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9. HELICOPTER TRAINING SIMULATORS: KEY MARKET FACTORS

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The training services and training equipment industry has been working in partnership with NASA and the FAA to constantly improve the ability of people in the air transportation network to perform their missions. This workshop is but another step in bringing technology and performance standards to bear on the training of helicopter crewmen in the civil sector. Your review of and contributions to the draft FAA Advisory Circular for Helicopter Simulator Qualification can significantly affect the quality and cost of pilot training for years to come.

I don't know whose idea it was when the FAA came out with its first Advisory Circular for fixed-wing simulator qualifications. You all remember "Appendix H." Whoever it was, ought to get a medal! That development established standards that have saved uncountable millions of dollars, provided a basis for vastly improved training, and provided a model copied around the world and by our own military in some procurements. Extending that precedent to vertical-lift aircraft is consistent with the advances in helicopter simulation technology and with the future demands on helicopter pilot training.

I wish to present an analysis of that future demand and to discuss some of the factors that will influence the market for helicopters and simulators. I will also touch briefly on other vertical-lift market offerings, including tilt-rotor and tilt-wing aircraft.

My sources include interviews with major helicopter and vertical-lift aircraft manufacturers, NASA studies, interviews with industry providers of training services and equipment, trade journals, and other published data on aircraft operating costs.

There are a number of factors that will influence the future demand for helicopter simulators. Chief among these will, of course, be the demand for civil helicopter aircraft and the types of the units sold and their missions (fig. 1).

The forecast shown in figure 1 covers the period 1991-2000. Although the delivery of civil helicopters looks relatively flat through this decade, notice the trend

toward light twins and intermediate helicopters. Light twins are defined as aircraft under 6,000 lb, and intermediates comprise the range of 6,000 to 15,000 lb. Most of the simulation equipment built to date has been for aircraft in these two categories.

The delivery of 5,330 aircraft in this decade will roughly break out at one-third domestic and two-thirds worldwide, with the hot markets being in densely populated areas such as Japan, the rest of the Pacific Rim, and Europe. There are some who feel that a critical juncture will be encountered in the 1994-1995 period, one that will be brought on by basic decisions on how to handle air-transport systems overloads. One scenario, which I will discuss later, could distort the delivery picture radically and impose heavier demands for simulator training in the last half of the decade. With that, let's take a look at some of the forces that shape the demand in the helicopter market (table 1).

There are several factors that are favorable to the helicopter market. The export business remains strong and is growing in densely populated areas. These are areas where all means of surface and air transport are becoming overburdened. Additional interest for emergency medical services and public sector helicopter utilization is also related to population growth, required response times, and available capital.

Conversely, the lack of infrastructure rather than overtaxed, developed infrastructure, is going to influence growing helicopter demand in Third World nations. There is no question that a possible up side scenario to the forecast shown in table 1 does exist and that it could kick in in the mid-1990s.

While development of the economies of Eastern Europe will provide market expansion, the supply side will be developed also the civil competition from the U.S.S.R. and other sources. Eurocopter could be a synergistic giant compared with the founding partners of Aerospatiale and MBB. The infrastructure for vertical lift is also growing along with helicopter demand; it includes

