Qs and As.

Thank you for your help on this.

Pete

Peter J. Rutledge, Ph.D.
Director, Enterprise Safety and Mission Assurance Division
Acting Director, Review and Assessment Division
Office of Safety and Mission Assurance
NASA Headquarters, Code QE, Washington, DC 20546

Pete Rutledge, 09:20 AM 2/6/2003 -0500, Your help is needed: Qs and As for Congressional T

ph: 202-358-0579

FAX:202-358-2778

e-mail: pete.rutledge@hq.nasa.gov

Mission Success Starts with Safety!

To: "Bill Vesely"
From: Michael Stamatelatos <mstamate@hq.nasa.gov>
Subject: Re: Additional Shuttle PRA Questions
Cc:
Bcc:
Attached:

Thank, Bill.

At 02:49 PM 2/6/2003 -0500, you wrote:

Michael, enclosed are additional Shuttle PRA questions. Bill Vesely

To: "Bill Vesely"

From: Michael Stamatelatos <mstamate@hq.nasa.gov>

Subject: PRA Q&A

Cc:

Bcc:

Attached: C:\Documents and Settings\mstamate\Desktop\1. PRA Q&As.doc;

Bill:

Here is what I have compiled on PRA, so far, from you and me, as input to the Administrator. He will testify on the Hill next week and we are preparing Q&As on a variety of topics to prep him.
Michael

X-Authentication-Warning: spinoza.public.hq.nasa.gov: majordom set sender to owner-code-qe using -f

X-Sender: jlemke@mail.hq.nasa.gov

X-Mailer: QUALCOMM Windows Eudora Version 4.3.2

Date: Tue, 04 Feb 2003 16:49:03 -0500

To: code-qe@lists.hq.nasa.gov, code-qs@lists.hq.nasa.gov

From: jlemke <jlemke@hq.nasa.gov>

Subject: Re: Supporting Bryan on the Columbia Accident Investigation Board (CAIB)

Sender: owner-code-qe@lists.hq.nasa.gov

At 07:49 PM 2/2/2003 -0500, Pete wrote:

Attached is a rough list we prepared today of investigative areas--for the most part these are areas in which the SMA community has some special expertise. For each area we have tentatively named an OSMA lead (and in some cases more than one person to work together). If you can think of other areas that we have not captured, and should, let me know. If we've associated you with the wrong area(s) or failed to associate you with the right area(s), let me know. We don't want to disrupt the investigation--we want to be prudent; we want to help Bryan. Think about whether and how you might be able to be helpful in these areas; then, before you take any action, write down your plan in a clear, concise manner, and send it to me--state what you might be able to do and how you would propose to do it. Then wait for a go-ahead from Jim or me. Keep in mind that we have asked the SMA directors at JSC, MSFC, KSC, LaRC, ARC, and SSC to work with us as needed, so this can be part of your plan, if appropriate.

There have been some questions about the attachment to the above email. Therefore I'd like to parse and restate Pete's direction. The specific action asked of us is:

1. "Think about whether and how you might be able to be helpful in these areas." If your name is next to the item, this means we are asking YOU if you think there is something to be done that would be helpful. If the answer is NO--so advise your boss.
2. If the answer is YES: "then, before you take any action, write down your plan in a clear, concise manner, and send it to me--state what you might be able to do and how you would propose to do it." Do not work the action--explain how it could be worked--including who, what, etc. (For QS--please run the plan by me before you send to Pete.)
3. "Then wait for a go-ahead from Jim or me (Pete)." (Pete--please run the QS go-aheads through me with a copy to Sylvia for tracking purposes.)

Easy as 1-2-3. (QS: can we do ours by COB Thursday? Thanks.)

johnl

John Lemke
Manager, System Safety Engineering
NASA HQ, Code QS
202-358-0567 FAX 358-3104
jlemke@hq.nasa.gov

"Mission success stands on the foundation of our unwavering commitment to safety"

Administrator Sean O'Keefe January 2003

X-Authentication-Warning: spinoza.public.hq.nasa.gov: majordom set sender to owner-code-q using -f
X-Sender: jlloyd@mail.hq.nasa.gov
X-Mailer: QUALCOMM Windows Eudora Version 4.3.2
Date: Tue, 04 Feb 2003 08:46:46 -0500
To: prichard@hq.nasa.gov, prutledg@hq.nasa.gov,
 Bill Bihner <wbihner@mail.hq.nasa.gov>
From: James Lloyd <jlloyd@hq.nasa.gov>
Subject: CAC
Cc: code-q@lists.hq.nasa.gov,
 "Dr. Michael A. Greenfield" <michael.greenfield@hq.nasa.gov>
Sender: owner-code-q@lists.hq.nasa.gov

Dr. Greenfield is instituting a process for the collection of technical questions and answers and will serve as NASA's technical clearinghouse for release to the outside community. He will be providing details on how this information is to be collected and dispositioned. He has set up an action center (referred to as the CAC) and will chair a meeting each day at 2 pm (location to be provided shortly). Bill Bihner is the Code Q representative and will be attending the meeting starting this afternoon.

