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Environmental Protection: Mandate for Change

By Howard Aylesworth

We have the opportunity to usher in extraordinary growth in aviation over the next century, unless we squander it. Demand forecasts are optimistic, market liberalization has taken hold worldwide, borders are becoming more transparent, and aircraft are cleaner, quieter, more efficient and reliable. So, what could hold the industry back? In order to grow, aviation must build public confidence that it is acting responsibly beyond its bottom line. Yet, aviation cannot achieve this alone. Those who benefit from aviation services must also contribute. Shared responsibility is in order.

Before September 11, 2001 this statement seemed reasonable. Does it still hold true today? I believe it does, if not more so. Terrorism has not irreversibly changed the course of economic and social progress, nor has it made the normal everyday concerns irrelevant; it has simply drawn unresolved issues into sharper focus. One such question is the relationship between the environment, prosperity, and business.

Aviation has much to be proud of. It links diverse communities, delivers the mail and reunites families, is a foundation of economies and transmission belt for coinierce, a developer and user of breakthrough technologies, consistently nets huge surpluses for the balance of payments, and has a remarkable safety record. Yet, aviation's contribution to national security and social well being has a potential negative side.

Our congestion and delay squander valuable resources. Based on anticipated growth, our noise and emissions could be a source of concern. Our options to address these present and potential

problems are limited due to lack of a substitute fuel, technology trade-offs, and underfunding of Federal research and development programs. And, our longstanding effort and considerable investment in solving these problems goes largely unnoticed.

To some we are perceived as non-responsive, inaccessible, complacent. To others we are seen as a source of moving jobs overseas, a growing contributor to global climate change, and a source of sleep deprivation and dirty neighborhoods. In addressing these issues while continuing to contribute to a better society, the aviation community is learning to cooperate in order to compete, but we need partners. Although these aviation issues have their own particularity, they are part of the larger environmental universe, a subject that has captured the public's attention.

Policy Climate and Framework

Public concern over the environment is deepening and broadening. The green record of European states is well known and acknowledged, albeit among the literati the schism between environmental rhetoric and environmental performance has been noted.¹ Australia, Japan, China, the Russian Federation, Central and Eastern European Countries, Canada, Mexico, Costa Rica, Brazil, and other OECD and developing countries also have environmentally aware populations and established environmental policies. Given other immediate and pressing needs, for the developing world this is seen as an important yet unaffordable luxury irrespective of public opinion.

In the United States the legal means and economic mechanisms to protect the environment are less visible, yet are quite well developed. This is built on a long history of public support and government action. Between 1987 and 1990 a strong majority of the population believed environmental standards could not be set too high. They supported continuing improvement regardless of the economic cost. A variety of national polls demonstrate these sentiments to be consistent up to the present time.²

Around the world, support for major efforts to improve environmental quality is marching forward, yet it has not formed because of familiarity with specific policies or prescriptions. Rather, this common wisdom is built around people's concern over their quality of life and well being.³ As participants in addressing these issues, we are afforded an unprecedented opportunity if we take the initiative. The question is, what should we do?

Although policy is a very generalized concept, it is not abstract. Viable policy options rest upon the consent of the governed, the legal and ideological foundations of nations, and the assessment of

what is key to accomplish next in order to move forward. Public consent, the battle for the hearts and minds of the populace, is the concern of the political establishment and the fourth estate, a topic well beyond the subject at hand. Therefore, I will address the remaining two imperatives of the policy-making process.

The core of debate on environmental issues is among and between the developed and less developed countries over questions of economic growth and the environment. These are important questions confronting the policymaker, ones that cannot be ignored. In this arena, as in others, budget constraints, standard of living expectations, and economic insecurities temper actualization of particular measures and the attainment of specific objectives. Yet, fundamental to current scientific endeavors is the question of the level of threat to human existence. If environmental concerns constrain or call into question the sustainability of existing industrial economies, they most certainly challenge the very precepts of how to provide for the needs of populations living in less developed countries.