TEN YEAR CIVIL HELICOPTER FORECAST

5,330 Aircraft by Weight Class

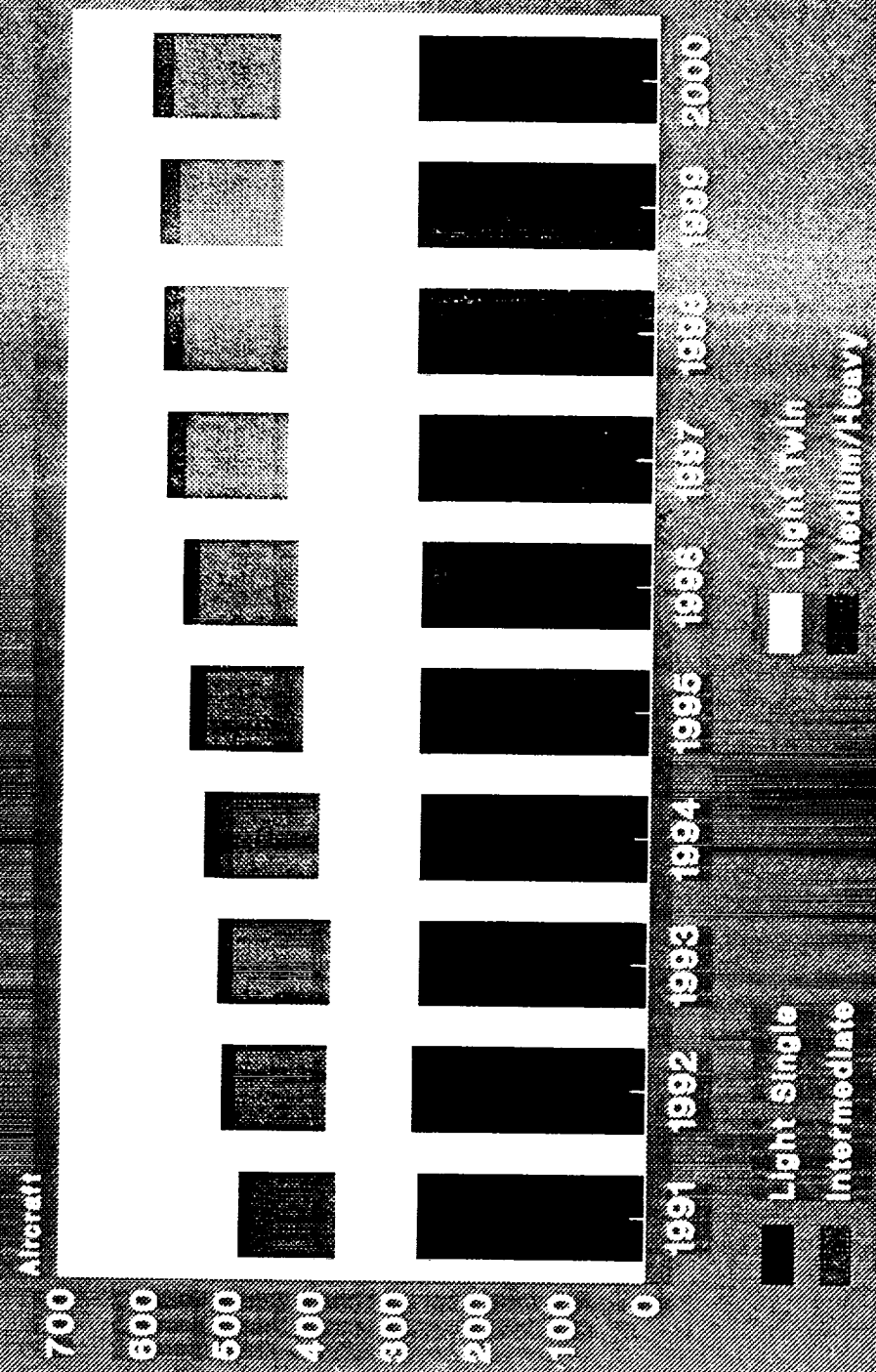


Figure 1. Ten-year civil helicopter forecast: 5,300 aircraft by weight class.

Table 1. Market forces

Positive forces	
1.	Export possibilities are growing High-density population areas Third World development Eastern Europe trading
2.	Vertical lift infrastructure is expanding
3.	New vertical-lift technologies may provide explosive growth to passenger and package express possibilities
4.	More reliable rotorcraft with reduced operating costs
Negative forces	
1.	Environmental concerns
2.	Safety and public image
3.	Availability of capital investment
4.	Competing technologies

pads, facilities, and, now, vertiports. Vertiports like the one planned for downtown Dallas can handle transitional vehicles such as tilt rotor and tilt wing, as well as helicopters.

If the newer "tilt" technologies are successful in penetrating the public sector passenger and cargo markets, and if the air-space regulations and infrastructure are properly developed concurrently, then there will be a fall out of additional helicopter demand capable of exploiting the same facilities and the same regulatory climate. For helicopters to position themselves for this market share the good work now being done to reduce seat-mile costs and to improve reliability, perceived safety, and environmental compatibility must be continued (table 1).

