These slides represent findings from about 9 years of observations and literature searches during the 1970s. Subsequent research expanded the issues significantly

This set can be used to introduce Accident and Incident Investigation and Investigation Management Courses

For information about the availability of other instructional aids, instructor guides and manuals or custom training aids, in paperback, HTML video, audio or CD media, email "me" at this URL.

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Thanks for acquiring this material. We are interested in helping you to use it successfully. Please feel free to contact Starline with any questions. If you have a contribution to improve the material you will be given full credit if you share it with us.

Depending on circumstances and your environment,

Before the presentation, it might be helpful to set up the students by posing the question:

If you investigate accidents, formally or informally, what do you consider to be the objectives to be achieved, and what investigation methdology do you use to achieve those objectives. Have they been successful?

What is the basis for your answers?

SAFETY PROGRAMS' HIDDEN DEFECT: ACCIDENT INVESTIGATION

A presentation reporting research into accident investigation process perceptions and methodologies. Adapted from a paper titled Accident Perceptions: A Case For New Perceptions and Methodologies

SAE Paper 800387

1980

Updated through January 2002

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This is simply a title slide

THE PRESENTATION WILL

- Review the questions that prompted the initial investigation process research ,
- Discuss the research findings, and
- Describe some applications and future actions suggested by the findings.

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Here is what's going to be covered, in general terms.

List of investigation problem areas

The major problem areas found include accident investigation:

- **OBJECTIVES**
- **SCOPE**
- **METHODS**
- **OUTPUTS, and**
- **USES**

To explain these problems adequately, we will have to talk about concepts, too. More about that later.

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This is the overview slide, reflecting the problems disclosed by the observations of investigation processes and related research

Why bother?

LET'S BEGIN

- **WHY Investigate accidents?**
- **In other words, why bother investigating this accident?**

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This slide opens the door to a fundamental question that is not often asked and if asked the answers are usually simplistic and superficial. Purpose of slide is to plant question in student's minds for exploration in more detail .

Slide is a liquid oxygen tank truck that blew up adjacent to a hospital.

This is a partial list of reasons accidents are investigated, observed during the research. Main point is to introduce awareness of the diversity of reasons, and show that investigation efforts are driven by very diverse notions.

Objectives for investigations

WHAT SHOULD BE THE OBJECTIVES OF MY INVESTIGATION?

- **What should I be trying to accomplish by investigating this accident?**
- **Are my objectives valid? Will the objectives tell us how to measure the success and value of my investigation and its outputs?**
- **Even more fundamentally, what concepts and principles are the basis for the answers?**

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The objective of this slide is to try to open up the student to introspection of their current perceptions and opinions, and encourage them to consider the possibility that new thinking might be interesting.

SCOPE?

SUPPOSE YOU WANT ME TO INVESTIGATE THIS ACCIDENT FOR YOU

WHAT SHOULD BE THE SCOPE OF MY INVESTIGATION?

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This slide introduces the concept of scoping an investigation project - e.g., what to address in the investigation. Don't try to get answers at this point.

By considering an investigation a project, students will be more amenable to discussing the process in terms of project goals, costs, staffing, resources, scheduling, monitoring progress, etc.

Be sure to commend anyone who has any inkling of the gravity of this question and its answer on the performance of an organization.

There will little agreement on answers to this question initially. Don't' rush students - they begin to see the big picture as the presentation progresses.

By the end of this slide, students should begin to recognize confusion in field.

Beginning and end

SAID ANOTHER WAY,

- **When should I say the accident begins and ends?**
- **What should I cover during the investigation?**

A MUCH MORE CRUCIAL QUESTION:

- **What concepts and principles - or theory - form the basis for your answers?**

NOW LET'S SHIFT GEARS FOR A MOMENT.

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This can be a contentious slide, depending on student experiences. Don't digress into the answers at this point. Focus on point that whatever the answer, there should be some conceptual basis for their answers - a fundamental idea that investigation process should be have a sound research foundation.

Methods?

Your operation is involved in this explosion . . .

WHAT METHODS WOULD YOU WANT ME USE TO INVESTIGATE THE ACCIDENT FOR YOU, TO ENSURE A GOOD INVESTIGATION?

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The widespread damage should help viewer recognize that selection of the investigation methodology, or how they go about the investigation, is an important and necessary decision.

Again, avoid discussion here except to clarify that they understand the question. Intent is to lead to awareness that there are different ways to investigate.

Selection criteria for best method

TO ANSWER THAT QUESTION COMPETENTLY, SHOULDN'T I KNOW

- **What choices of methods are available?**
- **The name of the method I should use?**
- **Why this is the best method for your purposes?**

WHAT ARE YOUR SELECTION CRITERIA FOR THE "BEST METHOD?"

- **Why is any one method better than another?**
- **Will the method you select lead to outputs that will satisfy you and my work product users?**

