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High accident rates are the most visible consequence of Sub-Saharan Africa's challenged aviation system, where physical infrastructure shortcomings and failures of political will have some nations' air transport systems locked into a downward spiral. Without interventions, their airlines risk more accidents and blacklisting by other regions, and may even have difficulty leasing, financing and insuring newer and safer commercial jets. However, new programs to finance the physical and institutional assets needed for improved safety, backed by international pressure to comply with world air transport safety standards, are building hope in the region.

The concept of aviation infrastructure used by the World Bank includes not only physical assets such as airports, but also elements such as laws and safety oversight. Sound governance and the political will to competently, strictly and transparently conduct safety oversight are essential elements, many specialists agree.

Disparity of safety levels around the world was driven home by six major airline accidents in fall 2005. The accidents provided "timely reminders that systemic deficiencies identified

BASIC NEEDS

Sub-Saharan Africa cannot afford to delay air transport infrastructure upgrades.

BY WAYNE ROSENKRANS

Left:
Sir Seewoosagur
Ramgoolam
International Airport,
Mauritius, supports
tourism. Above: The
control tower is a
freestanding structure
at Banjul, The Gambia.

under the Universal Safety Oversight Audit Program [USOAP] since 1999 were still present," said Dr. Assad Kotaite, then-president of the Council of the International Civil Aviation Organization (ICAO) in early 2006. Follow-up USOAP visits during 2001–2004 revealed that a significant number of the 162 countries had not prepared or implemented corrective action plans after the 1999–2001 USOAP audits.

"We collectively own the world safety record," said Paul Lamy, chief of the ICAO Flight Safety Section, during the May 2006 ICAO–Air Transport Action Group (ATAG)–World Bank Development Forum. "It is in everyone's best interest to support effective assistance programs."

Where help is needed most is obvious: The Africa operator region had only 3 percent of the world's flights yet 21 percent of the fatal accidents in the 1995–2004 period, according to a 2006 U.K. Civil Aviation Authority (CAA) aviation safety review of passenger and cargo operations flown by large jets and turboprop aircraft. The rate of fatal accidents — 4.5 per million flight hours — was higher in this region than any other.

The Nigerian CAA reported that African airlines had 14 fatal accidents in 2005, with 359 fatalities. Twelve of these aircraft were Eastern-built types. The International Air Transport Association (IATA) reckoned that 18 percent of all 2005 accidents involved airlines domiciled in its Africa region; 45 percent were fatal accidents and 70 percent were hull losses, said Martin Maurino, IATA's manager, safety analysis. The same data showed a hull-loss rate for Western-built large commercial jets of 9.21 per million sectors flown for Africa versus 0.76 worldwide.

IATA identified the most significant accident factors as "intentional noncompliance, 25 percent; flight crew training deficiencies, 25 percent; standards and checking, 25 percent; deficient flight crew communication, 20 percent; inadequate safety management, 15 percent; and poor regulatory oversight, 15 percent."

The main deficiencies reported by the ICAO Africa and Indian Ocean Planning and Implementation Regional Group in 2005 included failure to implement ICAO airport certification standards; no preparation for a safety management system (SMS); unstable primary electrical power and unreliable secondary power for navaids and lighting; lack of bird hazard programs; missing emergency plans and equipment; inadequate airport fencing and/or perimeter roads; insufficient or unavailable aircraft rescue and fire fighting; and inadequate pavement maintenance. Additional problems found included the lack of emergency drills, unserviceable airfield lighting and approach/runway lighting, faded and/or nonstandard markings, and excessive rubber deposits on runways.

Uncorrected problems included a lack of air traffic control (ATC) service, failure to implement current nonradar procedures for aircraft separation, inadequate coordination between air traffic control units, failure to publish current ICAO airport and airport obstacle charts, outdated geographic coordinates of ground facilities, and irregular issuance of notices to airmen. Nevertheless, progress was reported: In 2005 about 50 percent of deficiencies noted in air traffic services in 2003 had been corrected, as had 75 percent of aeronautical information services deficiencies.