It may have been all right for President Reagan to stand near his helicopter with his hand cupped over his ear saying "Sorry Sam I can't hear your question," but most folks do not take kindly to noisy machines belching exhaust in their neighborhoods. It gets particularly alarming when one of those machines makes an emergency autorotation down into a busy intersection. The public will have to be convinced that helicopter use can be expanded in a safe, environmentally compatible manner before they will vote the funds for helicopter purchases by police or for medical services or facility construction. Given the right technology, they might accept vertical-lift aircraft, at least as much as they do fixed-wing aircraft.

Capital is hard to find right now and it will continue to be so until debt loads are relieved and GNP's are on the rise again. This isn't the financial climate for getting a loan to build a beer hall in Baghdad, but investments that make sense, show a return, and are in the best interest of government, industry, and the public can still be managed.

Planning, combined with technology, can benefit vertical lift.

There will be competition for the funds and project support. Take the Boston-New York-Washington corridor for example. Reliever airports, additional runways, helipads, magnetic rail systems, and bullet trains will all be competing for the same pot of money.

Aside from all the light singles driving the training and private use numbers, the market continues to be driven by the working needs of the oil industry (table 2). By and large, the helicopter remains a working tool whose price is justified by the revenue returned for the task to be performed. Today its sales and use are still affected by a poor public image as a vehicle for general transportation. That image could change in the 1990s, but several factors will have to be overcome (table 3).

The seat-mile costs of helicopters are about twice those of regional fixed-wing aircraft, and the "tilt" technologies will bring that disparity down from 2 to 1 to about 1.2 to 1.4 to 1. Obviously other economic issues remain to be dealt with. Progress toward resolution of some of them is promised by the cost model of a complete door-to-door transportation scenario that applies a cost factor to the total time saved, as the air-traffic control system and facilities are further tuned to city-center-to-city-center operations. As the infrastructure grows to offer more possibilities, the economic model will improve as well.

Bear in mind, however, that other competitors for the traveler's dollars will not be standing still as constants in the economic model. They will be moving hard to capture public and private capital.

Table 2. Civil helicopter market segments

Segments
Training
Petroleum and industrial
Public service
Emergency medical services
Executive/corporate
Passenger
Comments
7,400 helicopters now flying in United States; main driving force: petroleum industry
Public service, including law enforcement, operates 1,400 units in 335 agencies
174 emergency medical services programs operate 231 units

Table 3. Vertical-lift passenger traffic market: factors opposing

1. Vertical-lift technology must overcome:
 - Noise and other environmental concerns
 - Seat-mile cost disadvantage
 - Lack of dependable IFR operations in icing conditions
 - Negative public image of safety and reliability
2. Air-traffic control systems must be changed to accommodate higher volume vertical-lift IFR traffic in vertiport infrastructure
3. Other modes of transportation are competing for private and public capital:
 - Reliever airports
 - Bullet trains

Today's congestion makes the case for civil tilt-rotor and tilt-wing research (table 4). The air-travel delays today at those 21 airports are estimated to cause a \$5 billion annual loss. By the year 2000, this grows to 50 airports with this magnitude of delays. Eight-four million dollars, the rough cost of an extra runway, is enough money for several helipads and for the tilt-rotor aircraft to use them. That structure, if it happens, will pump helicopter sales as well. It could very well be that the first working example of this will occur in the densely populated Japanese travel sector. The industry study team, studying tilt-rotor missions for NASA, reported that a single new airport would cost \$4 billion to \$6 billion. For half that cost, they estimated that an entire network of 12 urban vertiports could be built along with 165 40-seat tilt-rotor aircraft.

High fidelity and cost-effective training will continue to gain in importance in the vertical-lift market we have been looking at.

You all know that simulator fidelity isn't legislated or wished into being. The right data must be modeled in the right way and implemented on equipment capable of executing the model and cues in real time.

The forces acting on the vertical-lift market, which we have reviewed today, will create a continuing training demand. The trends indicate that the training will continue to shift toward simulation equipment and that the training will be provided by full-service training companies. Some key people are expecting a significant increase in simulator-base training demand in the 1995-1997 period.

