Trade and Transport Policy in Inclement Skies - The Conflict between Sustainable Air Transportation and Neo-Classical Economics

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THE CONFLICT BETWEEN SUSTAINABLE AIR
TRANSPORTATION AND NEO-CLASSICAL ECONOMICS*

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in embryonic form in several of the author’s books, including: AIRPORT
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INTERNATIONAL AIRPORT: LESSONS LEARNED (1997); and AVIATION LAW &
REGULATION (1993), and also in a paper delivered before the Health Council of
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TRANSPORTATION HAS BEEN described as the world's most serious environmental villain. Concerns over profligate consumption of non-renewable resources (i.e., fossil fuels), global warming, ozone depletion, and acid rain, as well as air and noise pollution, urban sprawl, congestion, and safety, warrant careful examination of the role of transport in making the planet less habitable. As one source put it, "[a]s a result of decades of careless development practices, our generation is now confronted with the reality of irreversible environmental damage."¹

Among the most prominent of non-renewable resources being consumed at a vigorous rate are fossil fuels, particularly oil. During the twentieth century, world energy consumption increased more than twelve times, while per capita energy consumption increased 3.7 times.² Fuel consumption by transport increases at the rate of 2.6% a year.³ The combustion of fossil fuels releases significant pollutants into the Earth's atmosphere; these include greenhouse gases, such as carbon dioxide, methane, nitrogen oxides [NOx], volatile organic compounds, and unburnt hydrocarbons. Greenhouse gases are those which are particularly effective in absorbing longer wavelength radiation beyond the visible light spectrum and trapping it in the atmos-

² See Esther Tan, Transport Sector Tops List of Polluters, NEW STRAITS TIMES, Nov. 21, 1995, at 15.
TRADE & TRANSPORT POLICY

Transportation accounts for forty-five percent of all volatile organic compound emissions. In earlier centuries, the pollution created by smaller human populations could be handled by the natural cleansing processes of rivers, seas and atmospheres – the carrying capacity of the planet was vast. But as the human population of the planet reached into the billions, the ability of natural forces to cleanse human emissions became strained, while at the same time, human projects like deforestation reduced the Earth's carrying capacity. Thus, human activity has significantly increased the volume of greenhouse gases in the Earth's atmosphere. Some estimate that human activity has doubled methane concentrations in the atmosphere and increased carbon dioxide by about thirty-five percent. Atmospheric concentrations of carbon dioxide have increased from 280-285 parts per million in the year 1800 (when coal was the primary fuel), to 350 parts per million today (with petroleum as the primary fuel). Unfortunately, carbon dioxide has an effective lifetime of centuries in the atmosphere. In assessing the global impact of fossil fuel use, the consensus of 2,000 top meteorologists and other experts was that the balance of evidence suggests these fossil fuel emissions have had "a discernible human influence on global climate." According to Professor Ulrich Schumann, aircraft carbon dioxide emissions "add linearly to emissions from other sources" and contribute to global warming.

Though most of the problem of pollution is caused by the surface modes, particularly the automobile, increased concerns are being raised by air transportation—the fastest growing mode of transport and the only human enterprise to emit pollutants directly into the upper atmosphere. Noise and emissions are the most serious environmental problems posed by commercial aviation. Aircraft and the airports to and which they fly are their source. The fundamental question is how to accommodate

5 See Benfield, supra note 3, at 657.
6 See Hearing on U.S. Global Change Research Programs (Mar. 6, 1996) (statement of Michael MacCracken before the U.S. House Committee on Science) [hereinafter "MacCracken"].
8 See MacCracken, supra note 6.
commercial economic activity without jeopardizing the environment in which we live.

This article examines the traditional means by which the adverse environmental consequences of air transport may be arrested and advocates consideration of non-traditional remedies. Within the traditional arsenal of prohibitory and remedial means examined are: U.S. legal and regulatory mechanisms; airport locational and environmental abatement alternatives; and technology and planning. Within the less traditional means of arresting environmental pollution and enhancing sustainability examined are: social norms; rational pricing; trade policy; and transport policy. A comprehensive solution to the problems of environmental degradation caused by air transport requires that all these areas be addressed.

No single remedy will likely work, and several are inextricably intertwined; but much progress can be made if they are pursued in tandem. The overriding objective should be to make transport least offensive as possible, so as to achieve sustainability. But before addressing remedies to the problem of environmental degradation, this article first assesses the problem.

II. ENVIRONMENTAL IMPACTS OF TRANSPORTATION

Much scientific inquiry and public policy debate have recognized the enormous problems that transportation plays both in the consumption of non-renewable resources and the discharge of unsavory emissions. Given that health is man’s most important asset, one might insist that prudent public policy insists that it be nearly inviolable. In 1946, the charter of the World Health Organization defined health as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.” The enhancement of human health, then, becomes a priority of the highest caliber.

As the major consumer of non-renewable energy resources (i.e., fossil fuels), transportation is among the world’s most prominent polluters (accounting for a third of the world’s carbon dioxide [CO₂] emissions), with the automobile being the single worst culprit. Yet many predict that emission controls will result in a decrease in global automobile emissions over time, as has already occurred in the industrialized nations. As the larg-

est single source of these problems, the automobile and other forms of surface transport have been the focus of sustainability analysis. In contrast, relatively little has been said or written about the role air transport plays in global emissions.13

Yet of all the modes of transport, aviation is uniquely global. The typical turbofan jet engine burning kerosene produces unburned hydrocarbons, soot, carbon monoxide, and nitric oxide (one type of nitrogen oxide).14 Hyrdocarbons produce smog, carbon monoxide takes oxygen out of the blood system, and nitrogen dioxide produces excessive nutrients in bays and estuaries (forty percent of the nitrogen oxide entering the Chesapeake Bay, for example, comes from air). Although air transport contributes a relatively small share of total pollutants (about three percent of global carbon dioxide emissions, for example),15 it is the only industry which discharges harmful emissions (such as nitrogen oxides and carbon dioxide) directly into the upper atmosphere, thus contributing more profoundly to global warming and ozone depletion. In the troposphere, jet engines generate ozone by photochemical reaction, while in the stratosphere, they may destroy ozone via catalytic reaction.16 Moreover, of all modes of transport, commercial aviation is growing fastest—outpacing any other form of transportation. This makes aviation of growing concern to sustainability in the twenty-first century.

University of California Professor Michael Prather, an atmospheric scientist, insists that both real-world observations and computer models show that aircraft engine exhaust can have a variety of adverse effects on the atmosphere. These include the emission of greenhouse gases and condensation trails that can alter upper atmospheric cloud patterns. According to Prather, aircraft gas emissions and contrails add up to an emission impact equivalent to that of the entire state of California.17 The most comprehensive study of the subject to date was prepared by the Intergovernmental Panel of Climate Change [IPCC], established by the United National Environmental Programme

15 See Jeziorski, supra note 10.
and the World Meteorological Organization to assess the impact of and options for mitigating climate change. Its 1999 report, *Aviation and Global Atmosphere*, was written by more than 100 experts and subjected to peer review of another 150 worldwide experts. In a February 2000 report to the U.S. Congress, the U.S. General Accounting Office, which reviewed the IPCC research, concluded that aircraft emissions are of potentially significant environmental concern for the following reasons:

- Jet aircraft are the primary source of human emissions deposited directly into the upper atmosphere. Some of these emissions have a greater warming effect than they would have if they were released in equal amounts at the surface—by, for example, automobiles.
- Carbon dioxide survives in the atmosphere for about 100 years and contributes to warming the earth. Global aviation's carbon dioxide emissions are roughly equivalent to the emissions of certain industrialized countries.
- Carbon dioxide emissions combined with other gases and particulates emitted by jet aircraft—including water vapor, nitrogen oxide and nitrogen dioxide (collectively termed NOx), and soot and sulfate—could have two to four times as great an effect on the atmosphere as carbon dioxide alone.
- The increase in aviation emissions attributable to a growing demand for air travel would not be fully offset by reductions in emissions achieved through technological improvements alone.18

This article now examines the specific environmental problems associated with air transport, beginning at the surface of the Earth and working its way up in elevation.

### A. Surface Contaminants

Various chemicals, abundant at airports, (such as oil, kerosene and aircraft de-icing fluid—particularly ethylene glycol) and other hazardous and toxic substances (such as solvents and metals) have the potential to cause environmental damage to

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soil, ground water, or surface water and ultimately, the human environment, if they stray off the airport property.\textsuperscript{19}

Prevention is more cost-effective than clean up. For example, Massport spent $61 million to clean up contaminated soil and ground water at Boston Logan International Airport. It was estimated that there had been 2,500 spills over three decades. The consumption of a million gallons of fuel each day inevitably results in some spills. Massport found thirty-one discreet areas of jet fuel in the ground at Logan.\textsuperscript{20}

Several airports have become proactive with respect to recycling and have established programs to reduce the amount of waste products leaving the field. Aircraft de-icing fluid is recaptured and recycled at many airports. Osaka’s Kansai International Airport recycles wastewater. Munich Strauss and Boston Logan airports have waste containers segregated for glass and cans, paper, and other trash so that the recyclable garbage can be collected.

B. Surface Level Emissions

The profound growth of population and its urban concentration has created localized concerns over carbon monoxide, ozone and other hydrocarbon emissions, as well as particulates, and odor (including the smell of unburnt or partially burned kerosene). The combustion of aviation fuel produces nitrogen oxides (NO\textsubscript{x}), carbon dioxide (CO\textsubscript{2}), carbon monoxide (CO), volatile organic compounds (VOC, including benzene, toluene, formaldehyde and 1, 3-butadiene), and particulate matters (PM\textsubscript{10}). Ozone is a secondary pollutant created from a photochemical reaction between NO\textsubscript{x} and VOC. Ground-based vehicles (e.g., towing vehicles, buses and tankers) emit NO\textsubscript{x}, CO and hydrocarbons. Land-side vehicular traffic is the major environmental degrader in the U.K. and Germany.\textsuperscript{21} Particulates are fine particles that go into the lungs when inhaled. Tempera-

\textsuperscript{19} See Jennifer Stenzel & Jonathan Trutt, \textit{Flying Off Course: Environmental Impacts of America’s Airports} 10 (Natural Resources Defense Council 1996). The major components of aircraft de-icing chemicals are ethylene and propylene-based glycol mixtures. See Netherlands, \textit{supra} note 11.


\textsuperscript{21} See Health Council of the Netherlands, Report on Public Health Impacts of Large Airports (draft of March 10, 1999) [hereinafter Netherlands (March 10, 1999)].
ture inversions can trap ground-based pollution, creating health risks. In the 1990s, a number of published epidemiological studies found associations between elevated levels of air pollution on the one hand and mortality and respiratory health care symptoms on the other. There is disagreement, however, on the nature, magnitude, and public health significance of the indications for health effects. During periods of high air pollution, human responses range from widespread slight reversible lung function deficits to the aggravation of symptoms among those who suffer from asthma, the hospital admission of patients with cardiopulmonary disease, and the premature death of the frail. Some effects emerge only after long-term cumulative exposure, including a latency period.\textsuperscript{22}

Aircraft and airports are significant polluters. Automobile traffic to and from the airport can also contribute significantly to pollution, noise and odor. Burned and unburned jet fuel aerosols contain several carcinogenic organic compounds, including Benzene and Formaldehyde. For example, pollution from take-offs and landings at Los Angeles International Airport alone is the equivalent of hydrocarbon emissions of 300,000 automobiles, and the NOx emissions of one million automobiles.\textsuperscript{23} Chicago O’Hare International Airport’s 900,000-flight operation ranks it as one of the top three to five toxic pollution sources in the state of Illinois.\textsuperscript{24} John F. Kennedy International Airport is the largest source of volatile organic compounds [VOCs] in New York City.\textsuperscript{25}

In 1993, aircraft at U.S. airports produced 350 million pounds of VOCs and NOx during their landing and take-off cycles [LTOs], more than twice their 1970 levels. An airport’s arriving and departing aircraft can create as much, if not more, ground level VOCs and NOx than their industrial neighbors.\textsuperscript{26}

C. Noise

Noise has been the most prominent of environmental concerns about the aviation sector since inauguration of the jet age in the late 1950s. Jet engines produce noise as fuel ignites and

\textsuperscript{22} See id.

\textsuperscript{23} See Testimony of John Kennedy Before the U.S. House Subcommittee on Energy, Committee on Science, Space and Technology (July 14, 1994).

\textsuperscript{24} See Henry Hyde & Jesse Jackson, Jr., The Partnership for Metropolitan Chicago’s Airport Future: A Call for Regional Leadership 21, 40 (Oct. 1997).

\textsuperscript{25} See Netherlands (March 10, 1999), supra note 21.

