Journal of Air Law and Commerce

Volume 22 | Issue 3 Article 2

1955

Planning for Suburban Heliports

Fred M. Glass

PLANNING FOR SUBURBAN HELIPORTS*

By Fred M. Glass

Director of Aviation, The Port of New York Authority.

THE last five years have seen the transition of the helicopter from a curiosity to a transportation vehicle of demonstrated utility. The wonderful achievements of the helicopter during the Korean War highlighted its military value and afforded a dramatic indication of the manifold uses to which its peculiar characteristics may be adapted in future peacetime pursuits.

The widespread interest in the helicopter has given rise to a number of studies by governmental, airline and various other planning groups with a view toward defining the future role of this vehicle in the nation's transportation complex. These studies have developed a number of conclusions which can be regarded as reasonably sound guides for use in future planning for this new mode of transportation. They have also raised a number of questions to which only inconclusive answers are presently available. These questions are primarily concerned with the economics of helicopter operation and its resultant effect on future helicopter traffic volumes and market patterns.

What do we now know about the helicopter? We know that its flight characteristics make it uniquely suited for a short haul vehicle for it has no need for large airports and long runways, and can thus operate into and out of midtown city areas. It can, therefore, provide intercity air service from downtown to downtown, over-flying surface traffic congestion and geographical obstacles, and, for the first time, can provide an air service which will be able to compete, from a service standpoint, with established surface carriers over distances under 175 miles. This short haul travel market comprises, in terms of passengers carried, the largest proportion of the nation's total travel market. It is this market in which the fixed wing aircraft has as yet been unable to make a substantial penetration.

The helicopter has only one important operational limitation. Because its engine must provide the power necessary for lift as well as forward propulsion, its cruising speed is not likely to exceed 150 miles per hour. As a result, in spite of the saving in total travel time made possible by its ability to utilize in-town terminals, the helicopter probably will be unable to compete with the faster fixed-wing aircraft for the travel market over 300 miles. The convertiplane has been designed to overcome this difficulty by combining vertical ascent and descent with high flight speeds. Present indications are, however, that the weight, extra power and mechanical complexity penalties the convertiplane must pay for combining the helicopter and fixed-wing flight

* Revised address before the Chicago Regional Planning Association, Chicago, Illinois.

characteristics will make it impractical for commercial use for many years to come.

An analysis of the potential helicopter travel market reveals three major components: short-haul intercity travel, suburban travel and aero-cab service between airports or between city centers and airports. They are, to a large extent, separate and distinct markets, with varying potentials, and each presents sufficiently different operating and service problems to suggest that their development will not take place simultaneously. The aero-cab market will be the first to receive service (inter-airport passenger service was inaugurated by New York Airways in July, 1953) followed shortly by intercity service and somewhat later by suburban operations.

While aero-cab service has been the first to be inaugurated, it will not be easy for it to succeed as an economically justified service. For some years to come, operators of this service may find themselves on the horns of a dilemma. To give fast and convenient service, a high schedule frequency will be necessary. On the other hand, a high frequency of service will require operating with small and medium size equipment, which will require high fares which will, in turn, tend to restrict the markets. However, we believe that this service will be able to provide substantial time savings over ground transportation where airports are located 45 minutes or more from city centers or where, as in the case of New York, the city is served by several airports widely spaced in the metropolitan area.

The intercity market appears to offer the greatest potential for helicopter usage. For distances between 40 and 300 miles, much time will be saved by the use of downtown to downtown helicopter operations which will enable the air traveler to realize fully the inherent time saving advantage of travel by air—an advantage which is now largely denied him over short distances because of travel times between city centers and outlying airports. This intercity travel market may be further subdivided into two parts:

1. Feeder service into large metropolitan airports for transfer to fixed-wing aircraft traveling to distant points. Helicopter feeder service will mean that many cities and large suburban communities which cannot support an airport will receive direct air service from local downtown terminals to the world's busiest airports.
2. Travel between cities located within a 40 to 300 mile radius. This part of the intercity market may be designated "the local intercity market," and will probably make little use of airports, using instead city heliports.

The suburban market corresponds in composition and geographic extent to that now served by surface commuter services. While fares will undoubtedly be higher than present surface fares, the flexibility and speed of the helicopter will make it attractive for those to whom speed and convenience are at a premium. The pronounced trend toward decentralization of metropolitan area population centers and

the consequent spread of large suburban areas has created many problems of traffic congestion and excessive local travel times. Many of these are capable of solution by suburban helicopter services.