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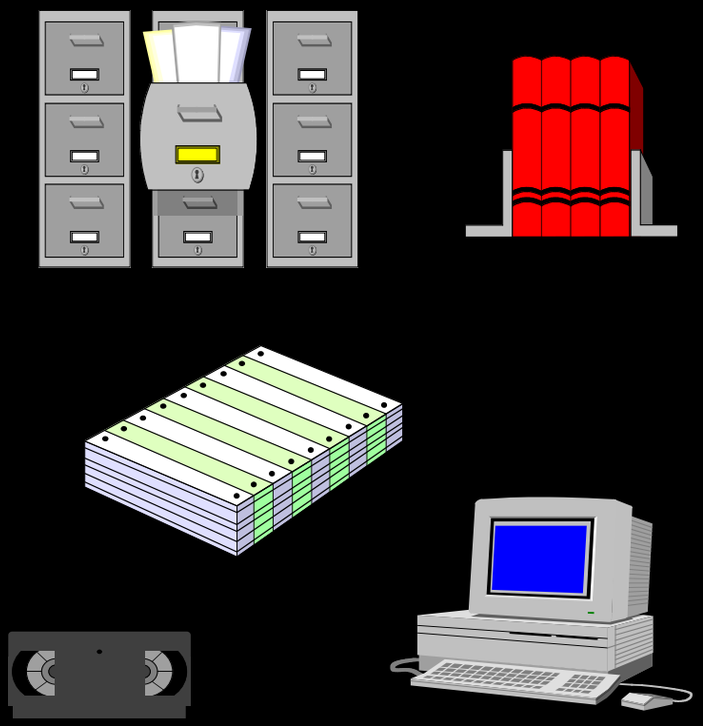
Main points are to reinforce awareness that methodological options are available, that selection of best methodology is should be a reasoned decision, and that selection should be based on results-oriented criteria.

Why question is attempt to reinforce need for a research foundation for investigation process, and answers to questions like these.

(research tried to address all these questions)

OUTPUTS?

AT THE END OF THIS INVESTIGATION, WHAT WORK PRODUCTS DO YOU WANT ME TO DELIVER TO YOU ?



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This gets to what you are expected to deliver at the end of an investigation. Illustrations are attempt to show that different output formats might be considered, to push students toward out of the box thinking by this stage.

Work product specifications

WHAT ARE YOUR SPECIFICATIONS FOR MY INVESTIGATION WORK PRODUCTS?

- **Where do I find the specifications documented?**
- **Do they really tell us what I should produce?**
- **How will you actually judge the quality of my work products? Others' work products?**
- **Are your criteria consistent from day to day?**

AGAIN, WHAT CONCEPTS LEAD TO YOUR ANSWERS TO THESE QUESTIONS?

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First questions start to get at investigation program goals and design and relationship

Last two questions get at quality assurance issue with more to follow.

(Principle thus far is the a problem well defined (the right questions) is half solved.)

Work product specifications

WHY DO YOU WANT ME TO INVESTIGATE WHEN YOUR INSURER, THE LOCAL CORONER, A GOVERNMENT AGENCY, SUPPLIER OR OTHERS WILL ALSO BE INVESTIGATING AND REPORTING ON THE ACCIDENT?

- **How will you actually judge the suitability and value of my work products? Others' work products?**
- **Are your criteria consistent from day to day?**

AGAIN, WHAT CONCEPTS LEAD TO YOUR ANSWERS TO THESE QUESTIONS?

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This slide closes the loop on the multiple purposes exposed earlier, by raising questions about the various outputs that result from these differences, and the problems the differences create. Focus on comparative value of different investigation work products, and tie question to the concepts on which answers are based.

Work product usage

AFTER YOU HAVE MY INVESTIGATION WORK PRODUCTS, HOW DO YOU PLAN TO USE THEM ?

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This is the first questions about how investigation work products are used, to start viewer thinking about question, and eventually leading to the gap between reasons for investigating and how results are used begin to show the divergence.

Work product usage

WHICH REPORT - MINE, THE POLICE'S, INSURANCE COMPANY'S - WILL HELP YOU *MOST*? WHY?

- **Why are there still some people who will complain to you that they need more or 'better' data?**
- **What exactly is wrong with my data, and how can we decide what added data would be worth getting?**

AGAIN, WHAT CONCEPTS PROVIDE THE BASIS FOR YOUR ANSWERS?

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This slide leads to a criterion for investigations - helping users the most, introduce the notion that prior problems may suggest why researchers engaged in statistical accident causation research never have"the right data" or not good enough data, etc.

Intent is also to reinforce idea that concept problems may be involved in or even responsible for problems.

A Lot of questions: Any answers?

LOTS OF QUESTIONS AND PROBLEMS FOR INVESTIGATORS!!!!! ARE THERE REALLY GOOD ANSWERS?

- **Be assured that these are not just rhetorical questions. They are real, and demand decisions by every thoughtful investigator who has ever investigated an accident or incident.**
- **The answers are rarely found in investigation books or taught in traditional accident investigation courses; otherwise you would already have all the answers at the tip of your tongue!**

STILL, THEY HAVE TO BE ANSWERED - BY EVERY INVESTIGATOR IN EVERY INVESTIGATION.

HOW?

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Main point is to introduce the idea that these questions are valid and real, and that they are answered during every investigation is some way or another. The real research challenge was to find out how they were answered and why.

Personalized investigations

- In the absence of concrete guidance, many investigators are forced to devise their own personalized methodologies and interpretations.

- these personalized methodologies result in personalized investigation decisions, and in widely differing, personalized accident investigation work products and accident data.

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Recognizing the source of these differences was a breakthrough realization during the research, underscoring the need for unifying conceptual guidance.

Adverse effects for investigators

- How can we avoid reports dominated by investigator's personal conclusions and experience, or worse a dominating investigator's or manager's conclusions on a team investigation?

- HOW CAN WE EXPECT CONSISTENT REPRODUCIBLE RESULTS FROM INVESTIGATION TO INVESTIGATION, OR AMONG INVESTIGATORS?

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This slide starts to lay the groundwork for the proposition that these differences are not trivial, and introduces the first of several criteria for what a better process should deliver..

Adverse effects for investigators (continued)

- How can we control the quality of accident reports relying on personal conclusions, without consistent investigation methods and objective quality assurance criteria?
- How can you link outputs to procedures or to previously predicted safety performance promised in safety approval documents or regulations, or derived from safety analyses?
- How long will the results be remembered and reused?