I have briefed Dr. Greenfield on our process for providing a list of questions to the CAIB. We will also be involved with supporting Bill Bihner and Dr. Greenfield in developing answers to technical questions where Code Q is the obvious source for the answer. We will also be allowed to review technical answers developed by others as part of the process for Dr. Greenfield's approval for release.

Jim

To: prichard@hq.nasa.gov
From: Michael Stamatelatos <mstamate@hq.nasa.gov>
Subject: Scenario
Cc:
Bcc:
Attached: C:\Documents and Settings\mstamate\Desktop\Scenario.doc;

Pam:
I gave this scenario to Pete yesterday morning.
He asked me today to send it to you to put into the material to be sent to Bryan.
Thanks,
Michael

To: prutledg@hq.nasa.gov
From: Michael Stamatelatos <mstamate@hq.nasa.gov>
Subject: Fwd: Scenario
Cc:
Bcc:
Attached: C:\Documents and Settings\mstamate\Desktop\Scenario.doc;

Pete:
Sorry. I forgot to copy you to this.
Michael

Date: Tue, 04 Feb 2003 15:43:07 -0500
To: prichard@hq.nasa.gov
From: Michael Stamatelatos <mstamate@hq.nasa.gov>
Subject: Scenario

Pam:
I gave this scenario to Pete yesterday morning.
He asked me today to send it to you to put into the material to be sent to Bryan.
Thanks,
Michael

To: MARY E KICZA <mkicza@mail.hq.nasa.gov>

From: Faith Chandler <fchandle@hq.nasa.gov>

Subject: presentations

Cc:

Bcc:

Attached: C:\Documents and Settings\fchandle\My Documents\Columbia\CAIB - Investigation Overview.ppt; U:\q_groups\QALL\NPG 8621\Overview\Integrated Draft 3 for NTSB 9_18final for Columbia.ppt;

Mary,

Here are two presentations that have been prepared recently.

One is for the Enterprises to give them an overview of how the HCAT - MRT - and field investigators are working together.

The other is a briefing that was prepared for the Columbia Accident Investigation Board at the request of Bryan... to provide them with some refresher information on investigation.

I am not sure what you are looking for.

Perhaps one or a combination of these would serve you.

If you have an opportunity, please mark the slides you are interested in. I can put together a custom presentation to meet your specific information needs.

Thanks.

Faith



Mission Success Starts With Safety

Meeting of NTSB/NASA on NASA Mishap Investigation Process

September 18, 2002

Jim Lloyd

NASA Headquarters

Office of Safety and Mission Assurance

David Whittle

Space Shuttle Program Integration

Johnson Space Center



Content

- **General**
 - Organization
 - Policy Overview
 - Procedural Overview
 - Techniques and Methods
 - Capability
 - Corrective Action Tracking
- **Space Shuttle**
 - Capability
 - Activity
 - Components and Mission Profile
 - Contingency Preparedness
 - Activation
 - MIT (Go Team)
 - Standing Mishap Board (Interagency)
- **Summary**



NASA Policy Support

- NASA has policy and contingency planning in place to direct the investigation of all mishaps (including Space Shuttle)
 - NASA Policy Document (NPD) 8621.1, "NASA Mishap Reporting and Investigating Policy," December 10, 1997.
 - NASA Procedures and Guidelines (NPG) 8621.1, "Procedures and Guidelines for Mishap Reporting, Investigating, and Recordkeeping," June 2, 2000.
- Policy may be downloaded from:
<http://www.hq.nasa.gov/office/codeq/doctree/doctreec.htm>



Mission Success Starts With Safety

NPD 8621.1G,

“Mishap Reporting and Investigating Policy”

Office of Prime Responsibility : Office of Safety and Mission Assurance (Code Q)

**Bryan O'Connor,
Associate Administrator**

- Establishes NASA-wide policy for mishap reporting and investigating—signed by the Administrator.
- Applies to mishaps occurring during NASA operations involving NASA or contractor personnel, and/or when NASA equipment/property is involved.
- Describes purposes of mishap investigation, board appointment authorities, roles of responsible officials, board levels, and responsibilities for final report acceptance and approval.



Mission Success Starts With Safety

NPG 8621.1G, "NASA Procedures and Guidelines for Mishap Reporting and Investigating and Recordkeeping"

Office of Prime Responsibility : Office of Safety and Mission Assurance (Code Q)

**Bryan O'Connor,
Associate Administrator**

- Establishes NASA-wide procedures and guidelines for mishap reporting, investigating and recordkeeping.
- Provides definitions of types of mishaps, reporting procedures, investigative techniques, report format, report timelines, report approval process, corrective action process, and lessons learned process.