\textsuperscript{26} See Stenzel & Trutt, supra note 19, at 7-8.
exhaust gasses and turbine blades strike the surrounding air. Reverse thrust as a means of braking increases noise volume. Aerodynamic noise is produced as air is displaced by the profile of the aircraft fuselage. Noise is also created by ground traffic of air and surface vehicles at the airport. A survey of residents near London’s Heathrow airport found a significant association between the level of noise annoyance and reported symptoms, including waking, depression, irritability, chronic tinnitus (buzzing in the ear), minor accidents, and health service use. According to one source,

The negative appraisal of noise leads to acute dysregulation of the organism both in a physiological and psychological sense: physiologically by, *inter alia*, the production of stress hormones, magnesium excretion and constriction of the blood vessels; psychologically by, *inter alia*, strain, annoyance and resignation. Continuing noise exposure would result in chronic dysregulation of the organism that would become manifest by chronic elevated cortisol and noradrelin levels, changes in calcium and magnesium ration in the heart muscle and atherosclerosis. In the long run this may lead to an increased prevalence of cardiovascular disease in the exposed population and possibly of other diseases.

Solutions have included land use planning (zoning) around airports, sound-proofing homes in flight paths, altering flight paths to minimize noise impacts, imposing flight curfews at night, and mandating quieter Stage three engines on aircraft. Prudent airport planning requires the measurement of aircraft noise, land use planning, and aircraft noise abatement procedures, such as quieter engines, home insulation, or residential area condemnation and relocation. Noise footprints also have been reduced through advanced aerodynamic and engine designs. Thus, noise abatement is a shared problem of airport designers, airline operations, and airframe and engine manufacturers.

Assessing noise impacts requires quantification of noise, including frequency, pitch, time of day, and number of intrusions.

28 Netherlands (March 10, 1999), *supra* note 21.
Several measures of aircraft noise have been developed. The U.S. Federal Aviation Administration [FAA] has adopted a noise threshold of sixty-five decibels [dB] DNL as the trigger for unacceptable noise levels. That standard has been criticized by environmentalists on grounds that it is based on an averaging of noise, rather than a loud single event such as a passing aircraft, and that the threshold of sixty-five dB is significantly lower than many people find annoying.

As an alternative, California and several European governments have adopted the community noise equivalent level [CNEL], which imposes a five-dB penalty during the hours of 7:00 p.m. to 10:00 p.m., in addition to the DNL's ten-dB nighttime penalty. Environmentalists have argued the threshold should be fifty-five-dB CNEL rather than sixty-five, and that single event noise rather than averaging should be taken into account by using the single exposure level [SEL] in conjunction with the CNEL.

Typically, airports and governmental agencies in developed nations embrace a multitude of methods for reducing noise pollution. For example, in 1990, Amsterdam's Schiphol Airport became one of the first airports in the world to formulate an Environmental Policy Plan. The comprehensive plan specifies twenty-four action items, from installation of a noise monitoring system to an environmental protection system directed at promoting the use of public transport. In 1967, the Kosten unit (Ke), named for Professor Kosten, was adopted to measure aircraft noise. The thirty-five Ke zone surrounding the airport has been reduced from 42,000 homes in 1979 to about 15,000 in 1990, with the use of quieter aircraft and better planning of runways and flight paths. Many houses near Schiphol have been insulated against noise. By 2015, the thirty-five Ke zone will contain an absolute maximum of 10,000 homes. Night flying must meet the twenty-six Laeq standard, which means that the annual average bedroom noise levels during night time (11 p.m. to 6 a.m.) must not exceed twenty-six dB, while day time flying must

32 See Stenzel & Trutt, supra note 19, at 4.
34 See Stenzel & Trutt, supra note 19, at 5.
not exceed the 40 Ke level. A fifth runway is being constructed at Schiphol to steer flight paths away from population centers.35

Aeroports de Paris also employ a multitude of innovative mechanisms to reduce noise impacts. Aircraft noise is monitored carefully by noise monitoring equipment at strategic points around Paris. At Paris' Orly Airport, strict curfews on aircraft take-offs and landings are imposed between 11:30 p.m. and 6:00 a.m. Aircraft landing fees are graduated depending upon noise emissions, with higher taxes imposed on noisier aircraft. Noise contour maps are drawn to identify regions where no new construction is permitted. Flight paths are directed around residential areas.36 Both to buffer noise and improve the aesthetic appearance of the airport property, a major tree-planting project is underway south of Charles de Gaulle Airport.37 Recognizing the need to keep the community informed about what the airport is doing to try to reduce noise bombardment and to encourage dialogue with the community, Aeroports de Paris established an Environmental Resources Center to act as a contact point and meeting place with the community and to display information on technology and pollution.38

D. THE GREENHOUSE EFFECT

The greenhouse effect is a natural phenomenon that warms the Earth, enabling it to support life. Without it, the temperature of our planet would be a frozen -18°C Celsius (C), rather than the current average of +15°C C. Light from the Sun penetrates the atmosphere, warming the surface and oceans of the planet. Much of this heat is re-radiated back out again in the form of infrared radiation. Because infrared rays have a longer wavelength than visible light, certain atmospheric gases, (labeled “greenhouse gases”) can absorb them. This absorption warms the atmosphere, which in turn, radiates some of that heat back again to Earth.39

The combustion of kerosene in an aircraft engine creates carbon dioxide (about three percent of total global carbon dioxide

35 See Amsterdam Airport Schiphol, Fact Sheet: Introduction to the World of Amsterdam Airport Schiphol (1997); Amsterdam Airport Schiphol, Balancing Environment and Economics (1997).
38 See Aeroports de Paris, Environmental Resource Center (1997).
39 See Environment Centre, supra note 7.
emissions) and water vapor.\(^{40}\) As the principal discharge of combustion, carbon dioxide is believed to be the single most significant factor contributing to global warming. Carbon dioxide traps the Sun's heat, increasing the planet's surface temperature; also contributing are nitrogen oxide, carbon monoxide, water molecules, chlorofluorocarbons, and methane.\(^{41}\) Some contend that the condensation trails of ice crystals flowing from jet engines at high altitudes may also exacerbate the greenhouse effect, although others deny this.\(^{42}\) Water trails are believed 10,000 times less damaging than other greenhouse gases, helping form contrails and cirrus clouds, whose shadows cool the Earth. But by blocking the planet's infra-red emissions, they also warm it by trapping heat in the atmosphere.\(^{43}\)

Because of fossil fuel emissions, transportation is by far the world's most vicious polluter. Among sources of \(\text{CO}_2\) emissions, transport has grown in both absolute and relative terms. In the United States, despite severe environmental regulation of automobile emissions, \(\text{CO}_2\) emissions emanating from transportation sources rose seventy-nine percent between 1965 and 1992, from 229 mmt of carbon to 408 mmt, a rate of growth outpacing any other source.\(^{44}\) By some accounts, the combined effect of aviation emissions of \(\text{CO}_2\) and \(\text{NO}_x\) emissions could represent ten percent of human-created global warming by the end of the twenty-first century, because the demand for air transportation may outstrip technological remedies.\(^{45}\) Only about half the carbon dioxide emissions are absorbed by forests, oceans, and such; the rest stays in the atmosphere as a greenhouse gas.\(^{46}\)

Transport also accounts for forty-three percent of \(\text{NO}_x\) emissions in the United States, and sixty percent in Europe.\(^{47}\) As we shall see, nitrogen oxide depletes ozone at higher altitudes, while paradoxically, below a level of 12km, \(\text{NO}_x\) increases the amount of ozone, acting as a potent greenhouse gas. In a 1998 study published in *Science* magazine, two dozen scientists concluded that aircraft emissions of nitric oxide interact with sun-

\(^{40}\) See Noble, supra note 16, at 19.

\(^{41}\) See Transport Canada, supra note 27, at 24.


\(^{43}\) See Jeziorski, supra note 10.

\(^{44}\) See U.S. Dep't of Transportation, supra note 4, at 66.


\(^{46}\) See Environment Centre, supra note 7.

light in the upper troposphere to produce ozone, resulting in the formation of more greenhouse gas than previously thought.\textsuperscript{48} In Europe, tropospheric ozone has increased 500\% since 1970; concentrations are increasing one to two percent per year in the Northern Hemisphere.\textsuperscript{49}

NO\textsubscript{x} emissions below cloud level are also washed to the Earth as acid rain. Acid rain can have a deleterious effect on forests and wetlands.\textsuperscript{50} Nitrogen oxides and other volatile organics combine to form tropospheric ozone, more commonly known as urban smog, which can irritate lungs, reduce resistance to infection, and aggravate heart disease, asthma, and bronchitis.\textsuperscript{51}

Since the mid-nineteenth century, global average temperature has increased about one degree Fahrenheit (0.5 degrees Celsius), and sea level has risen between four and eight inches (about 10-20 centimeters). By 1998, the earth’s surface temperature had reached its highest level since people first began to measure it in the mid-nineteenth century. The ten warmest years on record have occurred after 1983.\textsuperscript{52} The warming patterns are unlike those that might be expected from natural variability. No alternative solar or volcanic causes have been identified, suggesting that man may well be the culprit.\textsuperscript{53}

Though some authorities contend that the warmer climate can be explained by normal variation, the dominant view among climate scientists is that at least some of the contemporary warming is caused by the trapping of solar heat due to emissions of industrial gases such as carbon dioxide.\textsuperscript{54} It has been estimated that if we continue at our current rate of carbon dioxide pollution alone, average global temperatures will rise by 1.5\textdegree{} to 4.5\textdegree{} C over the next 40-50 years. If average global temperature rises by 3\textdegree{} C, the Antarctic and Greenland ice caps would partially melt and ocean water would expand, raising the sea level between 30 and 150 centimeters. A complete melting of the global ice caps is a process that would likely take several hundred years.\textsuperscript{55}

\begin{flushright}
\footnotesize
\textsuperscript{49}See Hindley, \textit{supra} note 42.
\textsuperscript{50}See Transport Canada, \textit{supra} note 41, at 24-25, 28.
\textsuperscript{51}See Benfield, \textit{supra} note 3.
\textsuperscript{53}See MacCracken, \textit{supra} note 6.
\textsuperscript{54}See Stevens, \textit{supra} note 52.
\textsuperscript{55}See Environment Centre, \textit{supra} note 7.
\end{flushright}
Global warming will also cause climatic changes, and alter crop production.

E. DEPLETION OF THE OZONE LAYER

Between twelve and thirty miles above the surface of the Earth, the ozone layer shields the planet from harmful cancer-causing ultraviolet radiation. Since 1967, the ozone layer over the equator has decreased by three percent and over Europe and North America by ten percent. Satellites have discovered an ozone "hole" appearing during the springtime polar vortex of the Antarctic stratosphere, while more moderate ozone depletion has been found at the mid-latitudes, where most of the Earth's population resides.\footnote{See MacCracken, supra note 6.} By 1996, the hole covered seven million square miles, nearly as large as the combined area of the United States and Canada.\footnote{See Ozone Hole Biggest Ever, Denver Post, Nov. 2, 1996, at 10A.} Each one percent decrease in the ozone layer can lead to a three to six percent increase in skin cancer.\footnote{See Egurbide, supra note 1, at 1095.} For human beings and other animals, increases in ultraviolet radiation can also cause immune system suppression, increased sunburns, cataracts and epidermal lesions, and reduced vitamin D synthesis. In plants, it can inhibit the process of photosynthesis, reducing agricultural productivity.\footnote{See MacCracken, supra note 6.}

Chlorofluorocarbons are the primary threat to the ozone layer; but the release of oxides of nitrogen into the upper atmosphere creates a series of chain reactions in which ozone molecules in the stratosphere are converted via photochemical dissociation into oxygen molecules.\footnote{See Transport Canada, supra note 41, at 26.} Scientists are also concerned that nitrogen oxide emissions above cloud level may represent a threat to the ozone layer, which shields the Earth from harmful ultraviolet radiation.\footnote{See id.} Approximately twenty percent of aircraft emissions occur at stratospheric cruise altitudes.\footnote{See Paul Stolpman, Environmental Impacts of Aviation Emissions (paper presented before the ABA Forum on Air & Space Law, San Francisco, CA, July 10, 1998).} The current state of scientific knowledge offers no definitive proof of cause and effect, for the chemical interactions and climatic conditions are quite complex and at an altitude in which they are notoriously difficult to measure. But ministers from
twenty-six OECD member states issued a consensus statement that "the balance of evidence suggests a discernible human influence on human climate . . . The environmental impacts of rapidly increasing air transport are also of concern."63

F. PROJECTED GROWTH OF AIR TRANSPORT & ITS EMISSIONS

Air transport appears to be growing faster than any other mode of transport. Passenger air transport grew 260% between 1970 and 1990, while air cargo grew 220%.64 Many project that global air transportation will double over the next ten to fifteen years, with developing nations growing at a faster rate than developed nations.65 According to some estimates, air travel could increase 500% over the next half century.66 Airbus predicts that the world’s airlines will purchase 15,000 new passenger jets as global air travel triples over the next twenty years.67 McDonnell Douglas predicted the need for 18,000 aircraft over the next two decades, with retirements comprising only about half of the active passenger fleet.68 The growth in demand and capacity for air transport appears to be out-pacing the ability of technological improvements to reduce environmental degradation.

Airlines are the second largest consumer of petroleum for fuel, behind highway transport (i.e., automobiles and commercial trucks), and ahead of rail and water modes.69 Commercial aircraft produce approximately 3150 milligrams of CO₂ and 1240 milligrams of H₂O per kilogram of aviation fuel burned. Air transport is only responsible for a small fraction of the Earth’s pollution, accounting for two to three percent of global carbon dioxide and nitrogen oxide emissions. But as noted above, aircraft are the only source of nitrogen oxide emissions in the upper atmosphere.

