086

Sci-Tech
SCIENCE · HEALTH · TECHNOLOGY

Living/Arts 28

TECHNOLOGY

Concern grows over inspections of aging planes

Boeing 747 was able to land at Honolulu Friday after a gaping hole was ripped in its fuselage. AP photo

Equipment limitations, human error mean some defects escape detection

By Simson L. Garfinkel
Special to the Globe

In January 1987, the skin tore open on United Airlines Flight 443, causing sudden depressurization of the Boeing 727-100 en route from Columbus, Ohio, to Chicago's O'Hare Airport. The plane made an emergency landing at Fort Wayne, Ind.

Last April, an 18-foot-long chunk of the forward upper fuselage of an Aloha Airlines Boeing 737 ripped away at 24,000 feet between Hilo and Honolulu. A flight attendant was swept to her death and 61 passengers were injured. Tiny cracks were later found on half of the Boeing 737 fleet.

In December, a 12-by-7¾-inch section of the skin of Eastern Airlines flight 148 failed, causing the Boeing 727 to lose pressure. The aircraft rapidly descended to 10,000 feet and made an emergency landing in Charleston, W.Va.

And last Friday, nine people were apparently sucked through a 10-by-40-foot hole that opened in the side of a United Airlines Boeing 747 on its way from Hawaii to New Zealand. That incident is under investigation, but suspicions quickly focused on structural failure as the likely cause.

For years, conventional wisdom has held that an old, properly maintained aircraft is just as safe as a new one. When airlines have replaced older planes, they have done so primarily for economic reasons – newer aircraft cost less to inspect and repair. "You reach the same point when you decide to buy a new car," explains Karen Ceremsak, spokeswoman for Eastern Airlines. "It doesn't mean that [older aircraft] are any less safe, they just require more maintenance. With proper maintenance, these planes can fly virtually for an unlimited period time period."

Manufacturers agree: "It's not a safety consideration,

AGING PLANES, Page 26

JSINGS/CHET RAYMO

? facts, Ma'am

e thought supernova 1987A had faded
ılong comes another surprise.
ıomers working in Chile have discovered
the heart of the exploded star. In the
outrushing cloud of shredded star-stuff
furiously-blinking neutron star, the col-
sive giant that tore itself apart in a deto-
'eb. 23, 1987.
said "surprise." Astronomers have long
, tiny, rapidly blinking sources of light,
ed stars. Pulsars have been observed at
ıds of explosion debris, such as the Crab
remnant of a star that blew up in A.D.
watch the thing happen, to observe a
of its birth, must represent to the discov-
time.
o years since the blowup. From the sur-
rom satellites in orbit, astronomers con-
ng star with instruments of every size
science journals are fat with reports of
ng out our understanding of how stars

hese reports make dreary reading. Here,
st sentence of a typical research letter
e, announcing the discovery of carbon
ants of supernova 1987A, the first-ever
in supernova debris: "The spectra con-
n in Fig. 1 a-e were obtained with a
neter (FIGS) attached to the Anglo-Aus-
) as part of an extensive programme of
to be described in more detail elsewhere
script in preparation)."

iest beginning, and the report gets more
goes along. There's a reason for the un-
the hearty dose of insider's jargon. Sci-
is faceless and passionless by design.
stand bare and unadorned, and can be
are without prejudice or emotion. This
ımunication has helped science achieve
wledge, a coinage of truth with interna-
Sgt. Joe Friday used to say: "The facts,

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re's no better place to find it than in
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ronomer and a respected writer. He is
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adpan scientific reports.
vivid picture of that evening on the
Chile two years ago when Oscar Du-
at the Las Campanas Observatory,
ok at the sky. He noticed an unfamiliar
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filky Way. He did not yet realize it, but
n 383 years to see a supernova with the

ginning a stunning story unfolds:
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ernova since the time of Galileo. The
as night rolls westward and stargazers
ustralia take note of the blaze in the
l of telegrams alerting observers world-
chedules, the hastily-sought plane tick-
sleep.
hrough the Earth from a detonation
ay, detected by instruments in a lead
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ore the supernova was observed visual-
ng in brightness, reaching a peak 88
righter than the stars of the Pleiades.
on yellow pads as theoreticians scram-
ns to theory.
ove the Earth registering gamma rays
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detection of molecules and radioactive
ova debris – a dying star seeding the
s of future worlds. Echoes of light from
Seminars and conferences, heated de-
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tion for time on telescopes.

e blinking pulsar, revealed as the cloud
ınds and clears.
raordinary two years, and the thrills
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code, prosaic and impersonal. British
John Ziman says this of scientific
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ll of bogus rhetoric, or an appeal to the
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ice works. That's why a Taoist, capital-
an can trust the research of an atheist,
om the USSR. That's why people of
tures were there on the mountain in
hare the excitement when a dying star
outhern sky.
id, "The facts, M'am, just the facts."

ofessor of physics at Stonehill College
ooks on science.