The state of scientific knowledge, however, does not support reaching any definitive conclusion at this time, although solutions are in order. The very best the policymaker can do is acknowledge the legitimacy of such questions, reach consensus on the trend and prepare for all eventualities. It therefore becomes incumbent upon those seeking specific policy approaches to shoulder the responsibility of providing viable solutions to populations in both the developing and developed worlds. In order to do so they must acknowledge and understand the mosaic of divergent national systems that develop and adopt internationally agreed-upon environmental policies.⁴ I shall limit my comments to western OECD systems as they pertain to environmental policy issues, as these are representative of the larger debate.

Western European countries began post-World War II economic reconstruction under a prevailing social democratic political philosophy.⁵ While not as ardent today as in the past, social democracy remains ensconced as a potent ideological force in the political fabric of Europe. Arising from this unique historical experience European legal and social attitudes are markedly different from those in the United States, Canada, and Japan. This has produced differing sets of expectations toward, and approaches to, the environment.

Under the Maastricht Treaty the principle that environmental protection shares equal status with economic growth became a leading factor underlying all relevant laws and policy among the European signatories. Today, this principle has been extended to

the question of whether the two can be “decoupled.” The United States has no such generally applicable mandate.⁶ Although both the United States and the European Community legally recognize that appropriate actions are the responsibility of governments and those who are governed, the ideological underpinnings of these distinct socio-economic systems produce differing policy prescriptions.⁷

The United States, traditionally committed to free international markets and elimination of government planning and financial sponsorship of business, relies primary on regulations and market incentives to accomplish environmental objectives. European solutions fully embrace these approaches, but emphasize the activist role of governments in promoting robust transportation and social policies, a practice that is augmented with direct public financial and commercial support to industry. The consequences of these two divergent approaches, however, ultimately rest on which parties bear the cost. This question naturally leads to consideration of the scope of environmental policies and how they are to be evaluated.

The United States employs cost-benefit analysis to make these determinations. This analysis is specifically mandated with respect to public investment and regulatory actions. Under cost-benefit accounting, rigorous identification of the nature and extent of the problem is made, analysis of various options is required, and both economic and social costs are monetized for comparative evaluation. The purpose is to provide a transparent, systematic approach for reaching decisions. Cost-benefit analysis is not necessarily binding; it is simply a strong guide for action.⁸

In Europe, on the other hand, the precautionary principle was introduced under the Maastricht Treaty. Under this principle, analysis is subservient to proscriptive action. It requires action to prevent damage once it can be shown with a degree of probability that damage is likely to occur unless action is taken. The precautionary principle changes the debate on environmental policy from considerations over “whether” action should be taken to “which” measures should be taken “when.” But, what standard should be used to determine how to apply the precautionary principle, and what threshold of damage is necessary to invoke precautionary measures? The European Non-Addition Regulation provides a useful example.

Objective Transparent Process or No?

The impact of aviation noise on local communities has been significantly reduced through the phase-out of Stage 2 aircraft,

known in other parts of the world as ICAO Chapter 2 aircraft? This phase-out was completed in the United States at the end of 1999 and will be concluded by April 2002 in Europe and other areas of the world.

Since the mid-1990's, and prior to completion of the ICAO-sanctioned phase-out, the European Union (EU) pressed for a further increase in ICAO noise certification standards and the accelerated phase-out of noisier Stage 3 aircraft on the basis of taking precautionary measures to address a potential noise problem. Absent securing support for its position in ICAO, and under the rubric of the need for international leadership, in April 1999 the EU approved the Non-Addition Regulation to ban the operation of selected Stage 2 aircraft altered to meet Stage 3 requirements, so-called "marginal aircraft".

This action fundamentally challenged the regulatory role of International Civil Aviation Organization environmental standards and recommended practices. The regulation introduced the use of engine design as the basis for restricting aircraft meeting current ICAO noise standards and the phase-out of Stage 3 aircraft. It was not based on any analysis of the extent, causes and incidence of the problem, and the decision was made without considering alternative solutions, the costs involved, and who would bear these costs.