Air transport infrastructure often gets lower priority than water, food, health, power, roads, education and social welfare, but the irony is that traveler confidence in aviation safety helps address all these by facilitating tourism, business travel, exports and investment. Serious safety concerns can mean that a manufacturing plant or product outlet will not be built, says Charles Schlumberger, principal air transport specialist in the Transport Division of the World Bank.

Airline passengers do not want to be any more concerned about arriving safely than they are about stepping into an elevator in a high-rise office building, he said.

Solutions underway include closely coordinating the efforts of ICAO, states, industry and development institutions to assist developing states; establishing regional safety oversight organizations; and promoting SMS. In extreme cases, ICAO said that the states should hand over safety oversight responsibility to a competent authority.[1]

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Deficiencies in the control tower cab on the roof of the airport terminal at Pemba, Tanzania, were reported in October 2005.

Reform within some CAAs and airlines has occurred only in response to international rewards or sanctions, Schlumberger said. "The 'stick' could be the European Commission [EC] aviation blacklist and/or canceling loans by the World Bank because of the state of safety oversight in certain countries," he said. "The 'carrot' could be our US$14.5 million grant to Cameroon for security and safety improvements at the airports and CAA. Experience shows that political will is the first issue to address — pleasant theoretical discussions and training achieve very little."

ICAO promotes regional safety initiatives such as cooperative development of operational safety and continuing airworthiness programs (COSCAPs); provides assistance and guidance for 200 projects in 100 states through its technical cooperation program; operates the Flight Safety Information Exchange Web site; pays

for some country-level corrective actions and regional safety oversight projects through its International Financial Facility for Aviation Safety funding mechanism; and arranges assistance from development institutions and industry through its Unified Strategy Program.

Roadmap Part 2

As *Aviation Safety World* went to press, release was imminent of Part 2 of the Global Aviation Safety Roadmap developed for ICAO by the Industry Safety Strategy Group (ISSG).[2] Part 1, issued in March 2006, outlined why states, regions and industry should address 12 problem areas, including these linked to infrastructure: inconsistent implementation of international standards, inconsistent regulatory oversight, barriers to the reporting of errors and incidents, and ineffective accident and incident investigation. Part 2 sets priorities based on an awareness of all world regions, said Robert Vandel, Flight Safety Foundation executive vice president and the FSF representative to ISSG.

The roadmap first targets Sub-Saharan Africa. "In 2006, there has been a near-universal agreement among international safety organizations to support improvements in Africa," Vandel said.

African safety specialists influenced safety initiatives launched in the 1980s and 1990s. For example, the FSF *Approach-and-Landing Accident Reduction (ALAR) Tool Kit* encourages proven interventions with or without advanced technologies. But some ALAR principles are made irrelevant by infrastructure deficiencies in Africa, said Capt. David Carbaugh, chief pilot, Flight Operations Safety, Boeing Commercial Airplanes.

"For example, we advocate flying approaches as published to improve safety," Carbaugh said. "Crews of at least one airline I know in Africa fly approaches using approach plates published in the 1970s because they got bootleg copies from another airline. In some areas, there are no navaids so crews use handheld global positioning system (GPS) receivers and basically make up approach procedures. Obviously, it's tough to follow Tool Kit advice there."

The effects of infrastructure deficiencies in Africa have not been as clear as, for example, the causes of approach and landing accidents worldwide. South African Transport Minister Jeff Radebe said, "One of the challenges … is the lack of detailed data. … Decisions on solutions and effective allocation of resources will continue to be difficult."

The effects of inadequate maintenance and the number of aging aircraft in Africa have been assumed to a degree. "As far as I know, a concentrated, in-depth study of infrastructure effects on the accidents in African countries has not been done," Carbaugh said. "While poor [aircraft] maintenance is part of the problem, it is rarely directly a cause. However, I believe that it is indirectly a cause of many of the accidents. Crews often have multiple inoperative equipment issues to deal with on every flight. Unfortunately, many of the accident reports do not go into this kind of depth."