Moreover, the per person-kilometer carbon dioxide contribution of aviation is between four and eight times that of travel by automobile, more than ten times that of travel by bus, and

64 See OECD, supra note 47, at 21.
65 See Transport Canada, supra note 41, at 11.
66 See Noble, supra note 16, at 19.
67 See Transport Canada, supra note 41, at 12.
68 See MDC Forecasts 5.7% Growth and Demand for 13,272 Aircraft, AIRCRAFT VALUE NEWS, Sept. 4, 1995.
69 See U.S. Dep’t of Transportation, supra note 4, at 170.
twenty-two times that of electric-powered train.\textsuperscript{70} For air freight transport, \( \text{CO}_2 \) emissions are twenty times per tonne-kilometer greater than for a medium-sized truck, and 240 times greater than slow rail.\textsuperscript{71} Thus, the trade-off for higher speed appears to be higher levels of pollution.

Carbon dioxide, methane, nitrogen oxide and ozone have all increased dramatically in concentration over the past half century as population, industry and transportation have exploded.\textsuperscript{72} Some sources ascribe to air transport a 24.3\% share of transportation-related emissions that could potentially affect the climate, and project an increase in energy use by this mode of 180\% by the year 2005. The International Civil Aviation Organization predicts a 65\% increase in fuel consumption between 1990 and 2010. Others predict that technological improvements will allow nitrogen oxide emissions to hold constant even while fuel consumption (now 180 million tonnes) doubles.\textsuperscript{73} Still other sources calculate that carbon dioxide emissions from global subsonic aviation may rise from 554 million tonnes in 1990 to 957 million tonnes by the year 2015. By 2020, emissions from aircraft could consume the 5.2\% reductions in greenhouse gases that the world community agreed to eliminate in Kyoto in 1997.\textsuperscript{74} Dr. Peter Bein predicts that even if global emission rates remain at present levels, \( \text{CO}_2 \) levels would still reach two and one-half times their pre-industrial level (about twice today’s concentration) by 2010. With increasing emissions, \( \text{CO}_2 \) levels will increase more.\textsuperscript{75} By the year 2100, aviation could account for 14\% of the world’s anthropogenic carbon dioxide emissions.\textsuperscript{76}

III. SOCIAL NORMS: SUSTAINABILITY AS THE NEW PARADIGM

Transportation pollution has created a growing problem. Any effort to arrest pollution and create a sustainable transport system must begin with educating the public about the problem in order to influence social etiquette and influence public policy makers. This is a challenging endeavor. Aristotle observed that

\begin{itemize}
\item \textsuperscript{70} See Hindley, supra note 42.
\item \textsuperscript{71} See OECD, supra note 47, at 69-70.
\item \textsuperscript{72} See Hindley, supra note 42.
\item \textsuperscript{73} See Jezierski, supra note 10.
\item \textsuperscript{74} See Noble, supra note 16, at 19.
\item \textsuperscript{75} See Peter Bein, Transportation, Global Warming and Business as Usual (British Columbia Ministry of Transportation and Highways 1996).
\item \textsuperscript{76} See Jezierski, supra note 10.
\end{itemize}
"[e]veryone thinks chiefly of his own, hardly ever of the public, interest." Individual self-interest is a powerful motivating force in a market system often manifested in terms of unconstrained greed. In his day, John Maynard Keynes noted:

The moral problem of our day is concerned with the love of money, with the habitual appeal to the money motive in nine-tenths of the activities of life, with the universal striving after individual economic security as the prime objects of endeavor, with the social appropriation of money as the measure of constructive success, and with the social appeal of the hoarding instinct as the foundation of the necessary provision for the family and for the future.\footnote{ARISTOTLE, Politics 1.}

Greed can incentivize a producer to externalize the full costs of production, fouling the atmosphere with emissions likely to harm us all in the long term. Thomas Wolfe perceived greed as the enemy of man:

I think the enemy is here before us . . . . I think the enemy is complete selfishness and compulsive greed. . . . I think the enemy is old as Time, and evil as Hell, and that he has been here with us from the beginning. I think he stole our Earth from us, destroyed our wealth, and ravaged and despoiled our land.\footnote{THOMAS WOLFE, YOU CAN’T GO HOME AGAIN (1940).}

Nevertheless, recent historical evidence indicates that social norms can be corrected to produce more socially desirable, communitarian results. For example, people have been successfully encouraged, through public campaigns, not to litter, not to expose others to passive cigarette smoke, and to recycle newspapers and aluminum. The latter effort is clearly a sustainable development approach, designed to reduce consumption of non-renewable resources (i.e., raw materials, landfills, and energy) and preserve forests. This evidence suggests that consumers and producers can be convinced that they have an individual ethical responsibility to act as stewards of the environment, dedicated to making sustainable choices with respect to personal movement, consumption, and production.\footnote{See National Round Table On the Environment and the Economy, Draft Sustainable Transportation Principles (Feb. 21, 1996) [hereinafter National Round Table].}

People can be urged to use public transport, bicycle and walk. When they must drive, they can be encouraged to team up with
other travelers in high occupancy vehicles [HOVs]. They can be urged to purchase smaller, more fuel efficient vehicles. They can also be encouraged to take a train rather than an aircraft for trips of about 300 miles or less. By doing this, we can move to an economy which relies less on fossil fuels and more on (natural gas and hydro-produced) electricity, solar energy, and hydrogen power. Transport management can be encouraged to "green" their firms, embracing the most environmentally desirable technology and operations. Already, management at Lufthansa and British Airways are embracing policies designed to portray themselves as "environmental friendly." When purchasing additional aircraft, Airborne Express chose the Boeing 767, pointing out that it had the lowest NOx emissions of any candidate aircraft, 17% less than the Airbus 300, and 48% less than the DC-10.\textsuperscript{82} Over time, and with dedicated effort, sustainability can become part of the fundamental ethos of collective corporate and national culture. European Union transport minister Neil Kinnock said:

[W]e want to commend those who have worked to sustain and improve public transport—and then spur them to greater efforts. And we want to cajole or embarrass those who have not made sufficient effort into changing their ways and heeding and emulating the best practice established in comparable areas.

We want to raise public and political awareness about the consequences of not developing workable answers to congestion. And, in the course of doing that, we want people everywhere to seek improvements that can ensure that the term "freedom of movement" retains some real meaning in the next two decades.

Governments at national and local level already understand that without a shift to public passenger transport, societies and economies will crawl more slowly and choke up more quickly. . . . Comprehensive and effective policies for securing change in transport patterns and use are therefore not optional extras. Together with education and training, they are the precondition of sustainable economic success.\textsuperscript{83}

The implicit thesis of laissez-faire is that unconstrained human greed will produce a better society. But beyond greed or primordial self-interest, there is a more fundamental principle rooted in the law of nature. As John Locke observed, "[t]he

\textsuperscript{81} See Jeziorski, supra note 10.

\textsuperscript{82} See Airborne Buys Boeing 767s, \textit{Air Cargo Report}, Jan. 18, 1996.

state of nature has a law of nature to govern it, which obliges everyone; and reason, which is that law, teaches all mankind who will but consult it, that, being all equal and independent, no one ought to harm another in his life, health, liberty, or possessions." \(^{84}\)

The concept of sustainable development first emerged in the 1980s out of the "green," or environmental movement, with a holistic, comprehensive, long-term view of man's impact on this planet. An early definition of sustainable development was "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." \(^{85}\) Thus, sustainable development focuses on conservation of the Earth's non-renewable resources and avoids pollution that threatens present and future generations of man and other life forms. Human activity should be pursued in the least damaging manner to ensure that the environment is left in a state as good as, or better than, we found it so that our grandchildren and their grandchildren will live decent lives.

In 1992, the U.N. Conference on Environment and Development, the 'Earth Summit,' met in Rio de Janeiro and embraced sustainable development as a global mission. In Rio, 180 nations signed an agreement to roll back greenhouse gas emissions to 1990 levels by the year 2000. In 1993, the European Union's Fifth Environmental Action Programme (subtitled "Towards Sustainability") identified transport as one of five target sectors. It concluded that present trends in air and road transport are causing significant environmental costs in terms of congestion, pollution, opportunity costs, health damages, and danger to life. \(^{86}\) In 1998, in Kyoto, the industrialized nations agreed to reduce greenhouse gas emissions below 1990 levels by 2008-2012. \(^{87}\)

Sustainable transportation has been defined as "[t]ransportation that does not endanger public health or ecosystems and meets mobility needs consistent with (a) use of renewable resources at below their rates of regeneration, and (b) use of non-renewable resources at below the rates of development of

\(^{84}\) John Locke, Two Treatises On Government, Ch. 2 (1690).

\(^{85}\) OECD, supra note 47.


\(^{87}\) See NASA Environmental Compatibility Research Workshop, Where Do We Go From Kyoto?, May 19, 1998.
renewable substitutes. Greene and Wegener added a third requirement that the rates of pollution emission not exceed the assimilative capacity of the environment. Yet it is clear that, as currently practiced, air transport fails to satisfy the first two conditions and may also fail the third.

However, sustainability does not require that all transport come to a halt. It attempts to promote a transportation system that is least offensive in terms of consuming the Earth’s resources and polluting of the Earth’s environment. According to one source, “[t]ransportation needs must be met without generating emissions that threaten public health, global climate, biological diversity or the integrity of essential ecological processes.”

National policy can be directed toward breaking the link between economic growth and energy consumption, giving priority to the development and consumption of renewable energy resources. The essential thesis of sustainability is aversion to harming the habitat of one’s fellow man or beast, as well as future generations. Thoughtful, moral people will find the essential wisdom and virtue in such a common objective compelling and will embrace it as their own. Educating the public is essential to implement the remedies which follow; otherwise they will fail without widespread public support.

IV. TECHNOLOGICAL IMPROVEMENTS

Second, mankind can, should, and must improve technology. Regulation becomes one means of stimulating development and introducing cleaner technologies. John Stuart Mill emphasized regulation as a means of achieving social good: “[t]rade is a social act. Whoever undertakes to sell any description of goods to the public, does what affects the interests of other persons, and of society in general; and thus his conduct, in principle, comes within the jurisdiction of society . . . .”

Regulatory standards have already resulted in marked improvements in fuel efficiency and safety, as well as a reduction in

88 OECD, supra note 47, at 7.
90 See Goetz & Graham, supra note 86.
91 National Round Table, supra note 80.
93 JOHN STUART MILL, ON LIBERTY, CH. V (1859).
environmental pollution in automobiles. Aircraft engine manufacturers are making significant progress in reducing noise and emissions. Aircraft are already 70% more fuel-efficient than they were four decades ago, and are predicted to be 40% more fuel efficient by 2050. Some nations are urging the International Civil Aviation Organization [ICAO] to require jet engine emissions from new aircraft to be reduced by as much as 40%. In 1993, ICAO reduced aircraft standards for NOx emissions under Annex 16 of the Chicago Convention by 20%. In 1999, ICAO announced that it will again lower the standards by 16% after 2003. The European Union has proposed an environmental directive calling for a 36% reduction in NOx emissions from jet engines.

Aircraft manufacturers have also dedicated themselves to curtailing emissions by developing energy conservation strategies and designing new engine combustion chambers. For example, smoke has been virtually eliminated from jet engines as opposed to the first smoky and noisy Pan Am Boeing 707 which landed in Europe on October 26, 1959. Peter Ruffles of Rolls-Royce argues for reduction of the sulfur content in aviation fuel, designing jet engines to produce less sulfur trioxide, or banning aircraft from flying in the stratosphere. The CFM56-5B turbofan engine, equipped with a double-annuar combustor, reduces nitrogen oxide emissions up to 50% over other engines in its thrust class. Some believe that significant progress can be made by developing a staged combustor—a system of burners that allow controlled fuel-injection and burning processes to reduce the period when combustion temperatures reach those in which nitrogen oxide is formed. It is estimated that addi-

94 See Martin Noble, How To Achieve Sustainable Growth, INTERAVIA BUS. & TECH. 23 (1999).
98 See Noble, supra note 16, at 19.
tional developments in combustor design may reduce emissions by 40% to 50% by the year 2010.\textsuperscript{102}

The problem is that jet engine technologies can work at cross-purposes—we want engines that enhance safety and efficiency, while reducing noise, fuel consumption, and emissions. However, improvements which reduce emissions can often increase noise.\textsuperscript{103} Conversely, improved bypass engines burn less fuel and produce less carbon dioxide and volatile organic compounds while increasing nitrogen oxide emissions, thereby contributing to the greenhouse effect and acid rain.\textsuperscript{104} Engines that power efficient new large aircraft emit more NOx as bypass ratios increase.\textsuperscript{105} A hotter jet engine burn reduces noise and improves fuel consumption, but increases emissions. Moreover, under existing technology, engine manufacturers cannot reduce NOx without increasing CO\textsubscript{2}.