These, then, are broad descriptions of the market potentials which may be developed by the helicopter. The extent and rapidity of their development will depend on a number of factors. The study of transportation history reveals that the growth process of a new method of transport involves a chain reaction among economic, technological and political elements. The growth of its traffic depends upon service and price relative to those of competing carriers or forms of transportation. The charges for the new service further depend on traffic volumes, the standards of its service, the costs of providing the service and the extent of government encouragement of the new industry. Costs depend, in turn, upon traffic volumes, operating methods, capital cost of equipment and facilities, and the service standards adopted by the carrier. Service standards and the capital cost of equipment and facilities are functions of their design and engineering.

From a technological point of view, the helicopter industry appears to be well on its way towards the production of serviceable reliable transportation vehicles which will provide the utility needed to attract the short haul passenger. Responding to urgent military requirements for larger and more specialized aircraft types, the engineers have, in the last 5 years, progressed from the small, relatively slow, single engine helicopter to twin engine helicopters of 25-40 place capacity, and with anticipated cruising speeds up to 150 miles per hour.

We may expect the engineers to continue to concentrate, for the next few years, upon expansion of useful lift and improvement of control mechanisms, especially as related to instrument flight conditions, and reliability. Although progress to date along these lines indicates that these efforts will meet with considerable success, the problem of design complexity will undoubtedly be aggravated by the military urgency to attain these goals at the earliest possible date. There must, then, follow a period of design simplification and perfection. Simplification of design and operation attainable during this phase, will be essential to the reductions in direct operating costs which will be necessary before wide-spread commercial use can be made of the helicopter. Based upon technical facts available today, we feel that this goal can eventually be achieved without undue sacrifice of previous achievements related to capacity, speed and range. As a result, the years 1958-1975 can become a period of concentration upon commercial helicopter types, and the rapidity with which the helicopter transportation market is developed, will depend to a large degree upon the success of these efforts to reduce costs.

Three helicopter operators, Helicopter Air Service, Los Angeles Airways, and New York Airways, are now providing service in Chicago, Los Angeles and New York respectively. While this is primarily air mail service, one of the carriers, New York Airways, began carrying

passengers between metropolitan New York's three major airports in July, 1953 and soon expanded this service to include communities in other parts of the metropolitan area. A total of 8,760 passengers were carried in 1954 with traffic now averaging about 1,200 monthly. Los Angeles Airways has also been carrying passengers since November, 1954 and is now averaging 300 monthly.

SABENA Airlines is operating a regularly scheduled intercity helicopter passenger service to eight cities in France, the Netherlands, Germany and Belgium, using Sikorsky S-55's. While this service is not now economically self-sufficient, it has already gained a surprising amount of customer acceptance (over 3,000 passengers were carried in the first two months) and has been feeding a substantial amount of business into the carrier's fixed-wing flights. It is interesting to note that 39% of their passengers had never flown before, a fact which tends to refute those who talk of limited traveler acceptance of the helicopter as a means of transportation.

The subject of future helicopter costs brings us into an area where very little is actually known and where few definitive conclusions are possible. As we have seen, the development of the helicopter to date has been primarily along lines of military necessity, where maximum utility is the primary consideration and little attention is given to cost of operation. Present helicopters, as a result, have proved inordinately expensive to operate, and we are here faced with the task of estimating just how far these costs can be reduced as equipment and operating procedures are improved in the future. Experience over a period of 20 years in the operation of the conventional airplane has tremendously improved the industry's ability to estimate costs in advance, but with aircraft as radically different as the helicopter, the problem is indeed difficult.

Underlying the whole problem, is the fact that, historically, short haul transportation has always lost money for the carriers involved. The railroads' annual passenger deficit exceeds one-half billion dollars, and they say that some of their long haul traffic is profitable, but that they all lose money on the short haul and commuter services. A recent study of intercity bus company operating results, presented before the Interstate Commerce Commission, shows that on a fully allocated cost basis, the carriers lose money on passengers who travel less than approximately 250 miles. A similar study of one of the country's largest trunk airlines indicates that the breakeven point is nearly 400 miles. Thus, if the helicopter is successful in exploiting its potential short haul market, it will be the first vehicle which has ever enabled the average carrier to make a profit in unsubsidized short haul operations.