Competing Values

Shaping development assistance worldwide are eight Millennium Development Goals of the United Nations — which have a target date of 2015. A committee of 19 African states representing the African Union also has laid out an agenda called the New Partnership for Africa's Development. The agenda partly seeks "to increase air passenger and freight linkages across Africa's subregions" and to "promote private-public partnerships in the rationalization of the airline industry and build capacity for ATC."

The Group of Eight major industrialized democracies and the European Union have agreed to increase development assistance in Africa by $25 billion a year by 2010 to support the objectives of the New Partnership for Africa's Development. Progress is scheduled to be

reported by the end of 2006 by the Africa Partnership Forum, and reviewed at the G8 summit in Germany in July 2007. In 2005, G8 leaders pledged to cancel the debt of the world's most indebted countries, mostly in Africa, providing about $37 billion of debt relief over 40 years, the World Bank said.

Radebe described what is at stake using data developed for ATAG by Oxford Economic Forecasting when he told a national aviation safety seminar in February 2006, "Air transport … generates about 470,000 direct and indirect jobs across Africa, contributing over $11.3 billion to African gross domestic product. If we add sectors such as tourism that owe their existence to the air transport sector, then the number of jobs increases to about 3.1 million and the contribution to African gross domestic product reaches some $55.5 billion."

Tourism-fueled economic growth requires safe flights from both outside of Africa and on intra-African routes. "Tourism is a driving force in a number of African countries, including Kenya, Mauritius, Morocco, Tunisia, Egypt, Ghana, Senegal and Tanzania, and is assuming an ever-increasing importance

in South Africa and Namibia as well," Radebe said. "An amazing 20 percent of all tourism jobs [about 675,000] in Africa are directly related to airborne tourists. … I assume the figures do not count the increasing number of African tourists traveling within the continent."

African and non-African airlines often are hobbled by infrastructure deficiencies, preventing, for example, the substitution of large jets for turboprop aircraft on internal African routes, Radebe said. Infrastructure improvements also can amplify the competitive disparities among airlines.

Christian Folly-Kossi, secretary general of the African Airlines Association (AFRAA), in a May 2006 speech said that African airlines are struggling to compete. "African air transport is in deep crisis," Folly-Kossi said. "The African market currently represents 4.5 percent of the global traffic. Out of this, foreign airlines operate more than 70 percent of the traffic and a small portion is left for Africans. … The global liberalization that was precipitated on the market, [without] control and safeguards, [had] a devastating impact on many African countries."
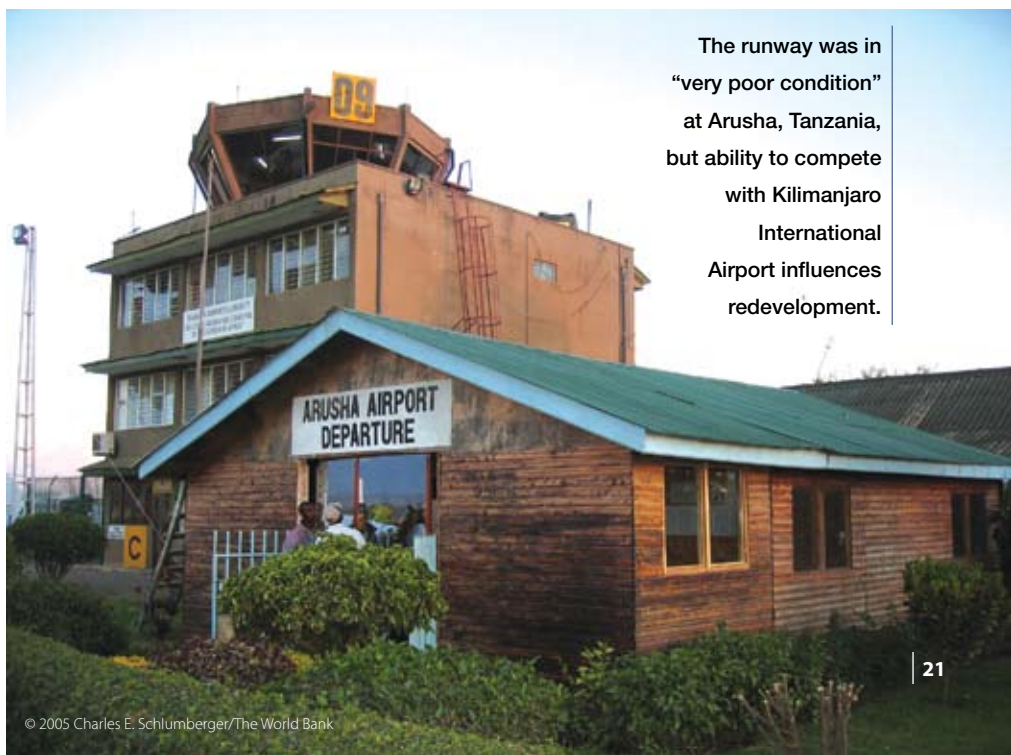
The runway was in "very poor condition" at Arusha, Tanzania, but ability to compete with Kilimanjaro International Airport influences redevelopment.

