Organizational Growth and Population Dynamics: Strategies for Success

John E. Butler
Dept of Management
Shidler College of Business Administration
University of Hawaii
2404 Maile Way
Honolulu, HI 96822 USA
808-358-2405/
Fax 808-956-8582
jebutler@hawaii.edu

Wai-ming Mak
Dept of Management and Marketing
The Hong Kong Polytechnic University
Hung Hom, Kowloon
Hong Kong, SAR, China
852-2766-7376
Fax 852-2765-0611
mswmmak@polyu.edu.hk

Organizational Growth and Population Dynamics: Strategies for Success

Abstract
This paper examines the impact of population decline on an organization serving youth, to determine its impact on membership over a sixty year period. A double population chain model is used to identify population dynamics at the city and organization level. The model shows that membership would be greatly affected and that the response could either be downsizing or restructuring of activities. A multi-attribute model is then used to identify the preferences in all age groups of scouting to identify the criteria that they value in a after school activity and which activities compete with scouting.

Introduction

Most organizations want to at least maintain their membership levels and if possible to grow. There is also a tendency for organizations to equate growth with success. While business firms can use non-size indicators such a profit or earnings per share, non-profit organizations normally associate membership growth and the degree of service to their membership as appropriate performance indicators. Business firms know that growth also can pose hidden problems and is often associated with lower profit rates in business firms (Dundas and Richardson, 1982).

Putnam’s (2001) research showed a tendency towards individuals to go “bowling along” in the U.S., which is reflected in a decline in the membership in many service organizations, fraternal groups and social clubs. Other countries may not be facing a trend towards not joining, but they are facing absolute population declines, which has a similar impact on membership based organizations. Some employers have become aware of these population impacts because they are finding it difficult to fill their work force needs. Service and charitable organizations have yet to feel these population impact, and thus are doing very little planning on how they will be affected and what responses will work to generate higher levels of membership. Noticing these population impacts is the essential first task, but as Sherwood's (2002) example of the frogs in the lily-pads shows, noticing can be difficult. The frogs do not notice that the lily-pads have overtaken their pond until it is too late to initiate a viable defensive option. Organizations and their executives have an equally difficult time noticing how population dynamics affect them because they occur slowly over long period of time.

Population dynamics are of interest to system dynamics researchers. The research has focused on things such as the carrying capacity of a location with respect to the number of people, plants or animals it can support (Faust et al., 2004; Sterman and Booth Sweeney, 2002; Meadows et al., 1992). Population decline has been the unwanted outcome and resulted from unwise actions, such as occurred on Easter Island (Bahn and Flenley, 1992), and not the result of a population choosing to have fewer children. Sterman (2000) points out that Easter Island's carry capacity was unable to sustain its population levels. In other cases there are physical constraints to growth related to the consumption of resources (Meadows et al., 1974). In a country such as China, this absolute decline in population may be welcomed news, but in other locations such as Japan, Singapore, Hong Kong and a number of European countries it is feared that this trend may affect economic growth because there will not be sufficient workers to supply the wealth needed to support an aging population. In addition, many of these countries have limited numbers of immigrants and policies that are designed to limit immigration. Schools can be closed if there are not a sufficient number of children to fill them, but the spaces available in non-profit organizations designed to serve the needs to children cannot be so easily reassigned to the growing population of senior citizens.

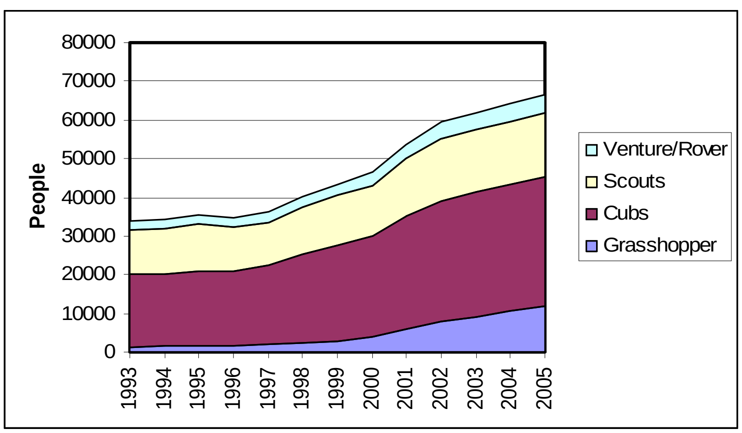
Organizations respond to change in different ways, but because organizations get very good at the things they do, they are often resistant to change. This is especially true for older organizations where their routines are deeply embedded, which leads to efficient and reliable organizations that are highly valued by society (Amburgey, Kelly and Barnett, 1993). Much of the existing research is focused on environmental or competitive changes, which leads to the decline of things such as the newspaper industry in many countries (Carroll, 1987). However, population change is so slow and so predictable, it escapes executives' attention. In addition, although the decline in population initially appears to be linear, its impact can led to non-linear consequences (Meyer, Baba and Colwell, 2005), which makes it difficult to analyze using standard statistical tools. System dynamics is especially suited for analyzing these types of problems, and because of its visual output is useful to organizations in formulating programs and policies to deal with population changes that affect their organization. Organizations can successfully develop strategies to cope with growth constraints related to demographic or social changes, such as Hall and Menzies (1983) outlined in their study of a Canadian Curling Club's efforts to maintain its membership levels in the face of changes in preference toward different sports and activities.