As was true in the fixed-wing experience, the acceptance and use of simulator-based training will be influenced by simulator fidelity, economic advantage, and a regulatory environment that permits credits for the training given. Helicopter simulation fidelity (table 5) is more difficult to achieve, in some ways, than is fixed-wing fidelity.

To begin with, rotors present a unique problem, given their flexibility and varying angles of attack. The

Table 4. Vertical-lift passenger traffic market: factors favoring

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1. Twenty-one airports now have delays of 20,000 hours annually. Predicted: by 1997, 33; by 1998, 41
 2. By the year 2000, prediction is for a 32% increase in jet transports and a 74% increase in passengers
 3. Half of today's commercial fleet is used for flight segments of less than 500 miles
 4. Situation worse in Europe and Japan
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Table 5. Simulator training: fidelity

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1. Aircraft data and data collection
 2. Modeling techniques
 3. Visual and motion cues
 4. Standards for performance
 5. Training program design
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blade-element solution offers an improvement over the process of tailoring a rotor-map-based design. Its use, however, requires model solution speeds unheard of in fixed-wing simulator configurations.

Unfortunately, the modeling and data problems don't end with the rotor. Fuselage aerodynamic data are difficult to gather and to document for slow forward air speeds, in wind, and in hover. Today, engineers have to "twiddle" with induced velocities, and there is a need for more data for translational lift. In slow-speed regimes, more and more and more resolution is required. Thirty-two-bit, floating-point computers will be needed.

Helicopter motion and visual cues are more complicated than they are for fixed-wing aircraft. Field of view is greater, with down-look angles that are important. Also important in helicopter training is the fidelity of onset and vibration cues.

Perhaps the biggest technical problem is the unavailability of binocular vision in the visual system. The low approach to the ground of a fixed-wing aircraft is fast enough to reduce the effects of this lack of height cue, but a helicopter hover to landing or autorotation is quite another matter. Confined-area vertical cues help, but the fidelity problem still exists.

We should all remember that a qualified simulator is still but a tool in a pilot-training program. The program itself must be designed, by the certificate holder or training-services company, to a high degree of quality and cost effectiveness.

Let's see if we can quantify some of the costs (table 6). I have made these reasonable assumptions as a basis for comparing simulator training costs with the

alternative of training in the helicopter. These costs (fig. 2) do not include any adjustment for the fact that simulator training hours can be more highly concentrated and can include training in recovery from a number of emergency or otherwise abnormal situations. Certainly there is more realism in the real-world environment, but there is more safety in the simulator.

Summing up key simulator market factors, I would conclude that fidelity is strong but with some key issues revolving around data collection and visual simulation remaining to be solved (table 7). The cost equation is practical and the demand is reasonably strong with mid-decade factors coming into play that could capture the attention of manufacturers.

Table 6. Simulator training: cost/hour assumptions

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- Light twin with simulator cost twice that of actual aircraft
 - 1200 flight hours and 3500 simulator hours
 - Depreciation over 10 years
 - Crew compensation and insurance not included
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Table 7. Helicopter simulators: key market factors

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1. Fidelity of simulator training
 - Data and models
 - Equipment technology
 - Training programs
 2. Cost of simulator training
 - Versus training in aircraft
 - Trend
 3. Training demand
 - Vertical-lift market in the 1990s
 - Helicopter demand factors
 - Trends
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Today there are only a few civil helicopter simulators that would fall into a classification covered by the FAA draft Advisory Circular that is under consideration at this workshop (table 8).

Table 8. Civil simulators

Bell 222
Bell 212/412
Sikorsky S76A
Sikorsky S76B/A
Boeing Vertol 234
Aerospatiale 332L
Sikorsky S61N

The forecast for new simulators in this decade is shown in table 9.

Table 9. Simulator forecast: 1990-2000

1. Light singles and twins, less than 6,000 lb	4
2. Intermediate, 6,000 to 15,000 lb	3
3. Medium to heavy, more than 15,000 lb	1
4. Other vertical-lift	
Tilt rotor	1
Tilt wing	1
Total	10

Whether these predicted buys are actually made will depend on all the market forces we have discussed today, not the least of which is the final form and implementation of the FAA rules for simulator qualification.