Many ICAO Member States have opposed the regulation in order to preserve the role of ICAO and the coherency of the international aviation system. Some fear the export of the European noise problem into their country, others are concerned over the potential restriction of entry into Europe or the price they might have to pay to retain it. Throughout the process the United States engaged the EU to seek international consensus on means to address the European noise problem and to permanently suspend the regulation. As a result of these efforts, and facing continuing international pressure, in May 1999 the EU suspended the effective date of the regulation to May 2000. Failing to persuade the EU to permanently withdraw the regulation, in February 2000 the U.S. submitted a complaint to the ICAO Council under Article 84 of the Chicago Convention.

Noting the absence of demonstration of the environmental need, the basis of the U.S. Article 84 complaint is "the regulation is focused more on targeting U.S. interests than on reducing airport noise," this on two accounts. First, the regulation is not based upon, nor does it make reference to, aircraft noise levels. Instead, the regulation is defined in terms of engine design, a criterion affecting only U.S. products. This has eroded if not eliminated the international market for a class of aircraft, many of which have improved

their environmental performance through application of new noise technologies and other means.

Further, the EU Non-Addition Regulation treats European air carriers differently from their non-European counterparts. It allows European carriers to sell and purchase within Europe the aircraft in question while prohibiting non-European carriers from selling into the European market, thus creating a dual market. **As** such, it enhances the value of the targeted aircraft that are on European registries at the expense of comparable aircraft on non-European registries. By targeting both non-European manufacturers and airlines, the regulation confers competitive advantage and distorts the market for these products.

This EU Non-Addition Regulation, enacted without the benefit of analyzing the environmental problem and giving no consideration to alternative means to address that problem or their costs, interjected a market-distorting policy into the environmental regulatory process while continuing to concentrate exclusively on aircraft technology as the solution to environmental problems. Yet, within ICAO, in which European States are active participants, another trend has emerged.

ICAO's Systems-Based Approach

The ICAO Committee on Aviation Environmental Protection (CAEP) is responsible for developing internationally accepted standards and recommended practices that lead to improved local air quality, mitigation of the atmospheric effects of aviation, and reduced community noise exposure. Having adopted cost-benefit analysis as the preferred method for making policy decisions, CAEP has established the principles that all actions must be “environmentally beneficial, technically feasible and economically reasonable.”

Whereas in earlier periods technology improvement was viewed **as** the primary means to accomplish its objectives, over the last decade CAEP began to develop a more systematic approach. Concern over the community impact of aircraft noise was the precipitating event. Based on the state-of-the art ICAO noise standard set in 1977, discussion focused to the accelerated phase-in of Chapter 3 aircraft that had achieved significant noise reductions due to the use of high-bypass ratio engines.

In its wisdom, CAEP resolved that parties other than air carriers had a stake in community noise protection. It was recalled the aviation community was being called upon to make very large financial investments, pointing out that the potential gains from the Stage 2 phase-out would not be realized if land use was not

controlled and insulation programs and noise-abating operating procedures were not implemented.¹⁰

This became the genesis of the Balanced Program for Noise Management that is currently on the ICAO agenda. However, further immediate work on the balanced approach progressed slowly and emissions issues rose to prominence. Although in the early half of the decade attention was paid exclusively to engine technology to further reduce emissions of nitrogen oxides (NO_x), further technology and non-technology means to address the broad spectrum of emissions concerns expanded the scope of ICAO policymaking.

The implications of over reliance on aircraft-based solutions was brought to the fore through discussion of the evolutionary and revolutionary progression of technology development and consideration of the performance trade-offs in addressing NO_x, carbon dioxide (CO₂), and noise.¹¹ Although significant gains had been made in developing technology to reduce noise and emission, the results did not proceed along a straight and narrow path. Rather, they follow the normal S-curve where technology gains are greatest after moving up the learning curve and before reaching the area of diminishing returns where further improvements are harder to make and come at greater economic and performance costs. It was found that when reaching new technology levels, development of breakthrough technologies follows no standard pattern, and that no revolutionary new technology was on the horizon.¹² This remains true today.