Concern grows over plane inspections

■ **AGING PLANES**

Continued from Page 25

but a matter of economics," says Elaine Bendel, spokeswoman for Douglas Aircraft Co.

Before last Friday, there had been 233 accidents in five years involving metal fatigue or corrosion in the United States, according to National Transportation Safety Board figures, resulting in a total of 95 fatalities. Thirty-six accidents, and 38 deaths, involved commercial airlines.

But as the list of accidents attributable to fatigue or corrosion grows, there is increasing concern over the adequacy of existing tests to detect the problems that America's aging fleet is experiencing.

A wide variety of "non-destructive tests," mandated by aircraft manufacturers and the Federal Aviation Administration, are conducted to find cracks, corrosion and signs of fatigue in aircraft. "The whole idea is to screen out the things that are going to fail before they fail," says John Newman, president of Laser Technology, a company that manufactures testing equipment.

Inspections usually take place at night – the only time the aircraft are not in use. They can find damage that is too small to be seen or that is hidden from the eye. But the tests have to be performed, and performed well, in order to work.

That doesn't always happen. Take the example of United's Flight 443: That plane's sudden depressurization was caused by a 2.3-inch crack in the skin. According to a memorandum circulated by United, later analysis revealed that the hole was due to a scratch made in the skin while the plane was being built.

Although that crack might have been detected by a test called an eddy current inspection, that test was never performed on the section that failed. "It was not a normal failure point," explains Sara Dornacker, a United spokeswoman. "Normal procedure at that point was, and still is, to do a visual inspection."

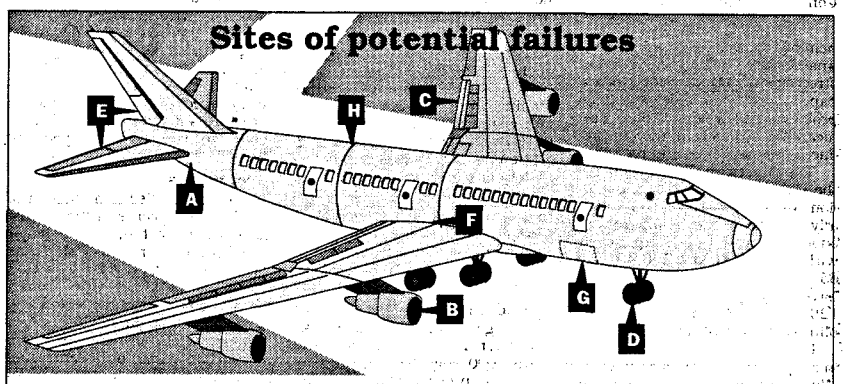
The United memorandum said the scratch had helped "to create a stress concentration line." Such lines, says Daniel Salvano, assistant manager of the FAA's aircraft engineering division, can "act as a magnifier of stress, and cause parts to fatigue faster than originally designed."

Tests designed to find tiny cracks do not work well over large areas – such as the entire body of a jet aircraft. Most eddy current and ultrasound inspections are performed with pencil-sized, hand-held probes that must be specifically designed for the area being tested. A chance crack would most likely be missed, Salvano says.

Even inspectors performing tests designed for specific areas sometimes make mistakes. "What happens to an inspector as he looks down a row of 1,800 rivets?" a panel on human factors asked last June at an International Conference on Aging Aircraft. "After he inspects the first 100, what happens to the next 1,700?"

In a paper presented in 1987 at the American Society for Non-destructive Testing, Donald J. Hagemair of Douglas Aircraft reported on an accident in which a wing came off a DC-3 "because of cracks that were missed by the radiographer. The cracks were clearly visible in the radiographs."

"I think the inspectors should be trained as well as medical doctors, but they're not," says Dr. Robert Green, director of the John Hopkins Center for Non-Destructive Evaluation. "Some of them are very good. Unfortunately, in some cases, the people doing the inspection have very low levels of education."



AFT PRESSURE BULKHEAD
A Moisture can corrode the metal structure that keeps pressurized air from escaping passenger cabin.

ENGINE
B Engines are the most trouble-prone component.

AILERONS
C And other control surfaces are X-rayed at regular intervals to look for internal damage

LANDING GEAR
D Wheels are inspected every time tires are changed.

ATTACHMENT LUGS
E Fissures have been discovered in bolts that fasten stabilizers to the tail.

WING ATTACHMENT POINT
F Casting that holds wing to fuselage tends to develop hairline fractures.

CARGO DOOR FRAMES
G These structures get rough treatment from baggage handlers. Deformed frames can cause pressurization problems.

LAP JOINTS
H Cracks can develop where panels of aluminum are riveted together.