Travel between capitals of some African states still requires a connection in Europe thanks to slow implementation of the continent's open skies agreement, the Yamoussoukro Decision, ratified in 2000. "The domestic continental market should be built, liberalized and controlled by carriers of the continent," Folly-Kossi said. "As prescribed by the Yamoussoukro Decision, Africa as a whole should … be a single airspace."

Ethiopian officials told a 2006 forum that the Yamoussoukro Decision "remains the single most important air transport reform policy initiative by African governments to date" to develop intra-Africa air services and attract private capital. Africa's domestic airline industry has been at an impasse, however, given problems such as managing the change from traditional bilateral route agreements between states and inexperience regulating airline competition. Abdoulie Janneh, under-secretary-general and executive secretary of the U.N. Economic Commission for Africa, said, "Unfortunately, some African countries are reluctant to fully implement the Yamoussoukro Decision because of their local aviation industry's fear of competition from foreign airlines." Competitors include companies in other African states and non-African airlines that invest in them.

World Bank Angle

Among several governments and large development institutions concentrating on Africa, the World Bank provides $251 billion in worldwide loan commitments, with about $32 billion (12.7 percent) allocated to the transport sector, primarily for roads. Only around $1 billion of that $32 billion has been allocated for air transport, including infrastructure. "With African institutions led by the African Union and ICAO, we are preparing a multi-donor facility [loans and grants] for 2007," Schlumberger said. "This Africa project, our first on a large scale, will be operational in 2007–2010."

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State priorities include road construction in Nigeria and malaria treatment by Médecins Sans Frontières staff in Burundi. A community rally on the airport apron at Bukoba, Tanzania, coincided with a World Bank visit.

Wayne Rosenkrans (FSF)

Schlumberger

The project includes elements to analyze and report on economic, legal and social benefits of liberalized air transport in Africa, the current state of infrastructure and aircraft operators, policy and institutional capacity of countries, assessing regulatory oversight of safety (i.e., through USOAP) and security and liberalization of air transport services; creation of an implementation strategy tool kit based on regional inputs; and coordinating all financial and technical assistance from several donors and partners.

One model project is in Tanzania, involving commitments of $20 million for runways and $10 million for automatic dependent surveillance–broadcast (ADS-B).[3] "In Tanzania, there is one radar in Dar es Salaam and … the country is huge," Schlumberger said.

Another model project is in Cape Verde, where TACV–Cabo Verde Airlines now operates weekly service between the national capital Praia and Boston using Boeing 757-200ERs. "Cape Verde received Category 1 [meets ICAO standards] from the U.S. Federal Aviation Administration [FAA] International Aviation Safety Assessment program after we had supported the country with a $1.2 million loan for capacity building and regulatory reform," he said. "There is a new law and a well-formed CAA staff. This is the dream we want our clients to achieve. Operating to the United States brings economic development."