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Adverse effects on others

GOING BEYOND THE EFFECTS ON YOUR OWN OPERATIONS, CONSIDER THE RAMIFICATIONS OF PERSONALIZED INVESTIGATIVE OUTPUTS ON

- **Your organization's and others' future safety policies - or regulations,**
- **Your organization's, or your industry's or others' safety program strategies and tactics,**
- **Your employees' and the public's opinions about the adequacy of your safety levels, or on**
- **Analysis and future efforts that use those data to define and solve safety problems, and**
- **In practical $, think about costs of litigation resulting from different reports about an accident!**

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This slide expands on the range of problems resulting from investigation shortcomings, by pointing out questions involving plans, strategies, views of safety program adequacy, the results flowing from inadequate investigations.

Like an Iceberg . . .

THE EFFECTS INCLUDE DELAYS, MISDIRECTION, INJUSTICES, DAMAGED REPUTATIONS, WASTE AND MORE.

- These problems are not readily visible to the public. The subtle ones are like the bottom of an iceberg. They are there, and they create lots of difficulties, but they are ***hidden***. Most people don't link these problems to inadequate investigations or investigation failures.

BUT THEY ARE LINKED, AND THAT IS WHY TRADITIONAL INVESTIGATIONS ARE

SAFETY'S HIDDEN DEFECT

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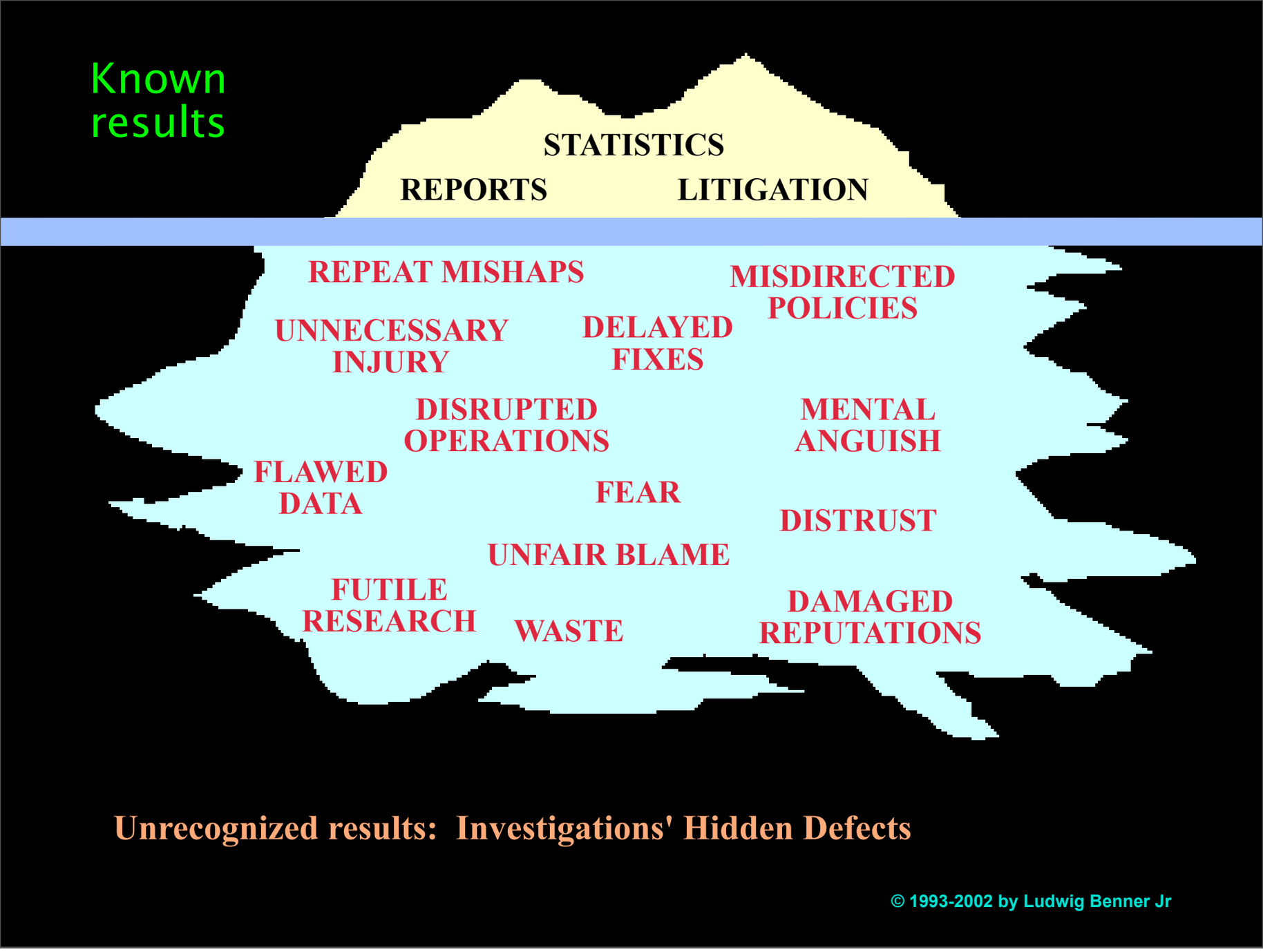
This leads to the conclusion viewers are (hopefully) ready to acknowledge these defects, and prepared to



This figure pulls together the many kinds of problems observed during the research

Investigation methods research

Little accident investigation process research* has been performed, and what has been done has not been well funded, or done with formality, especially in the United States.