ICAO standards and recommended practices pertaining to the air traffic system had not been considered in the context of reducing aviation emissions. Although operational measures were considered earlier, they were not acted upon, as CAEP efforts were focused to setting aircraft noise and engine emissions standards. Yet, the inherent limitations in the technology development process were bringing to the fore the need to consider other measures.

CAEP anticipated that air traffic system improvements, including improved operating procedures and use of advanced technologies, could reduce emissions to a greater extent than could be achieved through engine stringency alone. Quite simply, reduced delay and more direct routing uses less time and fuel, resulting in reduced emissions. Realizing this, ICAO agreed on the environmental need for air traffic modernization, and that the quicker this was done the greater the benefit would be.

Yet, reliance on aircraft technology to address aviation environmental problems is well ensconced, and creating an environmental mandate for broader policy response beyond aviation interests has been difficult, even though air traffic modernization is also a

technology approach.¹³ This political issue can and must be resolved.

At the same time, concentrated efforts to further develop and implement both technology and non-technological means to reduce aviation noise and emission must be brought to the fore and action taken. Central to this is land-use policy and investment led sustainable growth.

Concurrent, Inclusive Approach Needed

The old adage, “If it ain’t broke, don’t fix it” implies that if it is “broke,” fix it right. But, how do we know if it’s broken, and if it is, the nature and extent of the problem? To answer these questions we must establish the environmental needs and demonstrate the achievements of past efforts to alleviate the problems in a well defined, transparent manner.

Land-use Policy

The balanced program for mitigating community noise established by the ICAO Committee on Aviation Environmental Protection in 1991 was a far-sighted approach to reduce community exposure to aircraft noise. Since then, only three of the four elements of the balanced program have been actively pursued—use of operational procedures to avoid noise sensitive areas, reductions of aircraft noise, and soundproofing homes within the noise impacted areas, albeit these have not all been adopted in large portions of the world. Now, the fourth—land-use preservation and planning—has become the focal point for action.

Of those U.S. citizens affected by aircraft noise in 1975, less than 10 percent of the households now experience that noise level. This is a remarkable achievement due in no small measure to the Airport Noise and Capacity Act of 1990 (ANCA). Through ANCA and noise mitigation technology used in new and existing “hushkitted” and re-engined aircraft, communities have benefited from, and will continue to be protected from, aircraft noise while enjoying a seamless national aerospace system, but only with their help.

According to a recent General Accounting Office report, in the United States communities have squandered a priceless resource created by the phase-out of the Stage 2 aircraft fleet.¹⁴ This is most certainly indicative of practices in other parts of the globe, albeit countries such as Brazil have established effective land-use procedures to protect communities from unacceptable noise. The resource is the area of land near airports that is the result of aircraft manufacturers’ ability to produce aircraft that significantly limit the land area exposed to unacceptable noise.

Between 1991 and 1999 airlines and airports invested more than \$100 billion to reduce community noise in the U.S. while to this day encroachment of development into the noise contours that existed just before the phase-out began continues to occur. This is the area gained through the Stage 2 phase-out that is now being squandered. The GAO report outlines the problem. Twenty percent of the 50 largest U.S. airports—those that handle over two-thirds of flights in the US.—have reported that encroachment is also reaching into the noise contours as they exist today. This means it has already occurred past the noise contours as they existed when the Chapter 2 phase-out began ten years ago. An even greater number of airports report that development outside the present noise contour is reaching an alarming rate.

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Absent hard data it is difficult to estimate what the total encroachment might be. Yet, in trying to establish who will take responsibility to address this pressing issue, no party is stepping forward. Rather, airports and the communities they serve are calling for further restrictions to aircraft and for tighter ICAO noise standards while turning a blind eye to the problem they control.¹⁵ This is a negative sum game where everyone loses. Until communities begin to accept their responsibility for preserving and protecting land areas around airports, noise will continue to adversely affect those living close to airports. This situation thwarts efforts to meet needed airport capacity and impacts the economic growth in the communities that benefit from air transportation.