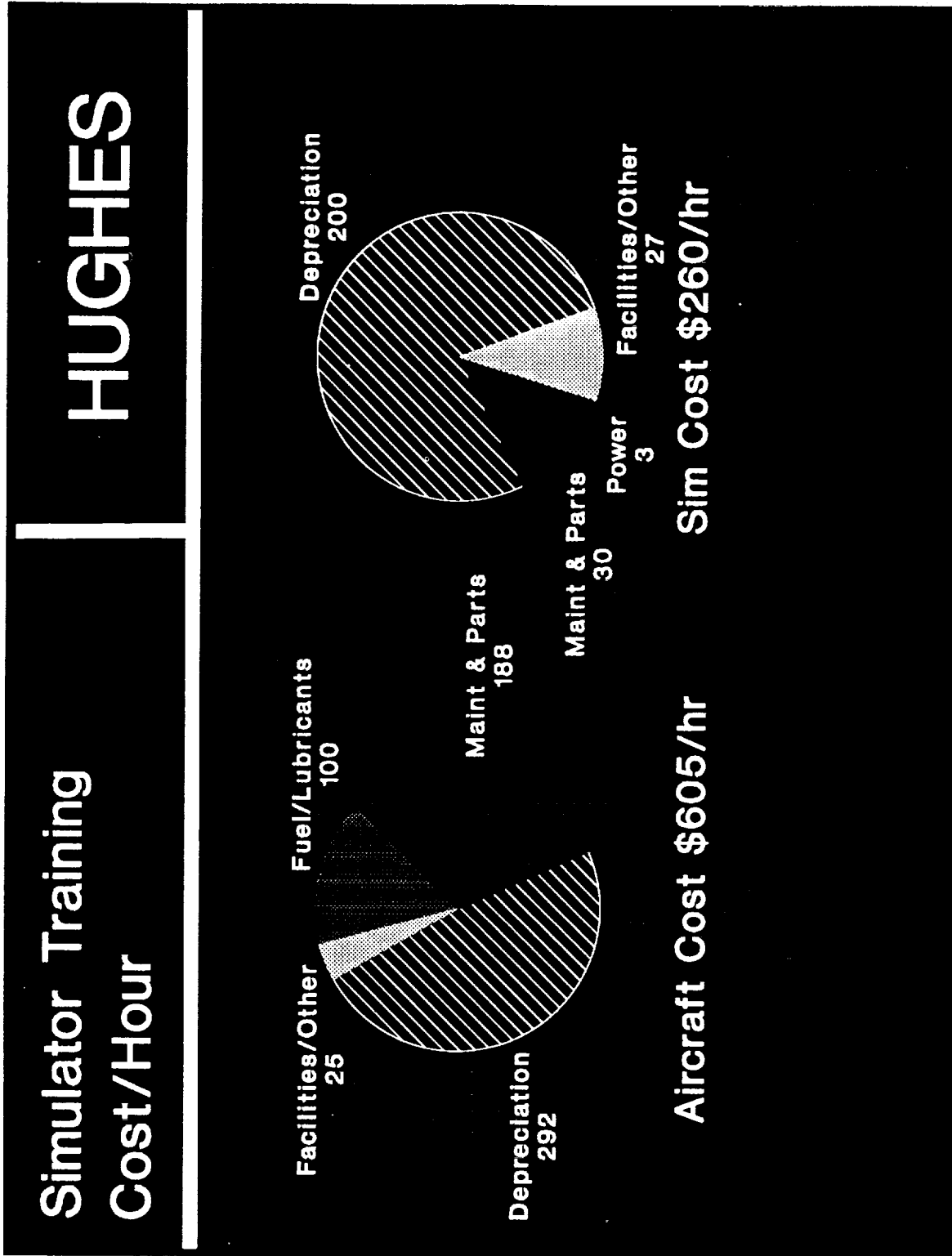


Figure 2. Simulator training: cost/hour.



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