A glance at the operating results of the three helicopter services now in operation in Chicago, Los Angeles and New York, gives us an idea how far helicopter costs must be reduced before they compare with fixed-wing experience. In 1954, direct costs of these operators varied from $3.12 to $4.68 per available ton mile. This compares with

14c per available ton mile for the trunk airlines and 22c for the Local Service Carriers. The helicopter figures translate into direct seat mile costs of about 35c, which is more than fifteen times that of the Local Service Carriers. If we assume a 60% load factor and a 3:2 ratio of direct to indirect costs, the helicopter fare to be on a "breakeven" basis would have to be close to $1.00 per passenger mile.

We hasten to add that a number of adjustments should be made to these helicopter figures before they are regarded as comparable to the airline short haul operations. Because of their difficult route structures and because their schedules must conform largely to Post Office mail requirements, present helicopter utilization is very low, in some cases as low as 2 to 3 hours per day. This results in very high per mile depreciation and insurance charges. The insurance rates themselves are substantially higher than for fixed-wing operation. A much higher than normal percentage of non-revenue miles was flown in helicopter service. The average helicopter flight has been from 9 to 14 miles. If this were lengthened to at least 100 miles, to make a real intercity operation, direct costs per mile might well be reduced by one half.

These adjustments might well bring the available ton mile cost of the S-55 helicopter from about $3.50 per available ton mile to $1.25, a figure somewhat approximating 5 times the Local Service Airline present cost experience. Even at this adjusted level, this seems to paint a pretty black picture for the helicopter, especially when one realizes that even the Local Service Airlines with whom this comparison has been made, are at present receiving 45% of their gross revenues in the form of mail pay and subsidy payments. However, we have left out of our analysis consideration of the cost reducing possibilities of new types of helicopters and improvements in operating techniques. If we look at the history of one of the nation's leading trunk line air carriers, we see how important these considerations may be. In the 20-year period from 1934 to 1953, this carrier reduced its operating expenses per available ton mile from $1.09 to 25c on a 1952 dollar basis. Thus, its present real costs are less than one quarter what they were a scant 20 years ago, and in 1934 the airline industry had reached a fuller stage of development than has yet been attained by the helicopter.

It is apparent, however, that for the present, helicopter service will be unable to stand on its own feet, economically speaking. This, then, brings us to the subject of the role of the government in the development of the helicopter. There can be little doubt that government policies, not only at the federal level, but at the local level, as well, will have a large hand in shaping the role of the helicopter as a common carrier. This has been true historically of all forms of transportation. What will governmental policies be toward this new vehicle? Will the government limit its activity to the granting of route certificates, or will it assist the operators with generous mail pay or direct

subsidy? Will it provide air traffic control and navigational aids adapted to the special needs of the helicopter?

The answers to these questions will determine in substantial measure the ability of the helicopter to penetrate the field of common carrier travel. It is, as we have noted, a brand new vehicle with special potentialities for valuable service in the short haul field. Initially, its costs are high and will continue to be so for a number of years. If it is required to be completely self-sustaining, its fares will of necessity be so high that it will virtually price itself out of the market and few will use it.

The helicopter enters upon the transport scene some thirty years after the beginning of commercial air transportation by fixed-wing aircraft. During this time government assistance played a dominant role in air's development. First, the federal government through the Post Office Department provided direct financial assistance to the carriers through the medium of mail pay. Second, much of the indispensable research in aerodynamics and design of equipment was financed by the government and the military. Third, several hundred million dollars have been invested largely by the national government to provide and operate a complex system of airways necessary to enhance the speed, safety and dependability of air service. Fourth, states and municipalities (and since World War II, the federal government) have lifted most of the financial burden of providing and operating airports from the shoulders of the carriers. All this assistance has enabled the carriers to concentrate their resources on enlarging their carrying capacity and on keeping their fares down to levels which have attracted the traveler in ever-increasing numbers until in 1953 the airlines received more revenue from the carriage of intercity passengers than either the railroads or the buses.