Some airports have already begun. For example, Baltimore-Washington International has a long record of protected land-use and, not surprisingly, community noise concerns are quite low. Unfortunately, the BWIs of the world are the exception rather than the rule. Yet, others airports such as Minneapolis-Saint Paul Inter-

national are focusing on community-based solutions as a vital element of a comprehensive solution. Not only must all communities accept their responsibility, as a kingpin in solving the noise problem they must actively work on the legal issues at hand.

Within the United States, land-use decisions rest with state and local governments. Although the U.S. transportation system has been established under the Interstate Commerce Clause of the Constitution, there is no federal preemption of land-use decisions even though these might be inconsistent with, or impinge upon airport access. It is therefore incumbent upon state and local governments to develop effective land-use policies at and around airports. Barring this, the federal government has the prerogative to hold airports and communities accountable for inconsistent land-use decisions under 14 C.F.R. Parts 150 and 161.

Under these provisions, should a local entity request federal funds for home insulation, repurchase or other allowable noise programs, funds could be withheld or embargoed for those dwellings that have been constructed within the relevant noise contour areas after a date certain. In cases of application for operating restrictions or airport expansion, noise exposure metrics could “discount” dwellings and/or buildings built after a date certain even though they were sited within the applicable noise contours extending to that which existed prior to the Stage 2 phase-out.

Such an approach would place responsibility for land-use decisions where they belong, on local entities. Credit could be given for those airports and localities that have accepted their responsibility, either by demonstrating past performance or by establishing viable programs to resolve existing—and eliminate future—encroachment.

Is this too expensive or impossible? If we are to have a national air transport system and the economic growth it enables, localities can no longer afford not to act. Community noise protection cannot be achieved by engine and airframe technology alone; operating procedures, while important, are limited as to what they can produce; and airports and air carriers must be able to realize a return on their considerable investment in noise mitigation.

Investment Toward Sustainability

The Agenda for the Twenty-First Century (Agenda 21) adopted at the U.N. Conference on Environment and Development in 1992 in Rio de Janeiro, established sustainable development as its goal. Since that time sustainable development has become the obligatory buzz word when setting environmental policies, yet very little progress has been made toward how the three pillars of sustainability—economic progress, social benefit, and environmental responsibility—are to be achieved.

Originally developed as a macroeconomic approach to growth, whereby use of scarce resources would be balanced against the capacity of the earth to sustain continued life as we know it while allowing allocation through pricing mechanisms, the concept of sustainability is now being applied to industries and economic sectors. Hence the vision of sustainable aviation. Because little progress has been made to understand what this means in terms either in itself or for the larger economy, attention is focused to questions of internalizing external costs and other market-based means to regulate economic activity through price and its affect on demand.

To me this seems to be a very *ad hoc* approach toward achieving the stated goal. Absent an alternative to present economic systems, the question of sustainability must be focused to making social decisions on how best to gain macroeconomic efficiencies in conjunction with developing proper mechanisms to achieve sustainable development. Rather than discussing the concept of sustainable aviation as if aviation itself can reach sustainability and then when joined by other equally sustainable sectors the economy can be deemed to have achieved this goal, I believe further work must be made toward understanding how economic activity can be made more sustainable and then allocating responsibilities to various sectors. The need for this approach is already apparent.

On the basis of the nascent science of climate change, a majority of developed and emerging nations have set off on the course of limiting greenhouse gasses. As a first try at this grand experiment, the target of reducing carbon dioxide emissions has been set at 5 percent below 1990 emissions levels on a national basis, plus or minus for differing countries. This seems quite a sensible approach until the question of how nations will achieve this goal during the 2008 to 2012 time period is entertained. While mechanisms for trading emissions reductions achieved in developed and developing countries to meet national targets are being examined, the real question yet to be resolved is how reductions will be allocated to specific sectors and/or companies.

The term “sustainable aviation” does nothing to solve this conundrum although it makes for good publicity. How is one to know aviation is “doing its share” or that it is sustainable? From a macroeconomic perspective aviation is part of the transportation sector that performs a unique function toward facilitating economic activity. Without transportation, communities would be primarily self-contained, a solution our foreparents found less than desirable and rather life limiting in times of crisis, and today an impracticality, barring the elimination of large parts of our populations. This

can be said of other sectors which are equally vital to maintain living standards and promote economic growth in the less developed world.