One informal research initiative has been under way for over 20 years. As observations led to new findings and hypothesis, each was tested and refined in the next subsequent step. As the work was applied, it helped resolve the problems just described.

*** as contrasted with *accident causation* research using reported accident data**

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This slide begins the transition to the problem answering parts of the presentation. It distinguishes the research from causation research, which is primarily performed on the results produced by investigations, to reinforce the focus on the the investigation process.

Findings

WHAT EXACTLY WAS DISCOVERED?

THE GREAT DIVERSITY OF THINKING AND REASONING AMONG INVESTIGATORS, THEIR BOSSES AND THE USERS OF THEIR REPORTS. THE WORK DISCLOSED

- **5 differing perceptions of "accident"**
- **44 differing reasons for investigating them**
- **7 different accident investigation processes**
- **6 different methodological approaches and**
- **3 differing types of deliverables**

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Diversity of findings was first red flag that all was not well in field, and that some serious work was needed to reconcile the differences, or develop alternatives. This is a pivotal element of the presentation.

When does accident begin and end?

Most importantly, there was and still is almost complete lack of agreement about what an accident is, and how to determine the beginning and end of each accident. Thus the scope of what will be investigated and reported in specific accidents varies widely.

Is it any wonder we have questions, delays, disputes, and lots of litigation after accident investigations - big and small- are reported?

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As evidence, refer to the many models, including a famous precursor/accident model by Reason; or the ambiguity of the popular definition of accident - an unintended, undesired event. Paper discussion issue is posted on the ludwigbenner.org web site

Perceptions of accident phenomenon

ONE OF THE MOST SIGNIFICANT FINDING WAS THE 5 DIFFERENT PERCEPTIONS OF ACCIDENTS:

Single event, viewing accidents as a single event like a lightning bolt or act of god; this is reflected in much regulatory compliance/violation thinking.

Chain-of-events, or linear sequence much like a row of toppling dominos

Factorial view, or an occasion involving ‘factors' which can be identified by statistical analysis methods.

Branched converging events chain, illustrated by converging fault tree charts; and

Multilinear events sequences, thinking of an accident as a process involving concurrent interactions that produce an unintended outcome.

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This is a summary of the principal categories fo view of the accident phenomenon.

What's better

- Knowing these differences can help you understand why others say and do what they do during investigations. But by itself, this knowledge will not produce better investigations.
- Realizing all this, was it possible to develop something better?

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Research led to more findings

That's what the research focused on next. The findings about different perceptions were used to distinguish observed results flowing from each, in terms of investigation practices, work products and their worth.

Their worth was judged by the performance improvements which followed.

That work led to . . .

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The research then looked into the results of different perceptions -what results they produced.

Research led to

- Synthesis of a perceptual framework that would help resolve all the questions investigators faced, and tie investigations to predictive analyses.
- Isolation of principles to help produce "better" investigations.
- Development of a comprehensive methodology that offers reproducible outputs.
- Development of training techniques to simulate investigations so the methods could be taught

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From the observations of the results, it became clear that some alternative to what existed at the time was needed, so the search turned toward the synthesis of a perceptual framework to resolve these issues. This was pursued in the literature and by further observations of investigation practices.

Conceptual glue

THE RESEARCH REQUIRED DEVELOPMENT OF A CONCEPTUAL "GLUE" TO TIE ALL THE INVESTIGATION PRACTICES TOGETHER INTO A CONGRUENT GENERAL FRAMEWORK.

- **In essence it required 'a system of assumptions, accepted principles and rules of procedure devised to analyze, predict or otherwise explain the nature and behavior of phenomena that we call accidents.'**

SUCH A GLUE WAS DEVELOPED.

LET'S EXAMINE THAT GLUE NOW.

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One of the first steps was to define what was required to provide an acceptable conceptual basis for investigations - as described in this slide.

A musical score will begin in a moment

PLEASE TURN TO THE HANDOUT.

IT HAS A MUSICAL SCORE SHOWN ON THE NEXT SLIDE, WITH NOTATIONS.

FOLLOW THE DISCUSSION ON THAT PAGE.

(The recording is from the original presentation)

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The breakthrough was a serendipitous discovery that the musical process and language of musical scores could provide underlying concepts being sought. As this was explored, the value of the analogy grew. The viewer should have the handout available as the narration begins.

A COMPARISON BETWEEN A MUSICAL SCORE AND MULTILINEAR EVENTS SEQUENCES CHARTING METHODS FOR ACCIDENT INVESTIGATORS

Actors:

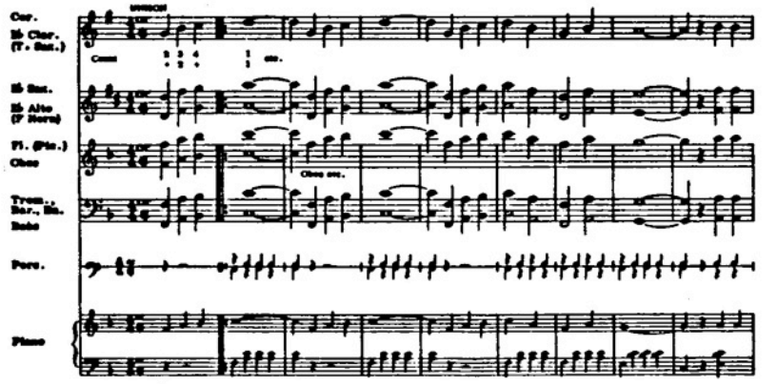
Implicit /Explicit players

1,2,3	cornet b clarinet t sax
4,5,6	e sax e alto Fr. horn
7,8	flute oboe
9,10,11,	tromb bar.,Bn. bass
12,13	drums
14	piano

Time reference scale:

t_o ——— t_{end}

When The Saints Go Marching In



Vertical alignments describe dynamic relationships among changes of state and steady states (at successive time units) produced by each events set

Horizontal lines and entries describe the time/locationally-ordered sequences of acts by each actor (events) defining their temporal and spatial sequential logic

By tracking the actions of individual actors from appropriate "records" one can reconstruct the entire sequence of events constituting the "song" and reproduce the "score." The score can then be reexamined and analyzed to serve the needs of the analyst.