Source: Time magazine

Knight-Ridder, Globe staff diagram/Jim Karalan

An array of testing methods is used

Highly specialized tests are used to check aircraft for fatigue or corrosion. They include:

X-RAYS – An X-ray can penetrate deep into complicated sections of a plane, such as the doors and control surfaces, and reveal cracks or flaws in the metal. In "isotope radiography," the X-ray film is placed around engine parts and a radioactive capsule is placed in the engine's combustion chamber. X-rays can examine a large area relatively quickly, but they are difficult to interpret. Aircraft have crashed because of cracks missed by radiographers.

EDDY CURRENTS – A magnetic field passed though a block of metal creates a tiny "eddy current" that can be detected by a special probe. Cracks in the metal interrupt the flow of the current, which can be displayed on a meter or screen. The test can find cracks invisible to the naked eye and as deep as 5/8th of an inch beneath the surface. The test is slow and specialized probes must be designed for each part.

ULTRASOUND – High-frequency sound sent into a block of metal will reflect from internal cracks. Hand-held ultrasound test machines have been used for years to test bolts and attachment lugs; larger testers now are used on composite materials. The sound is carried by jets of water "scanned" across the material's surface.

VISUAL INSPECTION – Cracks and damage often are visible to the naked eye. Sticky-brown stains, caused when tobacco-laden cabin air escapes during flight, often point right to a crack in a plane's pressure dome. Inspectors sometimes use cleaning fluid, magnifying glasses and high-intensity lights to highlight cracks.

DYES – Penetrating fluorescent dyes are often used on large sections, such as turbine blades or the aircraft's skin, but paint must first be removed, a costly, time-consuming procedure.

BOROSCOPES – Long tubes made with fiber optic bundles permit technicians peer into an aircraft's engine to look for evidence of damage. Newer boroscopes are equipped with high-intensity strobe lights and miniature television cameras that can videotape images or transmit them via telephone lines for evaluation by an expert.

– Simpson Garfinkle

Last month the FAA began a one-year study of inspection procedures, says Jessey Stevenson, project manager for the FAA's aging fleet effort. One object of intense scrutiny will be "the qualifications of the people doing those non-destructive tests."

The Conference on Aging Aircraft was the first time representatives from airlines, manufacturers, the FAA and foreign regulatory agencies had gathered to discuss maintenance, non-destructive tests and operator training.

Those attending were in nearly unanimous agreement that the problem of corrosion is not being adequately addressed. One airline official said corrosion accounted for 95 percent of planes taken out of service, while metal fatigue accounted for only 5 percent. The panel on inspection called for greater standardization of testing procedures.

At the conclusion of the conference, the Air Transport Association and Aerospace Industries Association established a task force including airlines, manufacturers, regulatory agencies, the National Aeronautics and Space Administration and professional organizations to review maintenance practices for aging aircraft.

Although it set out expecting to call for new inspection procedures, the first task force working group to complete its work concluded that inspection alone would not be adequate. That group, which had been focusing on Boeing airplanes, recommended instead a program of replacing critical parts of the airframe at regular milestones, says Jack Gamble, a spokesman for Boeing who has seen the report.

"The problem with inspections is the problem that, quite often, things do not get caught," says Gamble. "By replacing, you have got a better piece of airframe at that particular location than you would have it you inspected it and repaired it, because what you have is new."

Another developing problem is aviation's increasing reliance upon advanced composite materials for parts of aircraft, such as nose and engine cowlings, spoilers, rudders and ailerons. Composites are used, experts say, because they are stronger and lighter than the metal they replace. But because many composites are nonmagnetic and are made from layers of different kinds of material, many inspection techniques developed for metal won't work for them.

Composite materials can be inspected with specially constructed ultrasonic scanners, but such scanners are expensive and highly specialized. "A major problem is the cost of the different styles of equipment," says "There are many different applications, and there is not one piece of equipment that will fulfill all the requirements of composite inspection."

A typical system might cost as much as $135,000, says Richard Lam, USAIR's technical foreman for testing. Consequently, many aircraft operators resort to a lower-technology solution called a "tap test." The test involves actually tapping the part with a coin and listening to the sound produced. "You are listening for a different pitch," says Lam. "If I go over a hollow section, I am going to hear a different pitch, and I am going to detect a delamination."

"It is absolutely amazing," says Caesar Calafa, manager of the Structural Research Branch at the FAA Technical Center in New Jersey. "When these guys do a tap test, their ears are so attuned, they can do an excellent job, believe it or not."

"However," says Calafa, "detecting voids in composite materials is really not the problem. The problem is detecting weak bonds."

Improper manufacturing, damage or a poor repair job can leave a bond inside a composite at only half or a quarter of its original strength, Calafa says. These bonds often appear acceptable to the tap tests and ultrasound screenings. "So we need some type of equipment that will be able to detect a weak bond, and that is where we have been concentrating our efforts."

Until a reliable method is developed for such tests, says Clyde Kizer, vice president of engineering and maintenance for the Air Transport Association, composite surfaces will be replaced in aircraft long before their calculated time-to-failure.

Simson Garfinkel is a freelance writer in Cambridge.