Air transport is growing at a spectacular rate, potentially faster than the likely offsetting technological benefits of emissions reduction.\textsuperscript{106} Thus, barring the creation of a hydrogen (or some equivalent non-pollutive fueled) engine, growth in air traffic may outpace incremental improvements in aircraft engine technology, leading to a net increase in global pollution from this source. Even if emission levels remain static, it is unclear whether air transport will survive sustainability analysis. On this point, a Canadian government report concluded:

[T]he demand for aviation is expected to continue to grow in the long term, perhaps even doubling over the next 10 to 15 years. Such high rates of growth are likely to nullify many past achievements in reducing environmental impacts. Although the development of new technologies is progressing rapidly, it is not expected to be sufficient to stabilize the environmental burden caused by air transport, let alone reduce it. The problem created by the increasing burden of air transport will become relatively worse because other major sources of pollution are expected to be able to decrease their burdens significantly. As a result, the share of environmental deterioration directly attributable to aviation will increase. Therefore, the aviation industry will show a trend opposite to that of other sources . . . . Moreover, air trans-

\begin{itemize}
  \item \textsuperscript{102} See Transport Canada, \textit{supra} note 41, at 27-28.
  \item \textsuperscript{103} See Page, \textit{supra} note 95, at 39.
  \item \textsuperscript{104} See Paul Page, \textit{Airlines, Environment Regulators In Talks Over Plan To Change Jet Engine Oversight}, J. OF COM. 19 (1995); see also Noble, \textit{supra} note 16, at 19.
  \item \textsuperscript{105} See Rolls-Royce Seeks Study Of Cruise Altitude NOx Emissions, AVIATION DAILY, Oct. 18, 1994, at 91.
  \item \textsuperscript{106} See Noble, \textit{supra} note 94, at 23.
\end{itemize}
port is the only source that emits pollutants directly into the upper atmosphere, where pollution is global in its consequences.\textsuperscript{107}

But of course, predicting the future is a fool’s game. It may be that some combination of unforeseen technological developments may arrest the emissions problem. One must remember Thomas Malthus’ prediction that population growth, increasing geometrically, would outstrip the productive capacity of agriculture, which was increasing only arithmetically; eventually starvation and disease would check population growth, and mankind would be reduced to subsistence. When Malthus made his prediction in 1798, approximately one billion people inhabited the Earth. Today, nearly six billion people live on the planet, while the percentage of starving humans has declined. Malthus failed to anticipate that technological improvements in methods of agricultural production, pesticides, fertilizers, irrigation, and genetically engineered disease- and drought-resistant strains of seeds would combine to expand the carrying capacity of the Earth to support a growing human population. In fact, the very failure of natural forces to arrest population growth is in fact a profound catalyst for the problems described above—global warming and ozone depletion. According to Professor Robert Hardaway:

With each net addition to the human race the amount of land, water, natural resources, and air per human being is proportionately reduced. Thus more intensive use of each resource is required to maintain living standards and prevent or delay Malthusian consequences. Technology can, as it has in the past, enable mankind to make more intensive use of resources. At the margin, technology can even reduce the effect of population on the environment. But the danger signs are becoming increasingly apparent: the holes in the ozone layer, acid rain, the unsustainable depletion of water tables, and the loss of tropical forests.\textsuperscript{108}

The more difficult question is: do we put all our hope in the ability of science to control emissions via technology? Do we have to wait to act until science proves the existence of a cause-and-effect relationship between engine emissions on the one hand, and ozone depletion, global warming and/or acid rain on the other beyond a reasonable doubt (recall that tobacco companies continue to insist there is no correlation between smok-

\textsuperscript{107} Transport Canada, \textit{supra} note 41, at 57-58.

ing cigarettes and lung cancer)? If we wait, do we risk passing the point of no return so that future, more draconian efforts to arrest global warming and ozone layer depletion are "too little, too late," leaving the planet in worse shape than we found it? What excuse do we give our grandchildren when they ask why we did nothing? Were we oblivious to the risk, or were we simply apathetic?

A proactive policy would encourage both technological solutions to harmful emissions and programs to transport people and commodities in the mode most appropriate to achieve sustainability. We should insist that technology solve as much of the problem as it can, while recognizing that it may not be able to do it all. Government and industry must develop a cooperative and integrated approach to transportation infrastructure planning and development.\(^{109}\) This requires providing consumers with seamless multi-modal and intermodal transport alternatives so that they can choose the most sustainable mode. Airports should be linked to rail, transit, and bus systems.\(^{110}\) It also requires re-thinking urban sprawl along highway corridors, adding more asphalt to an increasingly constipated highway system, and paving more airport runways.

The modal choice consumers make depends upon price, availability, technical suitability, and quality of service.\(^{111}\) If a less environmentally offensive choice is unavailable, consumers cannot avail themselves of it. Given the fuel and environmental advantages of electrified high-speed intercity rail, rail should be built in dense corridors. Energy efficient and environmentally sound forms of public transport should be available to facilitate public mobility and expand the range of community travel choices. Although the initial economic costs of electrified rail systems are high, Europe and Japan have proven they are not prohibitive, and their long-term economic and social savings are significant.

New navigation technologies, such as global positioning satellite systems, may allow more efficient use of congested airspace, reducing fuel consumption and environmental degradation. Improvements in operational procedures and optimization of flight paths to reduce the noise footprints of aircraft on popula-

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109 See National Round Table, supra note 80.
tion centers will also reduce noise. Noise might be reduced, for example, by reducing climb rates below the prescribed engine power ratio, by lowering flap settings on the approach, dropping landing gear later, and reducing the use of reverse thrust for braking.

Further, some air transportation will be replaced by technological breakthroughs in telecommunications. Intracorporate business transportation has already declined as communications technologies have improved. Some insist that telecommunications is the only form of sustainable transportation. However, it is doubtful that "virtual travel" can replace the need for personal business contact, and the innate human motivation to travel. As personal income rises across the planet, more and more people will want to visit friends and relatives in remote locations, and "see the world." While deprivation of the individual freedom of travel would be an unsuccessful (and undesirable) endeavor, the more realistic alternative is simply to funnel human beings into less destructive means, modes, and types of transport to get them to their destinations. Technology will play an indispensable role in tweaking each mode to make it less environmentally offensive.

Emission controls in the field of automobile production have demonstrated that regulatory standards can serve as a catalyst to motivate industry to develop technologies designed to significantly curtail pollution. Recall that Detroit insisted that EPA emission standards were unattainable until Japanese cars exceeded them and arrived in U.S. showrooms. Critics of more stringent emission standards for jet engines point out that "the tougher standards would quickly be used to drive out older aircraft, driving down the values of existing fleets and sending costs to shippers and passengers up." Others insist "[a]ll-cargo services as we know them today will probably not survive . . . cargo rates will increase significantly, and traffic and service will decline." Increased taxes and pricing measures, which attempt to achieve fair and efficient pricing in transport, are objected to as having "very damaging effects for business, by raising the cost of transporting goods." Although higher consumer costs are

113 See Noble, supra note 16, at 19.
114 Page, supra note 95, at 39.
115 Page, supra note 104, at 19.
116 TRANSPORT GREEN PAPER, supra note 111.
an anathema both to the public and to market economists, as we shall see, higher fuel and transport prices may be a necessary evil on the path to achieving sustainability.

V. AIRPORT SITING

A. ENVIRONMENTAL FEASIBILITY

Siting an airport to reduce noise while enhancing passenger convenience and surface transport efficiency is a challenging endeavor.

Strict environmental laws have been promulgated in many developed nations of the world. Moreover, in democratic nations, political acceptability of airport expansion is essential if the project is to move forward. Both factors converge to make environmental feasibility (including mitigation of adverse environmental impacts) of an airport project as important as economic or engineering feasibility.\(^\text{117}\)

Early airports were built away from the cities they served, on inexpensive land, and where a minimum number of obstructions allowed maximum flexibility and safety in flight operations. Small aircraft flying infrequently created minimal noise reasons. But the growth of air transport in terms of size and range of aircraft, thrust of engines, and frequency of takeoffs and landings, coupled with the expansion of cities to engulf airports, has caused the airport’s needs for land and the aircraft’s bombardment of noise to collide with the interests of surrounding landowners. Edward Gervais, chief of airport planning at Boeing explained that, “[m]ost current airports have grown up from the DC-3 days, and now they’re surrounded by residences and businesses.”\(^\text{118}\) Airports are therefore challenged by the need to acquire sufficient airspace for access and sufficient land for ground operations, all within a potentially hostile political environment.\(^\text{119}\) The fact that aviation is the fastest growing mode of transport exacerbates the problem. That has raised the profile of environmental issues such as noise, land use, air and water pollution, climate change, and energy efficiency.\(^\text{120}\)

The decision to select a venue and build a new airport result from the decision that the existing airport cannot adequately

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\(^{117}\) See Federal Aviation Administration, AIRPORT MASTER PLANS 47 (1985) [hereinafter FAA].

\(^{118}\) Nisid Hajari, A Walk In The Clouds, TIME, June 22, 1998.

\(^{119}\) See generally HORONJEFF & McKELVEY, supra note 31, at 181-83.

\(^{120}\) See Stenzel & Truhl, supra note 19.
accommodate anticipated aviation demand. In determining whether a new airport should be built and assessing which of the potential sites should be chosen, the U.S. Federal Aviation Administration provides the following criteria:

The principal considerations for comparison of new sites to the existing airport will be airspace and airspace capacity, airfield and ground access costs (including value of time), aircraft operational costs, environmental impacts, financial feasibility, and long-term viability. Considerations also must be given to alternative roles for the existing airport and alternative transfer times to a hypothetical new airport.

We begin our review of the issue with the fundamental question of finding land sufficient in size and suitable in location for airport development.

B. Land

Airports consume vast quantities of land. Growing airports have a seemingly insatiable thirst for more land. Not only do airports require land for runways (typically about two miles long each), terminals (some of the largest public buildings ever), concourses, hangars, cargo facilities, kitchens, parking and highways, they restrict land use in their flight paths. For safety’s sake, approaches must be clear of office towers, water towers, and smokestacks. For sanity’s sake, the approaches must be clear of residential housing. Few cities have available, or reasonably priced, land within reasonable proximity of their central business districts for new airports. Airports that are built in an urban area frequently find themselves hemmed in by surrounding development.

As an example of an airport’s insatiable thirst for land, witness Amsterdam’s Schiphol Airport, hub to KLM Royal Dutch Airlines. In 1920, the airport consisted of a single field in the Harlem-mermeer polder. By 1945, it consisted of a couple of runways in a small corner of the polder. By 1967, the central buildings and four runways had consumed about a quarter of the polder. It began another expansion project in 1994 to grow

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121 See FAA, supra note 117, at 41.
122 Id.
123 See Mark Bourman, Cities of the Plane, BUILDING FOR AIR TRAVEL 180 (John Zukowsky ed. 1995).
to five runways and an infrastructure of roadways and railways by 2005.124

By the mid-1990s, as the Dutch government considered privatization of its 75.8% stake in Schiphol, it began to address the question of what to do about the government-imposed capacity limitations of 44 million passengers per year (Schiphol handled 27.8 million in 1996), 3.3 million annual tons of cargo (it handled 1.1 million tons in 1996), and day and night noise restrictions. Three alternatives were identified:

**An Overflow Model:** Combine Schiphol’s current runway system with a nearby overflow airport that would handle charters, cargo, and low-cost carriers.

**A Tandem Model:** Schiphol would handle only origination-and-destination passengers, while connecting traffic would be handled by an airport built on a man-made island in the North Sea near Lelystad.

**A Remote Runway Model:** Schiphol handles origin-and-destination passengers and cargo for all of the Netherlands, while connecting traffic operates out of a nearby airport on a man-made island connected by a high-speed people mover.125

In selecting a potential site for a new airport, the number of runways and size of terminal and other buildings should be estimated to project an overall contour of the airport, which will be useful for initial site screening purposes.126 Prudent airport planners acquire more land than is necessary to satiate current demand, allowing room for future expansion and restricting use of surrounding real estate via zoning and covenant restrictions. Ideally, the airport acquires control (if not outright ownership) of all land use falling within the airport’s 65 Ldn contours, leaving such land unoccupied, or devoting it to aviation-related activities, such as long-term parking, a rental car campus, or air cargo facilities, and such additional land as may be necessary for future airport expansion.127 So as to avoid the inflationary impact of land speculation and arbitrage, once a site has been se-

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125 Dutch Think About Selling Schiphol Interest, WORLD AIRPORT WEEK, July 15, 1997, at 3.
127 See *id.* at 32.
lected, land should be purchased expeditiously. Table 1 reveals the size of several of the world’s new airports.