While the answer to this issue is beyond the scope of this discussion, as a next best solution I believe aviation should not be treated alone. Rather, the transportation sector should be examined as to what solutions are available to its component subsectors and the costs and benefits of meeting environmental objectives compared. This might allow a more rational approach as to how to address environmental concerns while allowing for growing demand.

For example, aviation has no substitute fuel, whereas other modes of transportation do. This would suggest decisions be based on the understanding of what aircraft and engine technology is able to achieve relative to fossil fuel reduction technologies among the other modes. Clearly those modes might benefit from fuel switching whereas aviation cannot, at least at the present moment or foreseeable future. Aviation can, however, benefit through modernization of the air traffic system, and these technologies might be applicable to other modes of transportation. This, however, requires a broader policy context than the present emphasis on specific industries. Although emissions trading appears to be breaching this gap, it is neither a panacea nor is it presently providing broad impetus to further technological development.

Investment in "post-industrial" equipment and the infrastructure necessary to its use has been the engine propelling economic growth over the past decade. While consumption is the bed rock of economic activity, this investment has produced a more global economy linked through integrated communication and transportation networks. These, in turn, have arisen from the very nature of new technologies that are fundamentally different than those preceding them—we have moved from the era of physical labor reproducing machines into the age of machines that perform functions similar to human thought.

It is these machines that are behind the advances in aviation which show further promise to reduce emissions, noise, congestion, and delay. For example, development of the high by-pass ratio engines has produced substantial environmental and operational benefits. Alongside advanced combustor and fan technologies enabling greater by-pass ratios, modern electronics permit constant monitoring of engine parameters, allowing for greater efficiency and less fuel burn. Similarly, the Federal Aviation Administration's national airspace system (NAS) modernization plan utilizes air traffic management, communications, navigation, and surveillance technologies upon which the digital revolution is founded. Yet, as in

other sectors of the larger economy, these technologies are rapidly reaching maturity and new capabilities must be developed.

The overall capacity of the NAS is a function of a variety of important factors, including the design and operation of the airspace itself and the equipment that facilitates that operation. At present, FAA and NASA are engaged in substantial efforts to modernize the equipment, software and procedures to enable significant changes in how the available airspace and airports can be more efficiently used and how safety can be enhanced.

Improvement in the use of airspace is important to the provision of aviation services because of existing capacity constraints and delay, and because anticipated demand cannot be accommodated. From an environmental perspective, this increases fuel consumption, and therefore emissions beyond what an efficient system could achieve. While the present evolutionary system is designed around existing technologies or those that can be introduced within the next 10 years, planning for the future requires technologies yet to be developed. This, in turn, creates the business environment and incentives needed to encourage long term investment in research, development, and commercialization of new technology into products that fulfill mission requirements.

An important element of a long term national airspace system plan is that it clearly set out the system requirements, thereby providing a framework for meeting future demand and encouraging long-term innovative technology programs. This is yet to be developed. For the present, however, the NASA Research and Development Advisory Council estimates \$750 million in public and private funding is necessary over the next five years to develop the pre-competitive aircraft and airspace technologies now in NASA programs to the level where they are capable of being transitioned into commercial products.

While European and NASA program goals parallel each other, the European Union is pursuing a level of funding sufficient to make its efforts successful. On the other hand, current NASA funding levels of \$60 million per year are inadequate to produce viable pre-competitive technologies now under development. It has been said that the European research and development establishment is not as well developed as that of the U.S., but it is known that it is a credible, growing and well funded competitor. **And**, while information on NASA-developed technologies is made available outside the U.S., this is not true for U.S. companies. Non-European companies do not reap the benefits of European research and development efforts, yet Europe is not our only competitor.

Due to the high-risk, high-payoff nature of exploring the potential of these future technologies, public financing is necessary during the early phases of research and development, only to be superceded by the substantial investment made by industry to demonstrate and commercialize those technologies that prove viable. Public funds are leveraged many times over and the return on investment is manifold. Civil aviation is the single largest contributor to the U.S. trade balance, for example. Yet, there is public debate on the necessity for such investment, and recent budget priorities have reduced available funds. The way in which these issues are resolved will significantly impact the health of the industry, and with it the U.S. economy one way or the other.