By convention, events flow from the left of the page toward the right as time passes.

Notes:*

1. *Clefs indicate the line space and pitch, ie, the arena where the events take place.*

2. *Unison describes a policy for the activity*

4. *"Oboe,etc" (line 3-4) gives a warning sign to reduce the probability of confusion.*

*No pun intended!

4. *"count + 2 + 1 etc" (lines 1,2) leads to coordination of timing of actions by each actor.*

5. *define "location" for each next change of state(by scale + timing) and the duration of each steady state by the symbol used. "rest" symbols do the same.*

6. *defines the rhythm, or the basis for the coordination of the events during the conduct of the activity.*

7. *The "count" and "oboe" can be viewed as safeguards (or countermeasures) instituted by the composer or arranger to reduce the likelihood of mishaps.*

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This handout describes many of the points of the musical score analogy that follow.

Tape transcript p 1

You are about to hear five musicians and five instruments. Let's look at them as 10 actors. These ten actors will each act, step by step, according to certain timing, pitch and other specifications Their interactions will produce a melodious song.

If you read music, you can probably follow the score on the handout. You will hear some embellishments of the score, but I'm sure you will recognize the tune.

(MUSIC - harmonious band music)

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This and the next 6 slides provide the text of the audio tape. The music is an essential part of the presentation, needed to reinforce the process nature of the music, and by analogy, the accident process.

Tape transcript p 2

You are listening to 10 actors maintaining a state of dynamic equilibrium. Each new note changes a state, almost every moment. These combined state changes produce an overall "homeostatic" state. As long as the actors' actions blend together within certain tolerances, their dynamic equilibrium or stasis is maintained, even when some of the actors start to act with their voices.

(MUSIC- voices join band music)

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Key point is dynamic equilibrium during normal progression of song, and how that is maintained.

Tape transcript p 3

As each new word and note introduces a new state during the course of the song, there is some risk of a sour note. But what happens when several notes do not follow within needed tolerance ranges? The song is in jeopardy. Off-spec notes can disrupt our dynamic equilibrium, and transform the song into -- ?

Well, let's listen to what can happen.

(MUSIC- disharmony, confusion, audience shouting)

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This shows how an accident starts during the normal progression of events, just like an accident starts. Addresses the question about when an accident starts.

Tape transcript p 4

Notice how the song was transformed from music into noise. The changed pitch and timing by one or two actors brought the music to an end.

Well the similarities to an accident are very real, in my view. For investigation purposes, this analogy is helpful too. If you want to find out what went wrong during the song, we can find out this way.

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The next step is to lead into the investigation of what happened

Tape transcript p 5

We have a record on this cassette tape, of each action taken by each of the actors. Using the record, we can go back and track the individual actions by each actor to locate the first event that was out of tolerance, and which started this transformation process. As we then trace each actor's actions, from that point, we can document them by reconstructing the score as it was actually played during this mishap. This can be done using the same techniques we used for documenting the original score, as is shown on the handout.

Now, using these techniques, one can reconstruct and display the score of an accident, too.

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This introduces the "witness plate" idea, as changes leave their mark on related objects - or people

Leads to idea of tracking changes.

Tape transcript p 6

If we look at the accident score as a multilinear event sequencing chart, we can reconstruct the accident sequences from the data stored in people and things after the accident, using the same tracking or tracing techniques for each of the actors involved.

From this it is not hard to see how we can bring order to one's search for data, and how we can help test the data relevance as it becomes available during an investigation. Nor is it difficult to see how the score from one accident can help us investigate the next similar accident more efficiently. I have found that the efficiencies increase dramatically with each successive accident.

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Introduces the multilinear dimension of the score as analogous to the "score"of an accident process.

As explained, it provides a way to organize the data, with a time-actor matrix that will is adapted to the investigation process.

Tape transcript p 7

Nor is it difficult to see how the score from one accident can help us investigate the next similar accident more efficiently. I have found that the efficiencies increase dramatically with each successive accident.

[Instructor: Turn cassette recorder off here, and resume presentation]

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This slide introduces the notion that accident scores can be used beyond preventing the next accident.

Expanding the analogy

If you think about the music analogy, you will recognize how

- **Management is analogous to the composer,**
- **Supervisors are analogous to conductors,**
- **Workers are analogous with musicians,**
- **The workers' tools are analogous to the musician's instruments,**
- **Work procedures are analogous to the musical score itself . . .**

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This slide compares the roles in music with the roles in accident scenarios.

Expanding the analogy

And also how the music analogy is applicable to accidents in that

- **Process outcomes are analogous to the music produced,**
- **Events during accidents are analogous to sour notes**
- **Near misses are analogous to finishing playing the score despite a few unplanned notes**
- **Witnesses are analogous to audiences that observed the music produced,**

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This compares more aspects of the analogy.