Table 1
Relative Size of Major Airport

<table>
<thead>
<tr>
<th>AIRPORT</th>
<th>HECTARES</th>
<th>ACRES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macau International</td>
<td>190</td>
<td>469</td>
</tr>
<tr>
<td>Oslo Gardermoen</td>
<td>270</td>
<td>667</td>
</tr>
<tr>
<td>Osaka Itami</td>
<td>317</td>
<td>783</td>
</tr>
<tr>
<td>New York LaGuardia</td>
<td>275</td>
<td>680</td>
</tr>
<tr>
<td>Osaka Kansai</td>
<td>510</td>
<td>1,262</td>
</tr>
<tr>
<td>Paris Orly</td>
<td>629</td>
<td>1,552</td>
</tr>
<tr>
<td>Tokyo Narita</td>
<td>680</td>
<td>1,680</td>
</tr>
<tr>
<td>Tokyo Haneda</td>
<td>894</td>
<td>2,208</td>
</tr>
<tr>
<td>Shanghai Pudong</td>
<td>949</td>
<td>2,344</td>
</tr>
<tr>
<td>Tokyo Narita (completion of Phase 2)</td>
<td>1,065</td>
<td>2,631</td>
</tr>
<tr>
<td>Tokyo Haneda (completion of Phase 2)</td>
<td>1,100</td>
<td>2,717</td>
</tr>
<tr>
<td>Seoul Incheon</td>
<td>1,174</td>
<td>2,900</td>
</tr>
<tr>
<td>New York Kennedy</td>
<td>1,195</td>
<td>2,952</td>
</tr>
<tr>
<td>London Heathrow</td>
<td>1,197</td>
<td>2,957</td>
</tr>
<tr>
<td>Brussels Airport</td>
<td>1,245</td>
<td>3,075</td>
</tr>
<tr>
<td>Hong Kong International</td>
<td>1,248</td>
<td>3,084</td>
</tr>
<tr>
<td>Munich Franz Josef Strauss</td>
<td>1,387</td>
<td>3,427</td>
</tr>
<tr>
<td>Guangzhou New International</td>
<td>1,453</td>
<td>3,589</td>
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<tr>
<td>Singapore Changi</td>
<td>1,663</td>
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<tr>
<td>Amsterdam Schiphol</td>
<td>1,750</td>
<td>4,323</td>
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<tr>
<td>Jakarta</td>
<td>1,800</td>
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<tr>
<td>Kuala Lumpur International</td>
<td>1,850</td>
<td>4,570</td>
</tr>
<tr>
<td>Salt Lake City International</td>
<td>2,884</td>
<td>7,123</td>
</tr>
<tr>
<td>Paris Charles de Gaulle</td>
<td>3,104</td>
<td>7,667</td>
</tr>
<tr>
<td>Shanghai Pudong (full build out)</td>
<td>3,198</td>
<td>7,899</td>
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<tr>
<td>Second Bangkok International</td>
<td>3,200</td>
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<tr>
<td>Seoul Incheon (full build out)</td>
<td>4,743</td>
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<tr>
<td>Seoul Incheon International</td>
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<tr>
<td>Dallas/Ft. Worth</td>
<td>7,203</td>
<td>17,791</td>
</tr>
<tr>
<td>Kuala Lumpur International (full build out)</td>
<td>10,121</td>
<td>24,998</td>
</tr>
<tr>
<td>Denver International</td>
<td>13,760</td>
<td>33,987</td>
</tr>
</tbody>
</table>

The amount of land an airport will require is a function of: (1) the performance characteristics and size of aircraft that will use it; (2) the expected volume of traffic; (3) meteorological conditions (including average temperatures and prevailing wind speeds and direction), and (4) the elevation of the site (with higher-elevation airports like those at Denver and Johannesburg requiring longer runways than sea-level airports).\(^{129}\)

It is important to reserve land for future airport development. The government of Thailand set aside ample land twenty-five years ago near Bangkok for future airport development. Munich attempted to set aside seventeen square miles, which the German courts unfortunately whittled down to 5.4 square miles. Denver can also had the foresight to set aside an enormous land mass (fifty-three square miles) for future expansion of DIA.

Airports should be located so as to minimize adverse noise impacts. Of course, this lesson is closely related to the preceding one. Several Asian airports (e.g., Kansai, Macau, Hong Kong and Inchon) have been built on the ocean, not only because of the dearth of suitable level land, but because of the noise impact on dense population clusters. Landfill on seabed is among the world’s most expensive and complicated engineering feats. But once constructed, twenty-four-hour-a-day takeoffs and landings may be possible.

In selecting among alternative sites for a new airport, planners should engage in a cost-benefit analysis of each potential site across three dimensions—operational, social and cost. With respect to the operational characteristics of each site, issues such as land availability, airspace availability, the effect of any restrictions (e.g., topographical, meteorological) on operational efficiency, and both short- and long-term potential capacity rise to prominence. With respect to the social dimensions, the dominant considerations are proximity to passenger and cargo demand centers, adequacy of surface transportation access to the CBD and suburban residential areas, potential noise problems, and current land use and the need for zoning control measures in areas surrounding the airport. Finally, each will have differing economic characteristics, requiring a cost-benefit analysis.\(^{130}\)

\(^{129}\) See Horonjeff & McKelvey, supra note 31, at 199-200.

\(^{130}\) See ICAO, supra note 29, at 1-44.
VI. LOCATION

The three most important considerations for real estate development are location, location, and location. The same is clearly true for airports as well.\textsuperscript{131} The utility of an airport is largely influenced by its proximity to the business and residential areas of the metropolitan area it will serve. Although surface transport modes typically serve a city’s downtown, airports are placed on the periphery of a metropolitan area, both because of the enormous amount of land an air field requires, and the environmental impact of noise from aircraft.

Airport site selection requires an in-depth analysis of alternative locations, considering features such as physical characteristics of the site, the nature of surrounding land use development and flight path obstructions, atmospheric conditions, land availability and its cost, ground access, the compatibility of surrounding air space, and the site’s proximity to aeronautical demand.\textsuperscript{132} Each potential site should be systematically evaluated, deleting those with clear deficiencies in areas of construction cost, topography, airspace, ground access, and environmental impacts.\textsuperscript{133}

In assessing the physical characteristics of a site, topography is important, because runways need to be horizontal and flight paths need to be unimpeded by hills or mountains. Earth and rock may need to be blasted and removed if a hilly area is selected for the airport site. Drainage is also important, and a well-drained site is preferable to one that gathers water.\textsuperscript{134} Soil types also must be examined, because some expansive soils have a tendency to buckle, causing runways and buildings to crack.

Unobstructed airspace is also important to the safe and efficient operation of an airport. Therefore, new airports should not be located in a venue likely to interfere with the flight approaches of aircraft using other airports. High terrain, trees, and structures (e.g., skyscrapers, radio and television towers,}

\textsuperscript{131} See Dempsey, Goetz & Szylowicz, supra note 110, at 229.
\textsuperscript{132} See Spensley, supra note 128, at 72; Horonjeff & McKelvey, supra note 31, at 193.
\textsuperscript{133} See FAA, supra note 117, at 42. Specifically, the following criteria should be considered: Operational Capability; Capacity Potential; Ground Access; Development Costs; Environmental Consequences; Socio-Economic Implications; and Consistency with Areawide Planning. See id. at 44.
\textsuperscript{134} See ICAO, supra note 29, at I-42.
smokestacks) should also be avoided.\textsuperscript{135} An example of an airport with difficult approaches is Toncontín International Airport in Tegucigalpa, Honduras, where an aircraft must land between camel back mountains on one side and hillside dwellings so close that aircraft passengers can see people eating inside their homes. Further, the landing strip has no radar, runway lights, or instrument landing system, and has a deep ravine at the end of the runway.\textsuperscript{136} Another airport where the aircraft approach passes uncomfortably close to buildings is San Diego’s Lindburgh Field, where passengers can look out their windows and peer into office buildings and watch secretaries typing away at computers.

Prevailing winds may cause industrial smoke to limit visibility, and also should be avoided. Areas that fall within the migratory patterns or nesting sites of birds, particularly large birds such as swans and geese, should be avoided. Meteorological data may reveal that certain areas are susceptible to high winds, turbulence, fog, or high rainfall, which obstruct visibility or create turbulence, and these should be avoided too.\textsuperscript{137} Fog has a tendency to settle in lowlands where there is little wind.\textsuperscript{138}

Airport siting decisions have two primary, sometimes conflicting, dimensions — avoiding blasting land inhabitants in the flight paths with intolerable levels of noise, and finding suitable undeveloped land within reasonable distance of the central business district [CBD] of the city it will serve so that its inhabitants can conveniently use it. With regard to proximity to the CBD, and access to the new airport by the passengers who will use it, to facilitate public transport, London’s Gatwick airport was placed near existing rail corridors, while Frankfurt Rhine-Main was placed near the intersection of two Autobahn corridors.\textsuperscript{139}

Paradoxically, airports need to be located near population centers and surface transportation corridors so that people (including passengers, shippers of air freight, airline and airport employees) can use them conveniently. Yet the runways should be aligned so the flight paths do not cross over heavily populated areas. This requires compromise between these two con-

\textsuperscript{135} See FAA, supra note 117, at 31.
\textsuperscript{136} See David Beard, Ken Kaye & E.Q. Torriero, Flying the Dangerous Skies, DENVER POST, Jan. 17, 1998, at 17A.
\textsuperscript{137} See ICAO, supra note 29, at 1-40.
\textsuperscript{138} See Horonjeff & McKelvey, supra note 31, at 194.
\textsuperscript{139} Both were built in 1936. See John Zukowsky, Introduction, BUILDING FOR AIR TRAVEL 14 (John Zukowsky ed. 1996).
flicting principles. Building an airport too far from an urban area defeats the objective of reducing door-to-door transit times and increases pollution by surface transport modes. Therefore, it is important to obtain sufficient land at the runway ends, or to regulate the land use under the flight paths via zoning, so as to mitigate adverse noise impacts on the human population. It is also important to obtain sufficient land to satiate future capacity needs. "Land banking" can reduce long-term costs while minimizing future adverse environmental impacts.

Noise is a more serious political problem in developed vis-à-vis undeveloped countries. Airports and their flight paths should be located away from residential areas and schools, wherever possible. If possible, a buffer zone around the airport should be created to minimize conflict. Zoning of surrounding real estate to avoid such future uses should be imposed. Delineation of noise contours should identify which areas are most likely to be blasted by noise, and these should be zoned for light industrial, commercial, recreational or agricultural activity (so long as they do not attract birds) rather than residential housing.

Multi-generational efforts to deal with crowding and congestion at Chicago are instructive as to the serious problems posed by location, and the tension between centrality and periphery. Established in 1922 (and rebuilt in 1927) outside the developed area of the city, Chicago's Municipal Airport (later renamed Midway Airport after the Pacific naval battlefield of World War II) soon found itself hemmed in by residential and commercial development and unable to expand. A 1941 study reviewed several alternative locations of a new airport that would be close to the Chicago CBD, including a manmade island or polder in Lake Michigan, in the warehouse district on Chicago's south side, near the west side slums, or on stilts above a rail yard. A 1946 study recommended an area two miles south of the Chicago Loop, which would have required clearing of 242,000 blighted or near-blighted dwelling units. Mark Bourman summarized the problems with these alternative sites, saying, "the virtues of centrality were also its undoing: being close to industrial districts meant coping with smokestacks and smog; being close to the commercial district meant coping with high land

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140 See ICAO, supra note 29, at I-41, I-43.
141 See HORONJEFF & McKELVEY, supra note 31, at 199.
142 See id. at 193-94.
143 See Robert Bruegmann, Airport City, BUILDING FOR AIR TRAVEL 198 (John Zukowsky, ed. 1995).
costs and tall buildings; being in Lake Michigan near the Loop meant dealing with fog, spray, and trick winds; and being close to any site of economic value meant paying exorbitant costs for land acquisition." Ultimately, Chicago built O'Hare International Airport north of the city in 1963.

Contemporary efforts to build a third airport at Chicago, or a second airport at Minneapolis, have been thwarted by airlines not wanting to face new competition. Other cities have also failed in their efforts to build new airports, including New York (which wanted to build a fourth airport in the Great Swamp, New Jersey) and London. In order to find adequate land at reasonable prices and diminish political not-in-my-back-yard [NIMBY] opposition, newer airports have been built at greater and greater distances from the CBD (See Table 2). But growing suburban sprawl creates the same problems for peripheral locations as do central locations—difficulty in land acquisition, high costs, and political (NIMBY) opposition. Paradoxically, population increases create more demand for air transportation service.