It appears, however, that this liberal policy of assistance is undergoing revision. There is a growing conviction that the air transport system should begin to assume responsibilities of maturity and that it must prepare to accept a withdrawal or at least a contraction of government assistance. The recent separation of service mail pay from outright subsidy, and the insistence by the Post Office upon a policy of dispatching air mail via carriers whose mail pay rates are lowest are steps in this direction. A proposal that the commercial airlines should bear at least part of the annual costs of providing, maintaining and operating the federal airways system seems certain to be adopted in the near future. Again, the financial necessities of municipalities, coupled with the growing burden of outlays for airports they support, have already resulted, in many instances, in increased charges to their airline tenants.

In the face of this trend toward the curtailment of government assistance to trunk and local service airlines, can the development of the helicopter count on substantial government assistance? We believe that to a large extent it can, and our estimates of future helicopter

traffic levels for the New York area are predicated upon this belief. The Civil Aeronautics Board, in certifying the three helicopter services already operating, has recognized the desirability of acquiring experience with this mode of transport in order to test the feasibility of such services, both from a utility and an economic standpoint and has set rates of compensation that are adequate to maintain the services. The Post Office Department has adopted a "wait and see" policy in advocating additional helicopter services, but its long-standing policy of using the fastest means of transportation to expedite mail service gives assurance that as the helicopter is able to demonstrate improved dependability and decreasing costs of operation, its use in the carriage of mail will be extended.

The technological development of the helicopter will continue to be largely financed by the military because of the tremendous utility already demonstrated by this vehicle in carrying out a multitude of varying military assignments during the Korean War. That the Department of Defense is fully cognizant of the value of commercial helicopter operation was amply demonstrated by the persuasive nature of the views of the defense departments in supporting the applicants in the New York Helicopter Case. It would seem to be apparent that the prospective continuance of international tensions, which require a high degree of military readiness, decidedly enhances the probability that the national government will continue to encourage the growth of commercial helicopter transport services in order to accumulate operating experience under diverse conditions, to improve equipment and to maintain a reserve of transports and of personnel trained to maintain and operate them.

In summary, we may say that the helicopter clearly has its principal utility in the short haul passenger markets in which the service advantage in many cases is measured in minutes rather than hours when compared with surface modes of transport over distances up to 100 miles and with fixed-wing air transport from 100 to 300 miles. Its costs of operation for at least a decade will be markedly higher than those of fixed-wing aircraft, and much higher than those of surface conveyance. The helicopter must struggle for public acceptance. It is not unreasonable to expect a period of at least ten years before it can attain a really substantial place in the transportation picture. A commercial enterprise based upon the development of an entirely new transportation vehicle such as the helicopter cannot expect rapidly to reach significant stature on the basis of economic merit alone. It will require government assistance which, we feel, will be forthcoming.

With these considerations in mind, the Port Authority has estimated that 2 million helicopter passengers will be handled in metropolitan New York in 1960, approximately 60% aero-cab and the balance intercity. In 1965, the volume should increase to 3 million and by 1975 to over 6 million, of whom 25% will be aero-cab, 28% intercity and 47% suburban.

The mounting pressure of public interest in the helicopter plus the desperate need of most large cities in the country to improve their local transportation facilities and alleviate traffic congestion seem to dictate the early provision of city heliports. In certain localities, the helicopter may reach the traffic center of the communities served without incurring heavy expenditures for terminals. But in the larger metropolitan area where the helicopter must penetrate to the very edge of congested centers or sacrifice much of its service utility, the cost of providing terminals may well be very heavy.

We currently have underway within the Port Authority a series of studies to extend the work done in "Transportation by Helicopter 1955-1975." These studies include review of the design criteria for heliports to arrive at criteria for site selection, selection of sites for long-range development, preparation of development plans for each site, preparation of a preliminary cost estimate for such developments, and analysis of the costs from the standpoint of the projected traffic.

In these studies, we have found that there are unresolved factors in heliport and helicopter operations which make it difficult to develop criteria upon which actual construction can be based. The industry is making good progress in resolving many of these factors. It has been the privilege of members of the Port Authority staff to participate in industry conferences on heliports, such as with the Helicopter Committee of the International Air Transport Association. At such conferences, there seems to be a general acceptance of the philosophy that the helicopter of the future must be designed to conform to the heliport. Consequently, much attention has been given to the development of reasonable heliport size to meet future requirements. The future heliport size will be based on city planning requirements, projected helicopter performance, and economics.