Expanding the analogy

And also how the structure of a musical score can provide a model for

- **Creating the building blocks needed to develop accident descriptions**
- **Organizing, coupling and displaying investigation building blocks used to describe and explain an accident process**
- **Investigation outputs congruent with existing or planned process descriptions.**
- **Pinpointing problems in process designs as well as their implementation**

In summary, a conceptual framework for investigations

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This slide shows how the use of the musical score offers a model for the data handling tasks during investigations, and ultimately a conceptual framework for investigations.

4 Key principles

Within this conceptual framework, 4 key investigative principles were isolated;

1. THINK EVENT BUILDING BLOCKS

- **That is, transform all your accident information into single actions by individual PEOPLE or OBJECTS, breaking down what they did to fashion basic building blocks called ‘events'- the key to replicability and consistency**

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To utilize this framework, several key principles were developed by trying to fit observations during the investigation into the actor action matrix of the musical score.

The first was the need to transform observed data into a data language that would permit proper placement and couple of events on the matrix. From this need was born the event building block.

4 Key principles (continued)

Investigative principles were isolated:

2. THINK EVENTS IN A PROCESS

- **The approach is ordering interacting events, rather than a deductive or inductive logical approach. You document and assemble data building blocks into several sequential, timed and cross-linked strings of parallel events for each actor you are tracking during the accident- both animate and inanimate.**

Note: 4 kinds of logical reasoning during this process have now been identified; see Y2K MES Investigation Guides.

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The second challenge was developing a procedure to process the building blocks efficiently, quickly and validly. Again the matrix provided the key to the ordering of the data as data are acquired! This was a MAJOR departure from the traditional gather the facts then analyze them approach.

4 Key principles (continued)

3. MAKE MENTAL MOVIES

- **That means you try to visualize and organize the strings of events into ‘frames' of a mental movie to "see" all those interactions during the accident which determined its outcome; this forces recognition and closure of gaps!**

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The third challenge was to figure out a way to identify specific questions to ask as the investigation progressed to be able to proceed efficiently with additional observations. From successful investigators, the visualization process they used to organize the data informally was adapted to the new process, with the role of identifying missing "frames" in the scenario being developed.

4 Key principles (continued)

4. ESTABLISH RELATIVE TIMING OF EVENTS

- That means you have to show when each event occurred relative to each other related or coupled event in your flow charts.

- Relative timing is ignored in most accident investigations, reports and work products, and most accident causation research! A fatal defect in those outputs!

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Another challenge was to incorporate the timing of interactions into the data management process. This was satisfied in the same way as a musical score "times" the notes with their placement in the score.

Synthesized investigative methodology

TO APPLY THESE PRINCIPLES, AN INVESTIGATIVE METHODOLOGY WAS SYNTHESIZED, BASED ON GRAPHIC MODELING OF ACCIDENT EVENTS AS IN MUSIC SCORES.

THE 4 KEY ELEMENTS OF THAT TECHNOLOGY ARE

1. **A time line to discipline the testing of causally coupled relationships among events identified during an investigation,**

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The result was a new technology by which data are incorporated in a graphic model representing the accident process, involving 4 key elements. The first element is a time line, along which actions derived from the accident "witness plates" are sequenced.

Synthesized investigative methodology

THE 4 KEY ELEMENTS OF THAT TECHNOLOGY ARE, (Continued)

2 An actor-action matrix system to display and sequentially organize the events building blocks into a flow chart or model describing the accident,

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The second element was the actor/action matrix on which actions by involved actors could be arrayed. The single row for each actor provide a basis for determining whether there are gaps in the actions of a specific actor.

Synthesized investigative methodology

THE 4 KEY ELEMENTS OF THAT TECHNOLOGY ARE, (Continued)

3 An arrow convention to show the agreed-upon cause-effect logic flow or coupled interactions during the accident, and

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The third element was the graphic linkage of interacting or "coupled" event blocks to depict the flow of actions needed to produce the outcome.

Synthesized investigative methodology

THE 4 KEY ELEMENTS OF THAT TECHNOLOGY ARE, (Continued)

4 A system for identifying and tabbing countermeasures to indicate where the flow of events demonstrated a problem, subject to future control by some *change* -- in the design, a new safeguard, procedure, warning, or other risk-reducing action.

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The fourth element was a procedure to discover and define problem interactions which might be changed to reduce future risks.

Configuration of event blocks

The following slide shows the general configuration of the event building blocks and links forming the multilinear events sequencing matrix, to show and explain what happened. Countermeasure tabs indicate problem actions or relationships.

Events evidenced by observed changed states or conditions can be organized in the same way.