### Table 2

**Airport Distances from Central Business Districts**

<table>
<thead>
<tr>
<th>AIRPORT</th>
<th>DISTANCE FROM CBD (in miles)</th>
<th>DISTANCE FROM CBD (in kilometers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hong Kong Kai Tak (1929)</td>
<td>3</td>
<td>4.8</td>
</tr>
<tr>
<td>Geneva Cointrin</td>
<td>3</td>
<td>4.8</td>
</tr>
<tr>
<td>Brussels Melsbroek</td>
<td>4</td>
<td>6.3</td>
</tr>
<tr>
<td>Osaka Kansai (1994)</td>
<td>4</td>
<td>6.3</td>
</tr>
<tr>
<td>Frankfurt Rhine/Main (1936)</td>
<td>5</td>
<td>8.1</td>
</tr>
<tr>
<td>Salt Lake City International</td>
<td>5</td>
<td>8.1</td>
</tr>
<tr>
<td>Oslo Fornebu</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Detroit City</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Athens Hellinikon</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Denver Stapleton (1929)</td>
<td>7</td>
<td>11.3</td>
</tr>
<tr>
<td>Vancouver International (1930s)</td>
<td>7</td>
<td>11.3</td>
</tr>
<tr>
<td>Munich Riem (1939)</td>
<td>7</td>
<td>11.3</td>
</tr>
<tr>
<td>Manila Ninoy Aquino</td>
<td>7</td>
<td>12</td>
</tr>
</tbody>
</table>

144 Bourman, *supra* note 123, at 181.
145 See *id.* at 183.
146 See *id.*
<table>
<thead>
<tr>
<th>AIRPORT</th>
<th>DISTANCE FROM CBD (in miles)</th>
<th>DISTANCE FROM CBD (in kilometers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York LaGuardia (1939)</td>
<td>8</td>
<td>12.9</td>
</tr>
<tr>
<td>Austin Bergstrom</td>
<td>8</td>
<td>12.9</td>
</tr>
<tr>
<td>Zurich Kloten</td>
<td>8</td>
<td>12.9</td>
</tr>
<tr>
<td>Atlanta Hartsfield (1925)</td>
<td>9</td>
<td>14.5</td>
</tr>
<tr>
<td>Paris Le Bourget</td>
<td>9</td>
<td>14.5</td>
</tr>
<tr>
<td>Paris Orly (1961)</td>
<td>9</td>
<td>14.5</td>
</tr>
<tr>
<td>Chicago Midway</td>
<td>9</td>
<td>14.5</td>
</tr>
<tr>
<td>Paris Charles de Gaulle (1974)</td>
<td>12</td>
<td>19.4</td>
</tr>
<tr>
<td>London Croydon</td>
<td>12</td>
<td>19.4</td>
</tr>
<tr>
<td>London Heathrow (1946)</td>
<td>15</td>
<td>24.2</td>
</tr>
<tr>
<td>Chicago O'Hare (1955)</td>
<td>15</td>
<td>24.2</td>
</tr>
<tr>
<td>Hong Kong International Airport (1998)</td>
<td>15</td>
<td>24.2</td>
</tr>
<tr>
<td>Munich Franz Josef Strauss (1992)</td>
<td>16</td>
<td>25.8</td>
</tr>
<tr>
<td>Toronto International Malton (1937)</td>
<td>17</td>
<td>27.4</td>
</tr>
<tr>
<td>Kansas City International (1968-72)</td>
<td>17</td>
<td>27.4</td>
</tr>
<tr>
<td>Dallas/Ft. Worth International (1965-73)</td>
<td>17</td>
<td>27.4</td>
</tr>
<tr>
<td>Detroit Metropolitan</td>
<td>19</td>
<td>30.8</td>
</tr>
<tr>
<td>Los Angeles International (1930)</td>
<td>20</td>
<td>32.5</td>
</tr>
<tr>
<td>Houston Intercontinental (1967)</td>
<td>22</td>
<td>36</td>
</tr>
<tr>
<td>Bangkok Nong Ngu Hao (2003)</td>
<td>23</td>
<td>37</td>
</tr>
<tr>
<td>Hong Kong International (1998)</td>
<td>23</td>
<td>37</td>
</tr>
<tr>
<td>Denver International (1994)</td>
<td>24</td>
<td>38.7</td>
</tr>
<tr>
<td>Washington Dulles (1958-62)</td>
<td>27</td>
<td>43.5</td>
</tr>
<tr>
<td>London Gatwick</td>
<td>27</td>
<td>43.5</td>
</tr>
<tr>
<td>Stockholm Arlanda (1962)</td>
<td>28</td>
<td>45</td>
</tr>
<tr>
<td>Oslo Gardermoen (1998)</td>
<td>29</td>
<td>47</td>
</tr>
<tr>
<td>Detroit Willow Run</td>
<td>31</td>
<td>50.2</td>
</tr>
<tr>
<td>Buenos Aires International</td>
<td>32</td>
<td>51.6</td>
</tr>
<tr>
<td>Seoul Yongjong (2000)</td>
<td>32</td>
<td>51.6</td>
</tr>
<tr>
<td>Buenos Aires Ezeiza</td>
<td>32</td>
<td>51.6</td>
</tr>
<tr>
<td>Montreal Mirabel (1975)</td>
<td>40</td>
<td>64.5</td>
</tr>
<tr>
<td>Tokyo Narita (1978)</td>
<td>41</td>
<td>66.1</td>
</tr>
<tr>
<td>Kuala Lumpur International (1998)</td>
<td>41</td>
<td>66.1</td>
</tr>
<tr>
<td>Los Angeles Palmdale (proposed, but abandoned)</td>
<td>45</td>
<td>72.5</td>
</tr>
<tr>
<td>Chicago Kankakee (proposed, but abandoned)</td>
<td>50</td>
<td>81</td>
</tr>
</tbody>
</table>
Some airports have resolved the land and noise issues by filling coastal land in the ocean, albeit at enormous expense. Examples include Osaka's Kansai International Airport, Macau International Airport, Hong Kong International Airport at Chek Lap Kok, and Seoul's Inchon International Airport. A flight path over the ocean bombards no homes with noise and requires no displacement of existing commercial, industrial, or residential buildings.

Other airports have attempted to buffer noise and improve the visionary aesthetics by planting large volumes of trees around the airport perimeter. Washington's Dulles International Airport planted 1.5 million trees, for example. Milan's Malpensa 2000 project envisages planting a million trees and erecting other noise barriers, as well as undertaking other environmentally friendly projects, such as dedicated take-off and landing runways to avoid overflying the most densely populated areas, installing an underground pipeline directly from a refinery to reduce truck traffic on the highways and the aprons, and assuring that the water table under the airport remains pollution free. At Munich, more than a million shrubs and about 5,000 large trees were planted. Trees not only muffle noise, but also offer an aesthetically pleasing visual horizon to an airport. In selecting the types of trees to be planted, factors to be taken into account include which trees will most likely reduce noise year-round, the cost of the trees and the cost of maintaining them, as well as selecting the types of trees and shrubs unlikely to attract birds which may pose a flight hazard.

VII. ENVIRONMENTAL LAW & REGULATION—SUCH AS IT IS

This section reviews the impact of legislation and regulation upon airport siting and aircraft technology. The ensuing sections examine future legislative and regulatory actions.

A. THE U.S. STATUTORY REGIME

The United States has promulgated an extensive body of legislation dealing with aircraft noise and emissions that have a profound influence on airport planning, design and operation, and on aircraft engine noise. Environmental factors must be

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147 See Aeroporti di Milano, For You (1997).
148 See Flughafen Munich, Environmental Protection At Munich Airport 49 (1996).
considered carefully in the expansion of an existing airport or the development of a new one. Studies should be made of the impact of airport construction and operation on air and water quality, noise levels, industrial waste, and wildlife, and efforts made to mitigate the adverse environmental consequences wherever possible.\textsuperscript{149}

The most common environmental problem airports and aircraft pose is noise. Noise and other environmental impacts influence siting decisions. As noted above, land acquisition, runway realignment, or changing a runway extension from one end to the other can minimize adverse noise impacts.\textsuperscript{150}

The Clean Air Act of 1963 was Congress' first effort to address the problem of air pollution. Congress first dealt with aircraft noise in the Aircraft Noise Abatement Act of 1968,\textsuperscript{151} which authorized the FAA to set noise control and abatement standards for aircraft.

Comprehensive federal environmental regulation began with the National Environmental Policy Act of 1969\textsuperscript{152} (signed into law on January 1, 1970), which required the preparation of an environmental assessment [EA] and an environmental impact statement [EIS], the latter for any "major federal action significantly affecting the quality of the human environment."\textsuperscript{153} The EA determines whether potential impacts are significant, explores alternatives and mitigation measures, and provides essential information as to whether an EIS must be prepared. It also focuses attention on potential mitigation measures during the planning process, at a time when they can be incorporated without significant disruption and at lower cost.\textsuperscript{154} If the FAA concludes that there are no significant adverse environmental impacts, or that with appropriate prevention or mitigation efforts they will be minimal, it issues a "finding of no significant impact" [FONSI]. If however, the FAA concludes the impacts are significant (which is sometimes the case in a major airport project), the FAA prepares an EIS.\textsuperscript{155} The EIS must include an assessment of the environmental impacts, evaluate reasonable

\textsuperscript{149} See ICAO, supra note 29, at I-43.
\textsuperscript{150} See Spensley, supra note 128, at 79.
\textsuperscript{153} Id.
\textsuperscript{154} See FAA, supra note 117, at 49-50.
\textsuperscript{155} See Spensley, supra note 128, at 76.
alternatives, and suggest appropriate mitigation measures. It must review issues such as the impact of the project on noise, air quality, water quality, endangered species, wetlands and flood plains. However, the thrust of the statute is process; there is no mandatory obligation to implement mitigation measures, even if they are feasible.

These environmental requirements were explicitly affirmed for airports in the Airport and Airway Development Act of 1970. Such legislation has required that environmental factors be considered in both site selection and design. Airport master plans ordinarily must consider the following: (1) changes in ambient noise levels; (2) displacement of significant numbers of people; (3) aesthetic or visual intrusion; (4) severance of communities; (5) effects on areas of unique interest or scenic beauty; (6) deterioration of important recreational areas; (7) impact on the behavioral pattern of a species or other interferences with wildlife; (8) significant increases in air or water pollution; and (9) major adverse effects on the water table.

As an example of the regulatory labyrinth through which airports must pass to proceed toward development, consider this single sentence from Salt Lake City Airport Authority regarding a major terminal and air field expansion: “The current expansion has been in the planning process for nearly fifteen years and has included two Master Planning efforts, an FAR Part 150 document (an airport noise compatibility planning study), a Capacity Task Force Document, a Draft Environmental Assessment, and Expanded Environmental Assessment, and an Environmental Impact Statement as well as numerous smaller studies and documents.”

Congress amended the Federal Aviation Act in 1968 to require the FAA to prescribe standards for noise measurement and abatement. The FAA promulgated corresponding regulations thereunder for aircraft certification. The Noise Control Act of 1972 mandated that the EPA take an active role in the formulation and evaluation of noise standards, including air-
craft noise, coordinating noise regulation with the FAA. The statute explicitly allows citizen suits against any person allegedly violating any noise control requirement. The EPA also regulates aircraft emissions, although the FAA has veto power over any aircraft emission standards that might jeopardize safety. The FAA also has authority to review flight and operational procedures to determine how they might mitigate adverse noise impacts.

The Quiet Communities Act of 1978 provided federal funding and technical assistance for a noise control program to be administered by state and local governments. The Aviation Safety and Noise Abatement Act of 1979 focused on reducing the impact of noise by establishing a system for airport noise compatibility land use planning. Under it, the FAA promulgated extensive Airport Noise Compatibility Planning Regulations. That statute and the Clean Air Act of 1963 confer jurisdiction on the EPA and FAA to monitor and regulate aircraft engine noise and exhaust emissions. Airlines must comply with all applicable noise control regulations and exhaust emission standards.

In 1969, the FAA promulgated regulations requiring noise abatement technology on aircraft. Under these regulations, all Stage 1 aircraft were phased out from the U.S. fleet by 1988. The Airport Noise and Capacity Act of 1990 shifts authority away from airports to the FAA, requiring that airlines phase out Stage 2 aircraft by December 31, 1999. In 1991, the FAA promulgated regulations requiring airlines to reduce (by modification or retirement) the number of Stage 2 aircraft by 25% by December 31, 1994, by 50% by December 31, 1996, by 75% by December 31, 1998, and by 100% by December 31, 1999. However, a carrier may apply for a waiver from these requirements if 85% of

its fleet is compliant by the July 1, 1999, and if it has a plan for becoming fully compliant by December 31, 2003. The European Union also has adopted a program for phasing out Stage 2 aircraft over seven years, beginning on April 1, 1995.

But the problem of mandating less noise from jet engines is that it may result in worse emissions because the technology which reduces the decibel rate of engines requires higher temperature burn, which produces more pollution. Conversely, some technological improvements can reduce both noise and emissions. For example, Air Traffic Control modernization, particularly satellite navigation, will result in less circuity in flight paths, less congestion, and therefore less fuel burn and noise.

The 1977 Clean Air Act Amendments established the National Ambient Air Quality Standards. The combined impact of this legislation, the 1990 Clean Air Act Amendments, and the 1991 Intermodal Surface Transportation Efficiency Act is that non-attainment can mean ineligibility to receive federal matching funds for new transportation projects, such as airports and highways. One source noted, "To the extent that the growth of an airport leads to growth in flights, and the emissions from those flights, the administrative provisions of the Clean Air Act may act as a de facto limit on the size and operations of an airport in a given district that has not yet attained its air quality goals."

Section 404 of the Clean Water Act gives the U.S. Army Corps of Engineers jurisdiction over wetlands management. Since 1989, the U.S. government has embraced a "no-net-loss" policy toward wetlands, requiring wetland loss be mitigated by upgrading wetlands elsewhere. This policy helped derail Chicago's proposed new airport at Lake Calumet, and will likely drive other U.S. airport projects upland.

174 See Bourman, supra note 123, at 189. One relatively obscure piece of legislation that may impact older airport development is the Historic Preservation Act of 1966, 16 U.S.C. § 470, which requires that before federal funds are spent, account must be taken on the effect the project will have on any "district, site, building, structure, or object that is included in or eligible for inclusion in the National Register," 16 U.S.C. § 471; 36 C.F.R. § 800. Some airport facilities, such
B. LOCAL NOISE REGULATION & FEDERAL PREEMPTION

The United States government vested plenary power in itself over navigable airspace in the Air Commerce Act of 1926. Under the Federal Aviation Act of 1958, navigable airspace includes areas more than 1,000 feet above land as well as the airspace in the vicinity of airports needed to ensure safety in aircraft take-off and landing.