Although the larger question of setting priorities for public investment in transportation infrastructure and research and development to achieve sustainable growth is a longer-term issue, adequate funding to accomplish the program goals established under existing priorities must be forthcoming if the competitive position of the industry is to be sustained and environmental concerns are to be met.

Mandate for Change

The process for reaching international consensus on aviation environmental issues has become highly politicized. While the scope of potential solutions has been expanded, policy options still concentrate on aircraft technology, and market-distorting measures have been introduced. More effective use of international standards, greater reliance on comprehensive approaches, and shared responsibility are called for.

While aviation must be seen as an essential component of the transportation sector that is critical to all economic systems, environmental policies must be approached from the macroeconomic level, not from the perspective of the firm or industry upward toward the larger economy. The central issue underlying current debate on environmental policy is reaching consensus on "sustainability," that is, the relationship between economic activity and environmental integrity. In developing systematic solutions to achieve this end, the question of how to realize "Sustainable aviation" can only be approached from the standpoint of aviation's role in the "sustainable economy" and what all economic actors can contribute toward the solution.

Technology is viewed as the critical element in meeting environmental objectives. Yet, in light of diminishing returns in the technology development cycle and the uncertainties in developing breakthrough technologies, attention must be focused to the role of

non-technology solutions and integration of the public into the policy process. Local communities lack accountability, and developing the existing institutional and legal framework is essential for further progress on environmental protection. Central to this is land-use policy and investment.

Recent developments in the International Civil Aviation Organization and policy initiatives in the European Union suggest concentrating on solving the legal and political challenges facing national, sub-federal, and supranational governments, and on the need to strengthen implementation mechanisms. For the business firm and investment community, environmental protection is basic to the health of the bottom-line; all stakeholders must safeguard the investment in, and accept their responsibilities for, environmental protection; and sufficient government investment in pre-competitive technology research and development, and in the aviation infrastructure, must be made.

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Endnotes

¹ See for example, Lasse Ringius, *The European Community and Climate Protection: what's behind the 'empty' rhetoric?*, Center for International Climate and Environmental Research, University of Oslo (1999).

² Comparison of two Roper Organization national polls show a meaningful increase in U.S. support for environmental improvement, from 56 percent in 1987 to 70 percent in 1990. An American Viewpoint, Inc. memorandum to The Superfund Reform Coalition dated December 12, 1995 reported, "While Americans' attitudes towards government regulation generally remain unchanged from 1994, with 59% stating there is too much regulation, . . . the electorate holds vastly different views when it comes to the environment. Only 21% say environmental laws and regulations have gone too far, 36% not far enough, and 31% that they are about right. 77% of all Republicans believe there is generally too much government regulation today. However, when it come [sic] to the environment, only 30% believe environmental laws and regulations have gone too far. Our party is out of sync with mainstream American opinion. . . . There is a great deal of ignorance concerning the specifics of environmental regulation just as there is a great deal of ignorance about the budget." pp. 12-13. Hams Interactive, Inc. polls taken between 1997 and the present consistently show growing public awareness of environmental issues and the need for policy prescriptions; however, they remain uncertain regarding specific remedies.

³ The Organization for Economic Cooperation and Development has reported, "[Among OECD countries,] only a small percentage of public opinion considers that economic growth should be given priority even if the environment suffers somewhat; it also shows clear public support for environmental protection, even if this entails reduced economic growth." *Environmental Indicators* (Paris, 1991), p. 50.

⁴ The major features distinguishing socio-economic systems are forms of ownership, the context of democracy, the role of government, and the allocative mechanism. Among industrialized countries, free market, social democratic and socio-economic systems in transition are found, while centrally planned communist, market socialist, and market-oriented systems exist in the developing world.

⁵ See, for example, Fritz Sternberg, *How to Stop the Russians Without War* (New York The John Day Company, 1948) and the extensive discussion on this subject published in *Foreign Affairs* (New York) during the period 1943-54.