This paper addresses the issue of what an organization should do when it begins to realize that it is losing its customer, client or membership base. It does so by examining the impact of a decline in population on the Scout Association of Hong Kong (SAHK). A system dynamic model is used to identify the population impact. Then, a multi-attribute utility measurement procedure (Gardiner and Edwards, 1975) is used to identify the preferences of participants in the various age levels of scouting. These preferences are useful to help identify programs that could be developed to make scouting more attractive to young people. The final section involves identifying some strategies, based on these preferences, to determine their impact on maintaining organizational growth given a population decline.

Organizational Characteristics and Population Impacts

Hong Kong's scout movement has a rather long history, and its first scout troop was founded in 1913 at Saint Joseph's College. Its most difficult period was during World War II when the city was occupied, and scout activity rather limited. More recently, the return of Hong Kong to China required the SAHK to change some of its royal designators, but the local Chinese had assumed the top leadership positions in the SAHK during the early 1960s, which resulted in the SAHK having its ranks filled with experienced leaders when Hong Kong was returned to China. The SAHK has grown during most periods of time, with some Chief Commissioners having more aggressive growth goals than others. Generally, the Scout Association of Hong Kong (SAHK) has gone through period of growth, followed by periods of consolidation. In 1997 the SAHK selected a new Chief Commissioner and he set aggressive membership growth goals. There were dramatic membership increases in all scouting categories, as a result of these growth goals and policies (See Figure 1), in contrast to the 1993 to 1997 period where membership growth goals were more modest.

Fig. 1. Scout membership 1993-2002.



The supply of volunteer scout leaders acts as a constraint to membership growth in several scout age categories. While it might be reasoned that a decline in the birth rate would not have a serious impact on membership because the demand to join scouting exceeded the spaces available, the willingness of many to serve as volunteer leaders is a function of having children in scouting. Fewer children means that fewer parents fall into this volunteer category, and those that volunteer are likely to have shorter tenures. The sites available for use as meeting venues pose some membership growth constraints but these probably can be managed over the longer term. A final issue for the SAHK and any organization, which is functioning soundly, delivering high quality services, and experiencing membership growth is that they tend to be devoting all their energy and efforts to their ongoing programs and have little time and energy for the subtleties of long range planning. Like many organizations the leadership of the SAHK has the view that hard work, leader development, training programs and the inherent benefits of scouting will always provide a large pool of potential members, especially with respect to units geared for younger age groups.

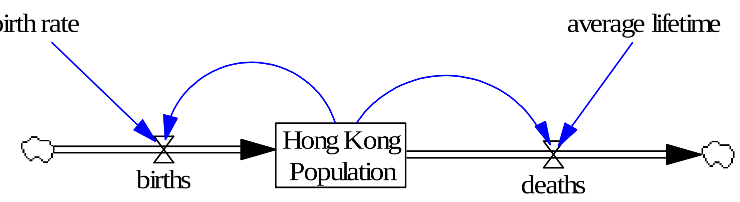
Although Hong Kong is now part of China, movement between Hong Kong and the Chinese mainland is still restricted, especially with respect to permanent immigration from China to Hong Kong. Population growth depends largely on local births, and these have been declining dramatically. The birth rate has dropped from 37 per 1,000 people in 1961 to 7.29 per 1,000 people in 2006. Factors that have a negative impact on Hong Kong's birth rate includes its high cost of living, small living spaces, limited space in the best schools, later age of marriage and long working hours. Hong Kong's birth rate may have reached a stationary minimum, but there is no reason to anticipate any increase in their birth rate in the near or long term, or a liberalization of immigration policy in the short term. The government has recently indicated that they would provide incentives for individuals who had a third child, but a local newspaper survey found that only 7% of couples indicated that they had any interest in this program.