As a result of our study and our participation in industry conferences, we have arrived at conclusions regarding heliport sizes and capacity which we deem satisfactory for long-range study purposes. The criteria should be re-examined before they are used in determining actual construction needs.

The size of the landing and take-off heliport is dependent to a great extent on the operating techniques used for the helicopter. As an example, a large two-engine helicopter would require an area approximately 800′ in length to make a forward take-off, if we apply normal fixed-wing criteria to accelerate-stop distances. To minimize the lengths of area required, other take-off techniques have been explored, such as the vertical and backward take-off. Today, industry thinking generally favors the vertical take-off which would permit operation from an area whose length is only 400′. The 400′ length is a reasonable size to accommodate in built-up metropolitan areas, and our study is based on the assumption that helicopter landing and take-off area will be 200 by 400 feet.

Although helicopter operations are considerably influenced by

wind velocity, we have concluded that one strip which enables operation in either direction will satisfy future requirements. This will mean that the helicopter operation must accommodate cross winds, but investigation indicates that this is operationally feasible.

It appears to us that the most efficient heliport operation will be one in which the landing and take-off areas are common, with the helicopter parking area located to one side. The size of the parking area will vary considerably with the characteristics of the helicopter. Such features as folding of the rotor blades and power-driven wheels (so that parking can be accomplished without the use of the rotor) will influence the space required per aircraft. Because of the complexity of the rotor hub and blade design, there exists considerable doubt that future aircraft will be equipped to fold the blades automatically. Likewise, because of the added weight it is questionable whether power-drive on the wheels will be provided.

For our study we have assumed that automatic blade-folding will not be provided but that the helicopter will be positioned with the rotor stopped either by power-drive to the wheels or the use of towing tugs. Positioning of the helicopter by mechanical devices has been considered but not accepted because of the inflexible use of the heliport apron which would result. Our conclusions regarding apron size for each helicopter is that parking positions for major heliports should be separated by a distance of 160 feet.

The capacity of the landing and take-off area along with the time the helicopter is parked at the gate will determine the number of parking positions needed. We have concluded that heliport capacity will be similar to runway capacity for fixed-wing aircraft both in IFR and VFR operations. Thus, we believe that heliport capacity will equal or exceed 40 movements per hour. At terminal heliports, the time the helicopter will require at the gate should be adequate for loading and unloading passengers, and refueling. Considering the size of future helicopters the application of an average of 12 minutes should satisfy gate time requirements. Using the 40-movement capacity and 12-minute gate time, we conclude a minimum of four gates are required, with at least one spare gate for overflow or disabled aircraft parking.

The approach zone slope (obstruction clearance plane) must be selected so that it does not excessively restrict development of property around the heliport. The slope will be influenced by the techniques which will be used to conduct instrument approach to the heliport. We believe that a reasonable prediction can be made on the slope which will be used. It appears that the industry will adopt a one-engine-out speed requirement in the vicinity of 35 miles per hour. This, then, would become the minimum instrument approach speed and the maximum rate of descent considered desirable for passenger comfort would be in the neighborhood of 500 feet per minute. Thus, application of a reasonable rate of descent along with minimum ap-

proach speed and clearance of obstructions indicate an 8:1 approach zone slope should be satisfactory. This slope appears reasonable for the take-off techniques being considered. This slope would permit a 50-foot building to be located approximately one block from the heliport indicating that such an approach zone slope is not unduly restrictive.

Protection of approaches through enactment of zoning legislation is desirable. However, this is a long and difficult process and in congested areas may be impractical because of the severe restrictions such zoning would place on multi-story building developments. It is advisable, therefore, to select landing areas having approaches over terrain which offers natural restrictions to tall obstructions. Waterfront property is a good example of such areas. Even here, however, there may be the problem of moving obstructions in the form of ship masts if the approach is over a ship channel or over a ship anchorage area. The alignment of approaches over open land areas such as parks, cemeteries, parkways, beaches, and marshes would be an alternative to waterfront sites.

An item which the industry realizes must be overcome is the noise produced by helicopters during approach and landing. This is critical to helicopter operation since the heliport must be located convenient to the downtown area. The manner in which helicopter noise will be controlled must yet be determined, but its control is a prerequisite to successful use.