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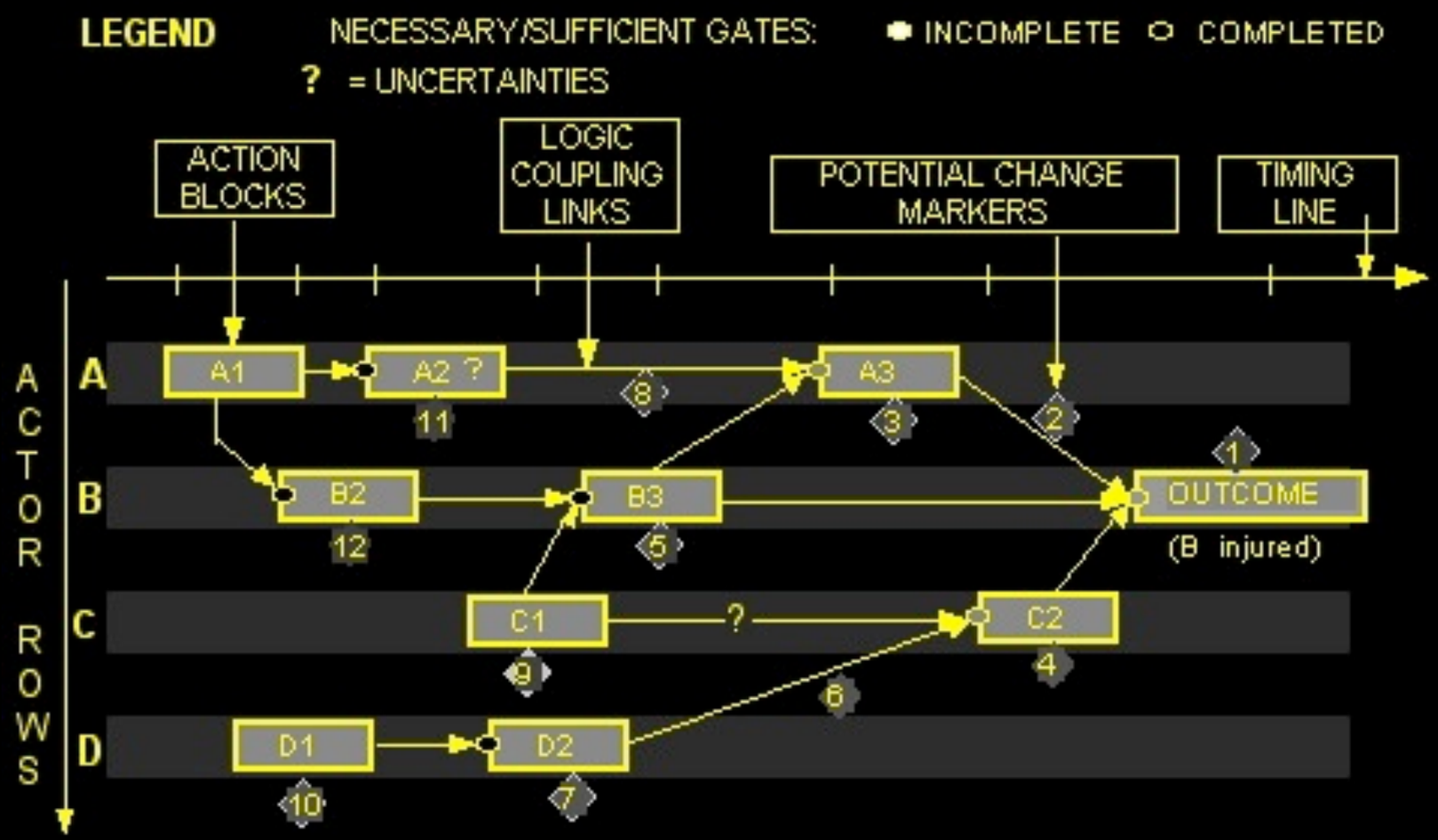
This introduces the general configuration of a MES worksheet as the investigation progresses.

Configuration of event blocks (2002)



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This provides an insight into how a worksheet, with the various linked events, provides a description of the accident, and explains why it happened.

Teaching simulations

SIMULATIONS OF THIS NEW INVESTIGATIVE PROCESS WERE DEVELOPED SO IT COULD BE TAUGHT. THE SIMULATIONS INCLUDE

- **An investigative plan that addresses the interests of all parties with a stake in an investigation**
- **Exercises with the new principles and methods to produce more productive witness interviews,**
- **Planning tasks for testing debris after an accident to avoid wasting a lot of time, money or data, and**
- **Exercises showing ways to transform and organize accident data so the analytic tasks are faster, more efficient, consistent and reproducible,**

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As the work progressed, another challenge was to ensure that the new process could be communicated successfully so it could be replicated by others. The result included several simulations of investigative tasks, shown here.

Does it work?

YES

BEFORE, DURING AND AFTER ACCIDENTS

- **In transportation, governmental, industrial and construction accidents and fire investigations**

THE EFFECT ON RECOMMENDATION DEVELOPMENT AND EVALUATION HAS BEEN DRAMATIC, TOO - THOSE CHANGES MERIT A SEPARATE PRESENTATION!

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The bottom line; does the new technology work? The answer is yes. Evidence includes some remarkable new insights into interactions during accidents, and some major improvements.

Teaching models

- Matrices can lead to generalized models of accidents
- The next slide is an example of a resultant teaching model, widely used in emergency response training.
- Safety improvements can be dramatic; firefighters trained with such models avoided fatal Hazmat injuries in transportation emergencies after 1979