Article 1, section 8 of the U.S. Constitution vests in the Congress the power to regulate interstate commerce; inconsistent state or local laws are struck down as preempted by federal law. Local governments have been preempted from exercising their police powers to promulgate noise abatement requirements, which affect aircraft flight patterns, or to impose curfews on unwilling airport proprietors.\textsuperscript{175} However, they may exercise their police, land use, and zoning powers to regulate the location, height and size of structures (for example, to prohibit the erection of a skyscraper at the end of a runway), as long as the regulation is for a health or safety purpose unrelated to the regulation of noise or the use of navigable airspace.\textsuperscript{176}

Aircraft noise around airports is a highly localized political and legal problem. Local governments and their airport sometimes find themselves in the cross hairs of litigation objecting to aircraft noise. Individuals seeking airport noise abatement sometimes use state nuisance and inverse condemnation laws. A property owner may allege that his property has been taken without just compensation in violation of the Fifth Amendment to the U.S. Constitution\textsuperscript{177} and receive monetary damages.\textsuperscript{178}

The flying of an aircraft directly over private property can constitute a “takings” under the Fifth Amendment of the U.S. Constitution if the noise and vibrations significantly limit the utility of the property to its owner and cause its value to diminish.\textsuperscript{179} Some state courts have held that flights from airports

\textsuperscript{175} See Gesualdi, supra note 162, at 246.


\textsuperscript{177} See U.S. v. Causby, 328 U.S. 256, 261 (1946).


\textsuperscript{179} See United States v. Causby, 328 U.S. at 261.
may violate common law doctrines of trespass or nuisance. Financial liability lies with the airport proprietor.¹⁸⁰

In *United States v. Causby*,¹⁸¹ the U.S. Supreme Court concluded that continued low-altitude military flights destroying plaintiff's poultry business constituted a "taking" under the Fifth Amendment of the U.S. Constitution, but that comprehensive federal regulation made the airspace a public highway above a certain altitude, for which no complaint could succeed on trespass grounds. Noting the conflicting rights of landowners to the air space in the immediate reaches of their land, and the need of overflying aircraft for access, Professors Prosser and Keeton have urged that "[a] privilege to use air space for overflight of any height could be recognized so long as the exercise of that privilege did not unreasonably interfere with the use and enjoyment of the land surface."¹⁸²

So as to minimize legal liability and political discomfort, numerous local airports have taken action to reduce aircraft noise or to mitigate its effects, including access or use regulations or restrictions.¹⁸³ Airport proprietors may exercise their proprietary powers to control noise by promulgating noise abatement and curfew regulations, provided that such regulations are fair, reasonable, and not discriminatory, and do not unduly affect the free flow of interstate commerce.¹⁸⁴ For example, some airports impose flight curfews (prohibiting takeoffs and landings during certain late evening hours), prohibit the landing of Stage two aircraft, or establish perimeter rules prohibiting non-stop flights beyond a specified radius.¹⁸⁵ However, "overbroad, unreasonable and arbitrary" regulations may be struck down by the courts as imposing an unreasonable burden on interstate commerce.¹⁸⁶ Noise restrictions must be fair, reasonable, and

¹⁸¹ 328 U.S. at 256.
¹⁸³ See Gesualdi, supra note 162, at 221.
¹⁸⁵ See e.g., Western Air Lines, Inc. v. Port Auth., 817 F.2d 222, 223 (2d Cir. 1987).
nondiscriminatory and intended to serve a legitimate public purpose.\textsuperscript{187}

Though airport proprietors may regulate use of the airports they control, efforts of local municipalities to regulate the flight of aircraft have been struck down as preempted by federal law. However, reasonable zoning ordinances that merely regulate or restrict airport location or ground operations or assure compatible land uses within the vicinity of the airport have been deemed not federally preempted and within the police power of the government as appropriately related to health, safety or general welfare goals. Paradoxically, without zoning, land around the airport perimeter may become a high-density development because the land is not suitable from a market perspective for low-density use. Airport zoning may restrict land use so as to, for example, limit the height of structures in the aircraft approach paths to assure safety.\textsuperscript{188}

Other means of avoiding inverse condemnation litigation include land use planning and zoning around airport perimeters. Airport planners must project the “noise footprint” that will fall on surrounding land by virtue of aircraft operations, with an assumption that an impact above sixty-five Ldn is incompatible with the reasonably quiet use of residential real estate. Zoning such land for industrial or agricultural use, for example, can be an effective means of reducing legal and political problems. An even more effective, albeit expensive, means of accomplishing the same goal is an outright purchase of all land which falls within the sixty-five Ldn noise footprint. This can be accomplished by resorting to condemnation powers under eminent domain, if necessary, or by purchasing “navigation easements” over surrounding land.\textsuperscript{189}

\textsuperscript{187} See Gesualdi, \textit{supra} note 162, at 256.

\textsuperscript{188} See \textsc{Edward Ziegler}, \textsc{Rathkopf's The Law of Zoning and Planning} § 60.01 (4th ed. 1999).

VIII. RATIONAL PRICING

Another potential solution to the problem of growing pollution in the air transportation industry is to price transport on a full social, economic, and environmental cost basis, so that the price consumers and investors pay reflects both the internal and the external costs to society of both production and consumption.\(^\text{190}\) Proper costs will play a significant role in sending consumers vital price signals, influencing their decisions and choices regarding transport systems and investments.\(^\text{191}\) Although counterintuitive, higher fuel prices will likely reduce the full costs borne as a consequence of fossil fuel consumption by society as a whole, thereby resulting in a more efficient allocation of society’s resources—the savings in pollution, congestion, and health care may far outweigh the higher price of fuel. As one source notes:

Paradoxically, increasing the cost of transport can bring economic benefits. People and firms who put a high value on their journey by vehicle will continue to use their cars. Service delivery, freight and emergency vehicles will be much aided by freer traffic, and their costs substantially reduced. The money saved can be used for environmental purposes, for public transport— even to reduce other taxes.\(^\text{192}\)

Ton Sledsens of the Netherlands Society for Nature and Environment predicts that an environmental emission charge of twenty cents per litre of aviation fuel would halve the projected growth of emissions in Europe, which accounts for twelve percent of global carbon dioxide emissions from transport.\(^\text{193}\)

The manifest problems are two, and they are formidable. First, how does one convince the public that his or her higher fuel costs are in our common interest, when taking dollars out of one’s wallet is a tangible, personal loss, and giving him or her cleaner air is an intangible collective benefit? Educating the public was the subject of an earlier section, and its placement as first on the list is not by accident. Second, how does one calculate the costs of global warming, ozone depletion, acid rain, con-

\(^{190}\) See National Round Table on the Environment and the Economy, Draft Sustainable Transportation Principles (Feb. 21, 1996); University of Colorado at Denver, Getting the Prices Right (1997) [hereinafter Prices Right].


gestion, and safety? That too, is a formidable task. But accepting imprecision as a given, we must at least give it a try.

Europe, for example, imposes a steep import duty on imported oil, whose origins lie in attempting to arrest a severe balance-of-payments outflow and strategic dependence on a politically volatile region of the world (the Persian Gulf). Even with these high taxes, it is not clear that Europe has fully costed fuel. Certainly, the United States' political infatuation with cheap gasoline at the pump has precluded full costing, as does the contemporary aversion to big government and high taxes. The U.S. federal gasoline tax was raised to eighteen cents a gallon in 1993. In 1996, the highest state tax was Connecticut's thirty-five cents. The average U.S. household spends $422 on gasoline taxes per year. Compared with what citizens pay in other industrialized nations, U.S. taxpayers feel relatively no pain at the pump.

The British government has attempted to calculate the social costs of transport. It estimates that the annual cost of ill health arising from air pollution is fourteen billion pounds, while congestion costs industry fifteen billion pounds. The OECD estimates that transport congestion costs developed countries two percent of gross domestic product (GDP). Others estimate that transport congestion costs the European Union 2% of GDP a year, accidents cost 1.5%, and air pollution and noise 0.6%. The European Union estimates that transportation's external costs (i.e., congestion, accidents, and air pollution) are ECU 250 billion a year. The U.S. General Accounting Office estimates congestion costs to be as high as $100 billion a year.

Recognizing that the taxes paid by transport operators are "significantly less than wider costs of environmental damage and infrastructure requirements paid by society," the U.K.'s Round Table on Sustainable Development called for the imposition of taxes on vehicles in proportion to the amount of pollution they generate. Similarly, the European Commission issued a

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197 See Transport Costs, supra note 190.
198 See Benfield, supra note 3, at 658.
Green Paper entitled “Towards Fair and Efficient Pricing In Transport,” which recognizes rail transport as one of the key modes for achieving sustainable mobility and reduction in accidents, noise and pollution. To encourage a shift to more environmentally friendly modes, Neil Kinnock called for firmer pricing policies which would force different types of transport to reflect their true costs to society in terms of accidents, pollution, and congestion. But the airline industry resists. Robert Ayling, CEO of British Airways, objected, “What would be the point of it? The industry can do little more than it is already doing, and the added burden of taxation would only make it more difficult to make the necessary investment.”

Although unpopular, fully costed fuel would send consumers better pricing signals, leading them to purchase less pollutive transportation alternatives (e.g., natural gas or battery-powered vehicles). With higher fossil fuel prices and improvements in technology, various forms of solar, natural gas, or hydrogen-fueled alternatives become feasible. A tax levied on pollution (or fuel as a rough proxy for emissions) could be collected in a trust fund to finance (fancifully) the issuance to everyone of an umbrella and UV sunglasses, or the costs of relocation away from coastal areas, or (more seriously) the medical costs of treating skin cancer. But higher taxes are politically unpopular. Increased taxes on financially distressed airlines will exacerbate their inability to replace aging, noisy, and fuel-inefficient aircraft.

Thus, internalizing emission costs can only be one of the arsenals of remedies designed to achieve sustainability, and it can take us only part way there. Other, market-based solutions might also be tried, such as emissions trading. The sulfur dioxide tradable permit provisions of both the Clean Air Act Amendments of 1990 and the Energy Policy Act of 1992 might serve as a model.

IX. TRADE POLICY

Beyond the existing legislative and regulatory paradigm, we might rethink U.S. economic policy in the areas of free trade and transportation. Trade policy has largely been shaped by the

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201 See Railway Renaissance Is Urged for Europe, FIN. TIMES, Feb. 6, 1996, at 8.
202 Noble, supra note 16, at 19.
203 See Prices Right, supra note 189, at 3-4.
writings of Adam Smith, who, in turn, was influenced by the French physiocrats who believed that the free movement of goods was in accordance with principles of natural liberty. Smith believed that national specialization, with each nation producing and exporting those products it could produce at lowest cost while importing and consuming those goods that could be produced at lower cost elsewhere, would increase the wealth of nations.\textsuperscript{204}** David Ricardo built on Smith’s foundation by advancing the law of comparative advantage, whereby international trade would be dominated by national specialization and free competition.\textsuperscript{205}

Laissez-faire has an intuitive and seductive individualistic appeal to personal initiative free of governmental intervention. Yet laissez-faire does not encourage individual self-restraint by airlines in the use of common environmental resources because such restraint conflicts with rational self-interest. According to Professors Goetz and Graham, “the airlines, transformed by globalization, liberalization and privatization into a resolutely free-market industry, can often express unreconstructive attitudes to environmental issues, which are perceived as simply interfering in their primary goal of making money for shareholders.”\textsuperscript{206}

Free trade has been promoted by neo-classical economists as enhancing consumer welfare by reducing the price of consumer goods. In the absence of trade barriers, goods will be produced in whatever part of the world in which they can be produced with the least resources. Under the law of comparative advantage, world prosperity will be enhanced as each region specializes in producing those products it can produce best, at lowest cost. In the contemporary United States, free trade has been promoted by both Republican and Democratic administrations. Yet from the perspective of sustainability, two problems emerge.

First, since production gravitates toward regions with lowest costs (assuming the product in question can be produced at comparable quality), highly pollutive production processes may gravitate toward those nations with the least onerous environmental restrictions. While historically we may have been content to allow any people to “foul their own nest,” we are learning

\begin{itemize}
\item\textsuperscript{204} See \textit{Adam Smith, The Wealth of Nations} (1776).
\item\textsuperscript{205} See \textit{David Ricardo, Principles of Political Economy and Taxation} (1817).
\item\textsuperscript{206} Goetz & Graham, supra note 86.
\end{itemize}
that the world’s environment is both highly complex and highly interrelated. Chernobyl revealed that Russian radioactive pollution could adversely affect life as far away as Sweden. Acid rain, global warming, and ozone depletion all are the common problems of a species inhabiting a small, confined, arguably overpopulated planet.