Mission Success Starts With Safety

NASA Mishap Investigation Policy

- The objective of a NASA mishap investigation is to:
 - Use information from the NASA mishap investigation process as a key element of NASA's mishap prevention program.
 - That is, understand what happened and prevent recurrence.
- The results of mishap investigations are not to be used in matters related to civil, criminal, or administrative culpability or liability, or for disciplinary actions.
- Mishap reporting process is overseen by Code Q to assure independence of mishap investigation process.
- Witness statements given in the course of a NASA mishap investigation are treated as privileged and non-releasable (to the extent allowed by law).



Mission Success Starts With Safety

Statement to Witnesses

NASA Procedures and Guidelines (NPG) 8621.1

The purpose of this safety investigation is to determine the root cause(s) of the mishap that occurred on _____, and to develop recommendations toward the prevention of similar mishaps in the future. It is not our purpose to place blame or to determine legal liability. Your testimony is entirely voluntary, but we hope that you will assist the board to the maximum extent of your knowledge in this matter. Your testimony will be documented and retained as part of the mishap investigation report background files but will not be released as part of the investigation board report.

NASA will make every effort to keep your testimony confidential and privileged to the greatest extent permitted by law. However, the ultimate decision as to whether your testimony may be released may reside with a court or administrative body outside NASA.

For the record, please state your full name, title, address, employer, and place of employment.



Mission Success Starts With Safety

Mishap Report Timelines

- **NASA requires quick and thorough investigation to ensure safe operations and the safety of the Shuttle fleet, which, in turn supports the Agency pursuit of mission objectives in science and engineering.**
- **Mishap investigations are thorough and timely, allowing recommendations to be implemented quickly.**



Investigation Techniques and Methods

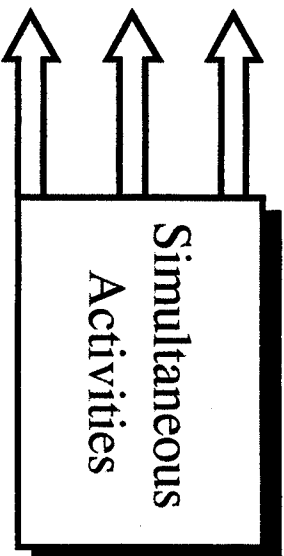
- Depth of investigation is determined by the severity of the mishap, potential for reoccurrence, and visibility.
- A variety of methods are used to determine root cause and significant contributing factors.
- Methods listed, suggested, and briefly described in NASA Procedures and Guidelines for Mishap Reporting, Investigating & Recordkeeping (NPG 8621.1):
 - Root cause analysis
 - Evidence and data analysis
 - Events and causal factors diagramming
 - Management Oversight and Risk Tree (MORT)
 - Change analysis
 - Fault tree analysis



Investigation Techniques and Methods

Comprehensive systematic method (a suggested NASA practice):

- Gather data.
- Create time line.
- Create fault tree.
- Merge fault tree and time line to create events and causal factor tree.
- Further investigate root cause.
- Perform cause test.
- Document findings along with root cause, contributing root cause(s) and significant observations.
- Each finding requires a recommendation in the final report.





Mission Success Starts With Safety

Investigation Capability

- **NASA has experienced professionals trained in investigation approaches by NASA.**
- **Courses at NASA Safety Training Center include:**
 - **Management Oversight and Risk Tree (MORT)**
 - **MORT-based Mishap Investigation**
 - **Human Factors in Mishap Investigation**
 - **Space Shuttle Crash Investigation**
 - **Aircraft Mishap Investigation**
 - **Mishap Board Chairperson training**
- **Technical professionals augment the core of the Board with special knowledge and expertise, e. g., Shuttle systems when Shuttle is an object for investigation.**



Investigation Capability (continued)

- **Core Competencies and Capability (human and laboratory resources):**
 - **Structures (metallurgy, corrosion, fracture, etc.)**
 - **Flight dynamics (turbulence, wake vortex, wind shear, etc.)**
 - **Propulsion (air breathing and rocket)**
 - **Aerodynamics (modeling, evaluation in wind tunnels, etc.)**
 - **Others (icing, air traffic operations & modeling, etc.)**
 - **Human factors, Human error analysis, root cause analysis, stress and fatigue analysis, ergonomic assessment, etc.**



Closeout and Tracking of Mishaps and Corrective Action

- **Formal acceptance and approval process (AA Code Q is final approving authority for all HQ appointed boards).**
- **Automated system--Incident Reporting Information System (IRIS).**
- **Closed-loop system to track recommendations through completion.**
- **Trending capabilities.**
- **Documents lessons learned.**