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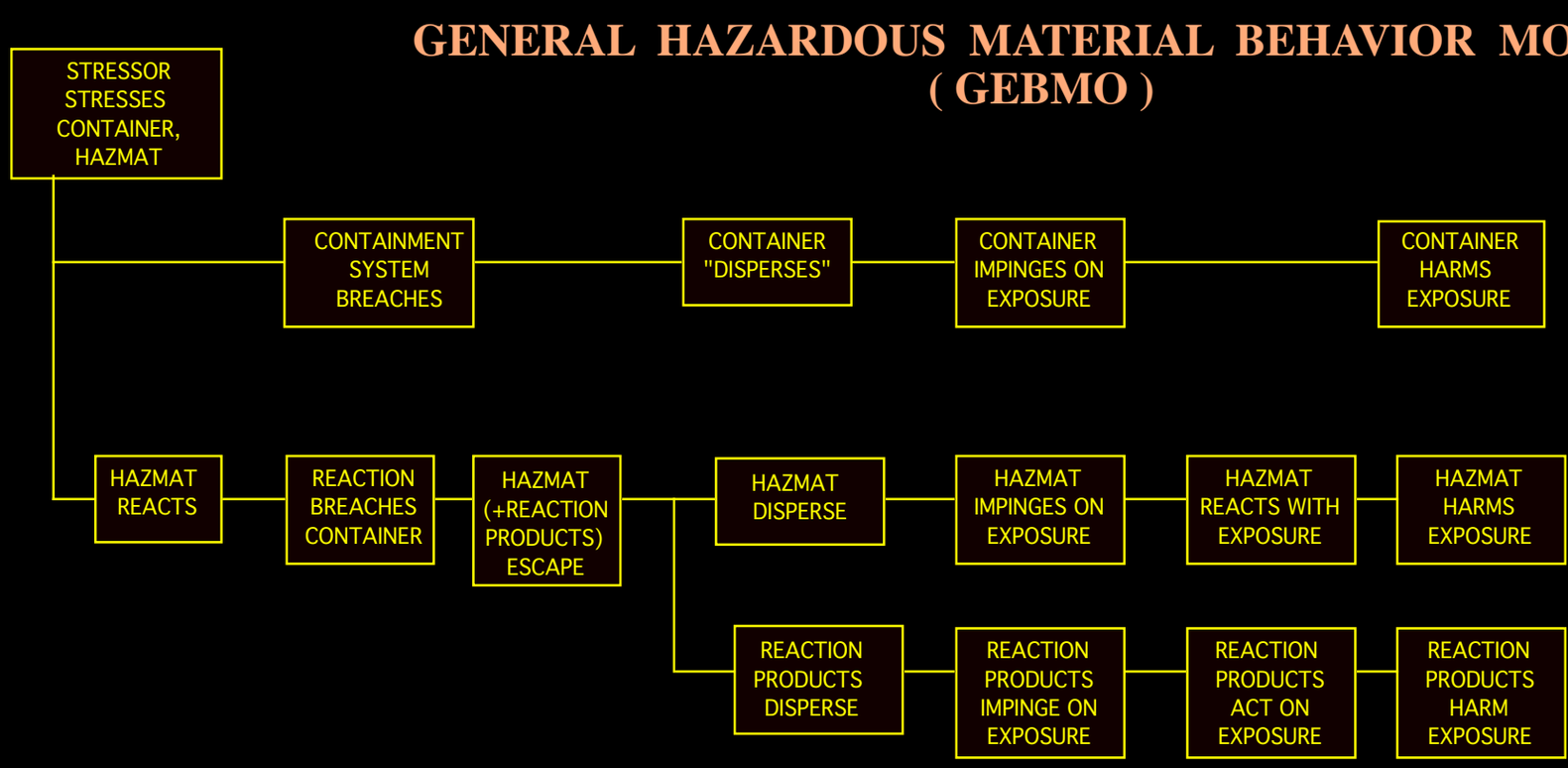
This slide describes one unique and beneficial result of the new investigative process - models of accident processes that have been recorded by investigators.

Teaching Model



Source: Benner, L., Hazardous Materials Emergencies, 1976

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This is the GEBMO model adopted by first responders to help them think their way through hazardous emergency responses - it was derived by utilizing the flow charting of events approach. It enable responders to understand, predict and control emergency outcomes.

What should investigators do about this?

SO, WHAT DOES ALL THIS MEAN?

- **In a word, you as an investigator are vulnerable to technical and professional obsolescence if you don't keep up with fast moving developments in this field.**
- **Your managers and co-workers are vulnerable to waste of resources and repetition of losses. Further, they are being denied the results your investigations should be achieving.**

WHAT SHOULD YOU DO? AT LEAST 3 THINGS.

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During the presentation of the original paper, investigators were challenged to think about what was presented, the consequences of not acting, and admonished to take three steps.

Look for best investigation technology

- ✓ **Reexamine your own work and methods, and the results they are actually achieving, and develop criteria for what you need to get done.**
- ✓ **Review, select and then master the best available investigation technology and methods to help you do your investigations effectively, promptly, consistently, and in the most productive way.**
- ✓ **Finally, look on any accident or incident you investigate as worth investigating properly and completely to gain new knowledge.**

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These are the challenges offered: rethink what you are doing, look for move toward best available technology and methods, and finally be prepared to invest what it takes to get better results.

IF YOU ACCEPT THESE CHALLENGES, YOU CAN HELP OTHERS TO STRIVE TOWARD ONE DESIRABLE IDEAL FOR INVESTIGATORS:

IDEAL = One report to serve all users:
A DESCRIPTION EXPLAINING WHAT HAPPENED

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This summary slide, presented in 1980, set forth the ideal toward which the investigation community should be moving - one accident report to serve all users.

Epilogue:

Subsequent to the original 1980 report, further research disclosed a way to achieve this ideal. The key change was to separate the production of a description of interactions during the accident process from subsequent analyses and uses of that description.

This means the primary investigation output is the *description explaining* what happened.

That requires different data, knowledge, tools and skills than the development of problem statements, remedial actions and post-implementation monitoring plans. These findings were first described in "Investigating Accidents with STEP" by Hendrick and Benner, Marcel Dekker, New York, 1986 and updated in subsequent publications by this author.

Continued->

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The epilogue is self explanatory. It makes the important point that development of a description and explanation of what happened needs to be treated separately from the use of those outputs for risk reduction and other purposes. ALL USERS share the need to start with a valid, credible and trustworthy description of what happened.

Epilogue:

Subsequent research also disclosed the significance of natural language limitations when describing processes, and the key role of the MES data structure first developed during this early time period. In 2004, new research explored use of event blocks as propositional logic statements, to be described in a forthcoming paper.

Information about latest guides, papers, presentations, software and reference publications can be found on the internet at these sites

http://www.iprr.org

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END

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This describes some ongoing research, and resources for further information.