Free trade expands existing markets, creates new ones, and as a corollary, places greater demands on environmental resources. Nonetheless, for the most part, trade negotiators tend to ignore or exclude environmental concerns from the process of drafting international trade agreements (though sometimes, as in NAFTA, they are included as side agreements).\(^{207}\)

Second, if production is to be located far from consumption, the transportation input increases. “Just-in-time” inventory allows garments formerly sewn in North Carolina now to be sewn in Seoul on Tuesday and flown overnight by Boeing 747 freighter and sold on Manhattan’s Fifth Avenue or Chicago’s North Michigan Avenue on Wednesday. Strawberries picked in Zimbabwe on Thursday are flown overnight and sold in Amsterdam markets on Friday morning. While worker incomes rise in Korea and Zimbabwe, and consumer prices fall in New York and Amsterdam, carbon dioxide and nitrogen oxides are released into the upper atmosphere, though consumers feel no economic pain. The jet flying the garments from Korea produces twenty times more carbon dioxide per tonne-kilometer than the truck from North Carolina it replaced, and the kilometers have grown by more than ten-fold, meaning CO\(_2\) emissions have increased by more than 200 times. Yet nothing in the price of the garment reflects that higher pollution contribution; in fact, the Korean-manufactured garment costs the consumer less than the North Carolina-manufactured garment it replaced, reflecting the lower labor cost input.

The market price ignores the social cost of production. Many of the displaced workers in North Carolina impose welfare costs on taxpayers, or mortgage default costs on lenders. These are nowhere reflected in the purchase price of the Korean garments. With its relentless bias in favor of the interests of consumers, neo-classical economists appear to forget that workers are consumers in different clothes.

Also not reflected in the purchase price, the pollution component has grown, and is growing, astronomically. Free trade has

\(^{207}\) See Egurbide, supra note 1, at 1091.
caused international air cargo shipments to grow at a profound rate. By focusing predominantly on input costs, market economists insist this increases allocative efficiency. Such a distorted view of costs and social welfare, autarky, or national economic self-sufficiency, with localized production and consumption, is more likely to produce sustainability than a globalized economy. Thus, if open, borderless markets are to survive, we must get the costs right. Economic principles appropriate for the eighteenth and nineteenth centuries may not be appropriate for the twenty-first.

Problems such as global warming and ozone layer depletion must be remedied by global, not unilateral, remedies. To the extent that moral persuasion and enlightened self-interest can convince the nations of the world to proceed with economic development in the manner which is least environmentally offensive, so be it. To the extent they cannot, then sustainability must become an essential feature of the *quid pro quo* for which “Most Favored Nation” status is traded. History is replete with economic boycotts or tariff walls raised around nations that engage in antisocial conduct. For example, the United States suspended all political and economic relations with Cuba for expropriating American property; it suspended trade and transport with the Soviet Union for invading Afghanistan; it suspended trade with South Africa for apartheid. At the very least, the United States can and should raise tariff barriers against environmentally irresponsible nations to account for the externalized costs of pollution.

X. TRANSPORT POLICY

Finally, the Intermodal Surface Transportation Efficiency Act of 1991 expressed a policy that the U.S. transport system should be “economically efficient and environmentally sound.” It emphasized the need to reduce transportation-generated air pollution and improve air quality. By creating a seamless and integrated intermodal transportation system, people and goods can move in the most efficient manner, taking advantage of the inherent benefits of alternative transport modes. To date, however, the required public investment in unclogging the bottlenecks and providing seamless interconnectivity between modes has been woefully lacking. Until such investment is made, transportation will fail to realize its full potential as a catalyst for

\footnote{2000] TRADE & TRANSPORT POLICY 687

broader economic growth. In an analogous sense, the communications industry has accomplished this by public investment in the ubiquitous highways of the internet.

Nonetheless, U.S. transportation policy has also been driven by neo-classical economics, with a heavy dose of deregulation and liberalization. International aviation policy embraces the unlimited entry regime of “open skies,” which stimulates competitive offerings for consumers, giving them more frequency and lower prices. Yet such a policy may also be antithetical to the creation of a sustainable transport system. Some Europeans note that highly-competitive, below-fully-allocated-cost pricing causes airlines to offer price structures which underbid the “greener” railway network\(^{209}\) (America has only a skeletal passenger railway system, so there is relatively little on this continent to underbid). Regulated international markets have significantly higher load factors (typically five percent higher) than deregulated domestic markets.\(^{210}\) This suggests that fewer competitive offerings may result in more efficient equipment utilization, lower per capita passenger fuel consumption, and consequently less environmental pollution. According to Professors Goetz and Graham, “unconstrained competition in air transport is wasteful of investment and resources, including non-renewable hydrocarbons and scarce airport capacity. It also increases the externalities of air transport, particularly atmospheric emissions, noise and terrestrial congestion.”\(^{211}\) The dominant megatrend on the deregulation landscape—the hub-and-spoke system—though enabling airlines to market a wider array of origin/destination city-pairs, increases circuity of air travel, congestion, fuel consumption, and thereby, pollution. The “S-Curve” relationship between flight frequency along the axis, and revenue along the other, encourages airlines to offer more and more flights to satiate the higher yield business traveler’s desire for alternative departure times. This too drives capacity upward, and along with it, fuel consumption and pollution. These are the results of a policy of deregulation and liberalization in air transport.

Contrary to the “open skies” regime promoted by the United States, the regulation of frequency and capacity in congested markets and congested airports would have several beneficial impacts:

\(^{209}\) See Jezioriski, supra note 10.
\(^{211}\) Goetz & Graham, supra note 86.
• It would increase load factors, which will produce more efficient aircraft utilization;
• It would lower per capita fossil fuel consumption and environmental pollution;
• It would increase the price of air transport to better reflect the full social cost of production and consumption, which will . . .
• Increase airline profitability, giving them the resources to . . .
• Purchase newer, more fuel efficient, and environmentally friendly aircraft.
• The airways and airports are public resources, and can properly be managed to serve the public interest. Excessive duplication of parallel route networks, while driving consumer prices down to the bone, contributes to excess consumption of air transport which, in turn, excessively consumes fossil fuels and contaminates the planet's atmosphere.
• Two mechanisms appear able to rationalize the market to reduce wasteful duplication. Governments could limit the number of carriers (or flights) in city-pair markets, selecting them on the basis of public interest criteria (including, for example, binding assurances by applicants that they would not extract monopoly rents from consumers), or auctioning off routes to the highest bidder. Historically, international aviation markets have been so rationed under bilateral air transport agreements, with each nation selecting one carrier to serve a specified city-pair route. Capacity limitations are inherent in such a process, for carriers have little incentive to flood a market with excessive capacity which is theirs—in which they have a vested property right. The result has been higher load factors and, therefore, more efficient equipment utilization than exists in unregulated markets. Longer stage lengths also contribute to 15% higher fuel efficiency in international vis-à-vis domestic operations.212

A second mechanism would be to eliminate antitrust restrictions on inter-corporate agreements, allowing competitors to rationalize the market. In some sense, U.S. aviation policy seems headed toward such a result, with code-sharing and other marketing and equity alliances coagulating the industry into a global

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212 U.S. Dep't of Transportation, National Transportation Statistics 200 (1995).
cartel. In a sense, globalization is a euphemism for cartelization. But one is reminded of the words of Adam Smith in his seminal treatise, *The Wealth of Nations*, where he observed that the interest of those who live by profit “is never exactly the same with that of the public,” but they “have generally an interest to deceive and even to oppress the public, and . . . accordingly have, upon many occasions, both deceived and oppressed it.” Thus, unregulated, noncompetitive markets also have a potential to create social ill.

XI. CONCLUSIONS

With commercial aviation growing at five percent a year (and in some parts of the world, the growth rate is even higher) the volume of flights will likely more than double within twenty years. This growth rate is out-pacing the rate of technological improvements designed to reduce noise, CO$_2$ and NOx emissions. Absent some as yet unforeseen technological breakthrough, the net result will likely be a significant increase in pollution and noise.

Such growth also creates congestion, a narrower margin of safety, and costly demands for capacity expansion. Yet one need only look at the Los Angeles basin, where highway congestion created gridlock and demands for capacity growth. California built new, and expanded existing, highways. Within a few years, highway congestion and gridlock reappeared as demand expanded to fill capacity. In 1991, the U.S. Congress decreed that the day of building additional lanes to satiate the needs of single-occupancy vehicles was over, insisting that existing capacity be used better, and that alternative and cleaner modes of transport be employed.

Airports are adding runways, concourses and gates. More than $200 billion in new and expanded airports are under way around the world. The air traffic control system’s capacity is being expanded to increase capacity. Over time, demand will expand to fill capacity. More and more homes will need to be condemned or insulated to spare residents the blast of aircraft.


214 Smith, *supra* note 203.

The air pollution, global warming and ozone depletion problems are more difficult to solve.

Government trade and transport policies are fueling this growth. Government policies favor globalization, whereby goods produced in one corner of the world are consumed in another. Under the law of comparative advantage, each nation produces that which it can produce most efficiently, as consumer wealth is enhanced. Strawberries picked in Zimbabwe on Tuesday afternoon are sold in Amsterdam markets on Wednesday morning, transported by a high-speed commercial aviation industry. But the externalities of environmental harm are not fully costed, allowing consumers to purchase products at prices that do not reflect the full costs to society of their production and consumption, thereby leading to excessive consumption of remotely-produced goods.

Transport policies of deregulation and liberalization also contribute to the growth of commercial aviation. Lower fares respond to consumers’ price elasticity of demand.\textsuperscript{216} The commercial decisions of airlines to add flight frequency are driven by the “S-Curve” relationship between frequency along one axis, and revenue along the other.\textsuperscript{217} A significant revenue advantage is accorded the carrier offering more flight frequencies than one’s competitor, thereby incentivizing more and more capacity and a price to fill every available seat. Clearly a by-product of deregulation, and motivated by a commercial desire to offer more frequent service to a wider array of origin/destination markets, the hub-and-spoke distribution system creates further congestion, delay, circuity, fuel consumption, and pollution.

Global networks and intercarrier alliances are exacerbating this trend by linking hub-and-spoke networks together. Code sharing and antitrust immunity are becoming common governmentally approved policies as megacarriers further fragment the air transportation system into the hands of global megacarriers.\textsuperscript{218} These alliances make possible nonstop flights between cities that otherwise would never support them (e.g., Cincinnati-Zurich, Memphs-Amsterdam). Were Amsterdam Schiphol Airport, for example, an origin-and-destination facility instead of

\textsuperscript{216} See Paul Dempsey & Andrew Goetz, Airline Deregulation & Laissez Faire Mythology (Quorum 1991).

\textsuperscript{217} See Paul Dempsey & Laurence Gesell, Airline Management: Strategies for the 21st Century (Coast Aire 1997).

\textsuperscript{218} See Dempsey, supra note 212.
an alliance network hub, the amount of traffic at Schiphol could be reduced by more than half.

The conflict between health policy, on the one hand, and economic policies in the areas of trade and transport, on the other, is one in which the deck is stacked against the former and in favor of the latter. As the new century begins, western economies are in full throttle toward a laissez-faire theological tilt. Moreover, generally speaking, the economic benefits of free trade and deregulation/liberalization are immediate, short-term, and focused. The health risks are less immediate, long-term, and more ephemeral.

Nonetheless, this author advocates a systemic approach be adopted which analyzes modes of transport on the basis of sustainability. A transportation system which promotes sustainable development would contain three attributes: (1) it must be environmentally sound; (2) it should be efficient and flexible; and (3) it must be safe and secure. Each of these criteria contains three elements—technology, planning and policy, and ethics.219

Sustainable transportation is but a single component of a need to develop a comprehensive approach of sustainable development. But given commercial aviation's aggressive consumption of non-renewable resources and its noxious emissions, transportation must be an essential focus of any comprehensive attempt to achieve sustainability.

The problems posed by the transportation sector are enormous and require a holistic method of arresting undesirable trends. Again, one solution appears unlikely to resolve the problem. But a combination of projectiles launched toward different points on the target may produce the transportation network which is least environmentally offensive and most sustainable, so as to keep the irresistible force of transportation from colliding with the immovable object of ecological health. While we must no longer be physiocrats, we need neither become Luddites, nor enemies of travel, to accomplish sustainability.

In order to accomplish the objective of sustainable development, several prevailing (but false) paradigms must collapse:

We live in a time when the prevailing wisdom is that the market can do no wrong and the government can do no good. The

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enmity with which many contemporary Americans hold government emerged during the Vietnam-Watergate era, and continues to this day. That paradigm must shift if we are to resolve these difficult problems, for government must, of necessity (as a necessary evil, if you like) contribute to the collective solution.

The neo-classical definition of efficiency, focused predominantly on consumer welfare measured in terms of marginal cost pricing—with its incomplete assessment of social and economic costs—must be recognized as often sending consumers incomplete, and therefore incorrect, pricing signals, and as a crippled methodology for driving public policy.

The "more is better" paradigm must also shift to one of "more is not necessarily better."

Individual, short-term ("Me" generation) well-being must be absorbed into the broader, and more sustainable communitarian objective of achieving collective, long-term well being for ourselves and those who come after us.

Because pollution is a global problem, traditional notions of national sovereignty must recede sufficiently to allow a multilateral effort to achieve global remedies.

Like Alice through the looking glass, we must reassess all the critical assumptions that influence our public policy and our individual conduct, particularly the conventional wisdom promoting profligate consumption and unregulated markets. As difficult as it is to face up to these problems, and as painful as several of these solutions appear to be, the alternative is leaving our children's children's children a world which is unfit in which to live. That we cannot, in good conscience, do. As theologian Deitrick Bonhoeffer observed, "the ultimate test of a moral society is the kind of world it leaves to its children." 220

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