The World Bank also has a $150 million project to help 23 West and Central African CAAs comply with ICAO safety and security standards, and enhance security of their main international airports. In the first phase, Burkina Faso received $6.46 million and Mali received $5.51 million in International Development Association (IDA) credits; Cameroon received

$14.5 million and Mali received $7.1 million in IDA grants. Safety-related elements of the financing include technical assistance for safety oversight and autonomy; basic communications and aircraft inspection equipment; and replacing navaids at the primary airports.

Another project is a $44 million IDA grant to Sierra Leone partly for airport infrastructure and for improved airport authority management.

Whether revenues from aviation alone can pay for infrastructure depends on local factors. For example, the Tanzanian CAA raised $10.3 million for its infrastructure in fiscal year 2005–2006 by imposing an $8 airline ticket safety surcharge for international passengers. Mongolia, in North Asia, distributes about 30 percent of $40 million received annually from overflight fees to air transport infrastructure, regulation and safety oversight, Schlumberger said.

Sometimes infrastructure benefits the whole continent. An example is IATA's technical assistance for ATC communications in Angola, Ghana and Sudan, and for ATC surveillance in Democratic Republic of Congo (DRC), Nigeria, Sudan and Tanzania.

"IATA assistance [in DRC] has resulted in the deployment of the VSAT [very small aperture terminal, fixed satellite terminals that provide interactive or receive-only voice/data communication] network," Maurino said. "The Régie des Voies Aériennes (RVA), the Congolese air navigation service provider, has established a special investment fund derived from RVA en route charges collected by IATA. Without the extended VHF coverage in western DRC, two new international RNAV/RNP10 [area navigation/required navigation performance] routes could not have been opened to traffic in May 2006."

VSAT now provides many aeronautical fixed telecommunication network links, correcting a deficiency that lasted for decades. "This set of [telecommunication] networks will provide a robust backbone for the improvement of both fixed and mobile communications," he said.

FAA initiatives in African states have included technical advice on GPS navigation, law making and rule making. "Our Safe Skies for Africa program is engaged in 'invisible infrastructure' — not concrete and steel," said Hank Price, an FAA spokesman. The program and IATA jointly provide flight inspection services for satellite-based systems and related procedures in 14 states.

"ICAO's Model Civil Aviation Safety Act and Model Civil Aviation Regulations [MCARs] and associated guidance materials have been adapted to meet [states'] own needs and requirements," he said. "Cape Verde, The Gambia, Ghana, Liberia, Nigeria and Senegal have used the MCARs. With FAA assistance and financial support, Kenya, Tanzania and Uganda have used the MCARs as a basis to revise and harmonize their regulations for use under a proposed regional safety oversight organization."

Jumping Ahead

Advanced technologies could allow some nations to jump ahead of inadequate legacy infrastructure, and often will be "scalable for free," according to Boeing Commercial Airplanes.[4] Major safety-enhancing technologies include ADS-B, satellite-based navigation, airborne collision avoidance system, terrain awareness and warning system and flight data monitoring.

Schlumberger advocates rapid adoption of satellite-based instrument approaches. "At the 2002 ICAO air navigation conference, I said that developed countries should start financing

standalone GPS approaches in Africa," but the proposal met opposition from those seeking an even bigger technological leap, he said, while "Africa has air carriers … flying into mountains every week or every month."

Years later, the EC, European Space Agency and Eurocontrol are preparing to augment GPS and Galileo satellite navigation system signals in Europe and Africa with the European Geostationary Navigation Overlay Service (EGNOS); EGNOS certifications for air navigation with GPS signals and Galileo signals are scheduled for 2007 and 2008, respectively.

"If I want to fix the problem today, I take what works," Schlumberger said. "We are losing lives, so we should finance what is available today to reduce accidents. The World Bank budgets about $100,000 to $150,000 to conduct a WGS 84 airport site survey [for a GPS approach with vertical guidance] that enables descent to 250 ft above the highest obstacle, typically a minimum descent altitude of 400 to 500 ft."