Our study indicates that refueling facilities will be required at the major downtown heliports inasmuch as flights, particularly of the intercity type, will terminate and originate at these points. Our study today indicates that refueling will be practical for structural heliports but with considerable initial cost, and maintenance and operational costs. The fuel system costs for heliports atop multi-story buildings will be considerably greater than the costs for near-ground level sites. It is likely that the refueling facilities will result in an increase in insurance rates for the heliport structure which might penalize severely a multi-story-building heliport.

The landing and take-off area must be stressed to provide for the impact loading imposed by the landing helicopter. Normally, this impact factor would be negligible. However, in emergencies it can become a major load factor. Our study has shown that for large helicopters the impact loading will be determined as .7 the gross weight applied to an area equal to the ratio (in square inches) of 16,000 lbs. to the gross weight of the helicopter multiplied by 144.

Much popular discussion has indicated that rooftop heliports are desirable. We find that one serious objection to rooftop operation will be the effect of weather on such sites if on a multi-story building. In the New York area we find that ceilings will be 500 feet or below about 5% of the time, will be 300 feet or below about 2¾% of the time, and will be 100 feet or below about 1% of the time. The heli-

copter can operate in weather which is considerably more severe than that suitable for fixed-wing aircraft, possibly such a minimum of 500 feet and ½ mile. However, the ceiling must be measured from the level of the heliport. Therefore, it is obvious that the operation will be penalized from a dependability standpoint by the added elevation of the building.

To be successful the helicopter must be able to operate in a terminal area without materially affecting fixed-wing traffic or airport capacity. Accordingly, we have analyzed our own metropolitan area to see whether such an arrangement is possible. We are convinced that the helicopter can be operated independently of fixed-wing traffic in areas where the helicopter is beneath or between fixed-wing aircraft. It appears that the only time coordination will be necessary between fixed-wing and helicopter aircraft is when the helicopter must actually enter the airport to land or take-off at the terminal. Otherwise, if the helicopter stays within designated routes which will have a maximum width and altitude, its operation should be independent of fixed-wing traffic. The ability to operate in this fashion is an absolute requirement and air traffic control and electronic personnel must accept this concept.

As a summary, it can be said that the following factors must be considered in the selection of commercial heliport sites:

1. Proximity to traffic generating centers.
2. Vehicular accessibility and availability of public transportation.
3. Proximity to post office facilities. Since mail pay will be of major importance to the economic success of the helicopter in the initial stages, the importance of this factor is apparent.
4. A site with sufficient size and proper elevation. Elevation ranging from ground level to that of a relatively low building seems preferable. The space needed for the landing area combined with the necessary parking facilities will require an area of a size that may often prove difficult to assemble in downtown sections.
5. The location must be one that will allow helicopters to operate in conjunction with other helicopter traffic in the area without detrimental effect on fixed-wing traffic.
6. Existing obstruction clearance and possibility of obtaining permanent approach protection by zoning or through natural means.
7. The approach area should permit emergency landings in case of engine failure without serious damage to helicopter occupants or property owners. This requirement may later be eliminated by improvements in one-engine-out performance.
8. Cost of site development.
9. Possible effect on use of neighboring property as a result of noise of helicopter operations and air blast effects.

10. Practicability of providing refueling facilities. Bulk storage will be necessary and delivery by barge should be considered, where possible, to reduce costs.

It appears that the terminal building and vehicular access space requirements for the heliport will involve a small area as compared to the total heliport area. It is visualized that functions and facilities will be somewhat of a mixture of airport and bus terminal facilities. The scope of the facilities will be very much on the order of those provided at a bus terminal for passengers where large volumes of traffic are handled with minimum accommodations, whereas the actual functions will be similar to an airline operation at an airport.

Thus, we have need for gate positions, covered passenger access to those positions, small ticketing counters, a small baggage claim area, and provision for vehicular access. In addition, there will be need for a small control tower facility at major heliports, need for offices for airline operational functions (such as: dispatch, communications, ramp employees, pilot lounge, and ticket sales), and space for heliport management. The provision which should be made for visitors, spectators, and concessions will depend on the location and neighborhood.

Regional planning of a heliport system is desirable for a successful and economic operation. Since the helicopter is a relatively expensive form of transportation, the choice of localities which it will serve must be made with care. If properly located, protected and operated, the heliport will provide over the years an increasingly important transportation facility for farseeing and aggressive communities.