⁶ To the best of my knowledge, the only exception is the Lower Mississippi Development Commission Act which places economic development within the context of environmental sustainability concerns. In the U.S., environmental statutes are directed to address specific problems through a prescribed set of remedies, and are not generalized to encompass economic development issues,

This is not to say, however, that economic and environmental concerns are not interlaced. Rather than being addressed **as** an operating principle, such concerns are normally addressed through the regulatory process and the courts; a process closely tied to Constitutional law and the U.S. legal codes.

⁷ The National Environmental Policy Act of 1969 (NEPA) was designed to institutionalize an anticipatory environmental concern and is not directed to control specific types or sources of pollution. NEPA identifies that, in addition to mandating the federal government to act, “each person has a responsibility to contribute to the preservation and enhancement of the environment” (42 U.S.C. 4331 (c)). U.S. law defines “**person**” to be either an individual or legally constituted business enterprise. “Concerned with principle rather than detail,” NEPA provides a deliberative, analytical process for federal agencies to incorporate environmental considerations into their primary decision making responsibilities, Senate Rept. No. 91-2%. 91st Cong., 1st Sess. (1969).

The Fifth Action Programme on the Environment (EU Program) recognizes that sustainable development requires that, in addition to the EC and national European authorities, public and private enterprises and the general public have responsibility for the environment. The EU Program identifies five target sectors, transportation being one, and specific environmental issues requiring policy attention.

⁸ The International Civil Aviation Organization (ICAO) Committee on Aviation Environmental Protection accepted cost-benefit analysis **as** a criteria for action at the Second Meeting in Montreal, December 1991. *Committee on Aviation Environmental Protection, Second Meeting, Montreal, 2-13 December 1991*, Report (Montreal, 1992), p. 7-E-1.

⁹ ICAO is the United Nations body responsible for international aviation. Created in 1944 on the signing of the Convention on International Civil Aviation, signatories “agreed on certain principles and arrangements in order that international civil aviation may be developed in a safe and orderly manner and that international air transport services may be established on the basis of equality of opportunity and operated soundly and economically.”

¹⁰ *CAEP Report, id.*, p. 6-1 and pp. 7-D-1 & 2

¹¹ In general, for situations where “n” objectives involve tradeoffs, at best only n-1 objectives are able to attain a solution at their maximum. For example, if the objective is to lower CO₂, NO_x, and noise, at best only two of these could be maximized. The optimal solution would be that set of technologies that would produce the greatest gain in all three. In this case the trade-off involves both positive and negative values. Production of CO₂ and NO_x emissions has an inverse relationship in some applications; aircraft noise performance comes at the expense of greater NO_x production in some cases.

¹² Aviation and the Global Atmosphere, A Special Report of the Intergovernmental Panel on Climate Change Working Groups I and III, Cambridge University Press (1999), Chapter 7.

¹³ This is due in part to how the issue is framed. For example, the FAA Strategic Plan places the environment **as** an enabling issue, that is, a means to accomplish the Agency's mission of Safety, Security and Efficiency. While air traffic system improvements are viewed **as** a core activity that is essential to accomplishing the FAA mission, the environmental concern of eliminating congestion and delay to reduce emissions is balkanized from the core activity. As such, it is extremely difficult to create a bridge between those solving problems related to the core activity and those working on the enabling activity, albeit FAA readily admits the environment is one of the defining issues that could limit the future growth of aviation.

¹⁴ Aviation and the Environment: airport operation and future growth present environmental challenges (RCED-00-153), General Accounting Office, (Washington: August 2000).

¹⁵ Within 10 years operators have transitioned to all Stage 3 fleets. This year ICAO set a new Chapter 4 (U.S. Stage 4) noise standard for new aircraft designs. It's far more rigorous than the Chapter 3 standard and demonstrates that manufacturers have continued to make progress in reducing noise. While many of today's aircraft exceed this standard by a wide margin, the newest aircraft in the 120-to-190seat class exceed it by only a small margin.

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