Satellite-based navigation for Africa comparable to the level established in the U.S. already is on the horizon. "The implementation of RNAV procedures at selected African international airports will set examples for the use of RNAV procedures at secondary airports where ground aids do not exist," Maurino said. Ten reference and integrity monitoring systems soon will complete preoperational trials for EGNOS, which will provide ICAO's APV-1 performance level, 20 m [66 ft] vertical accuracy. Four additional reference and integrity monitoring systems will be required to enable APV-1 approaches throughout Africa.

The World Bank favors ADS-B for African states for ATC surveillance. "We can implement a dual system GPS-based or flight management system-based Mode S extended squitter [ADS-B 1090 MHz data link] for air carriers and a GPS-based Universal Access Transceiver (UAT) ADS-B data link for general aviation [in Tanzania]," he said. IATA's position favoring ADS-B as the surveillance tool — but suggesting multilateration as an interim solution — has been accepted by African states, Maurino said. Pending implementation of ADS-B, multilateration could enable ATC to track aircraft equipped with the Mode S extended squitter or ADS-B UAT or Mode S radio frequency data link (ACAS/ACAS II) or basic Mode A/C transponder replies.[5]

African leaders have considered ADS-B trials in light of ICAO's endorsement of the Mode S extended squitter; the avionics in new Airbus and Boeing airplanes; and Australia's experience. Airservices Australia in 2007 is scheduled to be first to implement ADS-B across a state's entire upper-level airspace, providing radar-like surveillance throughout domestic airspace above 30,000 ft with 28 ground receivers and upgrades to its air traffic management systems.[6]

Worldwide auditing prompts action to fix infrastructure, and African CAAs have taken strong interest in the IATA Operational Safety Audit (IOSA). "USOAP for states has led to COSCAP projects and to the joint safety oversight project of the East African Community's Africa and Indian Ocean office," Maurino said. "A total of 104 airlines and 32 states have participated in IOSA seminars, and 19 gap audits [pre-audit assessments of where standards are not met] have been conducted in developing countries worldwide, with another 29 scheduled in 2007. Seven of the 19 airlines have already progressed to a full IOSA audit. Madagascar and Nigeria have mandated IOSA."

Ultimately, perpetuating the current safety level can mean that the only passenger airlines capable of profitably serving Africa will be a few non-African carriers such as Air France and British Airways and a few African operators such as Ethiopian Airlines, Kenya Airways and South African Airways, Schlumberger said. "I don't think the world will give up on safer aviation in Africa, but we can't just wait another 20 or 30 years," he said. ●

Notes

1. International Civil Aviation Organization (ICAO). *Report: Directors General of Civil Aviation Conference on a Global Strategy for Aviation Safety.* March 20–22, 2006.

2. The Industry Safety Strategy Group comprises Airbus, Airports Council International, The Boeing Co., Civil Air Navigation Services Organization, Flight Safety Foundation, International Air Transport Association and the International Federation of Air Line Pilots' Associations.

3. The U.S. Federal Aviation Administration has announced that initial implementation of automatic dependent surveillance-broadcast (ADS-B) for all U.S. airspace will begin in fiscal year 2007; the full evolution is expected to take 20 years. ADS-B equipment aboard an aircraft downlinks data, including its three-dimensional position, once per second.

4. Lewis, Michael. "Challenges and Opportunities of a Next Generation Air Transport System." A presentation to the ICAO-ATAG-World Bank Development Forum, May 2006.

5. Wide-area multilateration uses "time difference of arrival" techniques that enable an air traffic control central processor on the ground to triangulate three-dimensional aircraft positions from basic aircraft transponder replies or other data downlinked to a network of low-cost ground receivers that later can be used for ADS-B.

6. Airservices Australia. "Airservices and SITA Undertake ADS-B Trial in Indonesia." Media release, Feb. 15, 2006.