With close to seven million residents and a 5.5% unemployment rate there is little current worry about the lack of population growth, except for firms in a few high technology areas, who often can attract well educated foreigners to fill these jobs. However, for an organization such as the SAHK, the implications of a continuous decline in the population and a sustained low birth rate is that this will dramatically reduces the population in the age groups it is most committed to serving. The leadership of the SAHK has not expressed any apparent worry about the dwindling number of potential recruits, in part because it has experienced dramatic growth in recent years. In addition, the SAHK has been actively trying to turn itself into a learning organization (Mak, 2003), adopting practices advocated by Senge (1990) and others, as a way of ensuring that it remains an important organization serving youth in the community. In this respect it is being proactive about increasing its attractiveness to those not currently involved in scouting and to increase the retention rate of those involved in the movement. However, this implies an increasing market share strategy, as the youth population continues to decline. This may require more resources to attract the same number of young people to scouting. In this respect the preferences of young people and the ability of the various scouting programs to satisfy their preference could have a large impact on the future scout population.

Descriptive Model

Hong Kong's population dynamics drive our model. To determine if people could accurately predict the impact of the lower birth rate on Hong Kong's long term population, we asked MBA students, with an average of ten years work experience to estimate Hong Kong's population in sixty years. After being given the relevant birth rates and life expectancy, most predicted modest population drops of 100,000 to 500,000. Part of the reason may be because during the past twenty years Hong Kong population did grow, but the growth was a function of people living longer. A simple model of Hong Kong's population (See Figure 2) indicates a drop in population from 7 million to 4.9 million in sixty years (See Figure 3). In the full research model, this is adapted to use only those in the age range likely to have children (See Appendix A). In response to the current declines in younger age groups the government has closed some primary schools, and indicated that Hong Kong's senior citizens moving to the Chinese mainland could use their health insurance there, which saves the government money because hospital costs are lower there, but there has been very little planning with respect to adjusting to an older and smaller population.

Fig. 2. Basic population model



Once the basis parameters of the population model are established an aging chain model (Forrester, 1969) was built that corresponds to the age grouping used by the SAHK. Figure 4 presents an illustration of the aging chain with respect to grasshopper scouts, which serves the youngest members of scouting. Appendix A depicts the complete model, while the documentation is contained in Appendix B. In the full model seven level variables make up the population chain. Four levels correspond to the various scout age groups (6 to 7, 8 to 11, 12 to 15, and 16 to 25). One level represents those too young for scouting (under 6), one for those in child bearing years (middle) and one for the older aged segment of the population (older). Expatriates, who are not permanent Hong Kong residents, are not included, although they are a sizeable population segment.

Fig. 3. Hong Kong's population projections over 60 years.

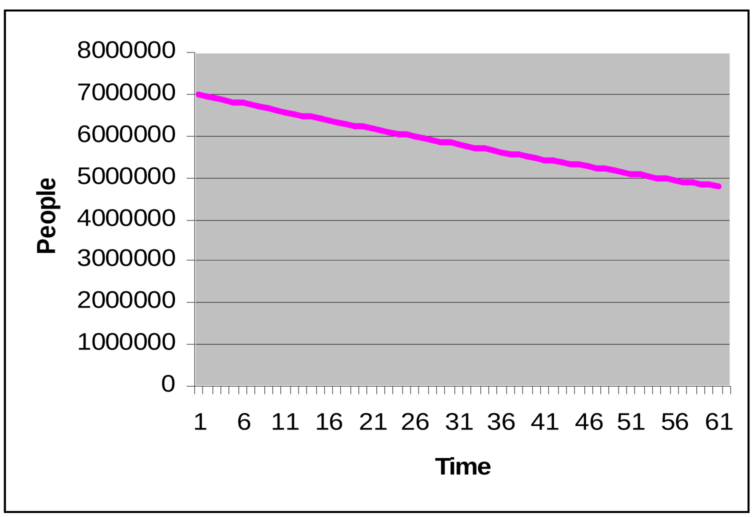
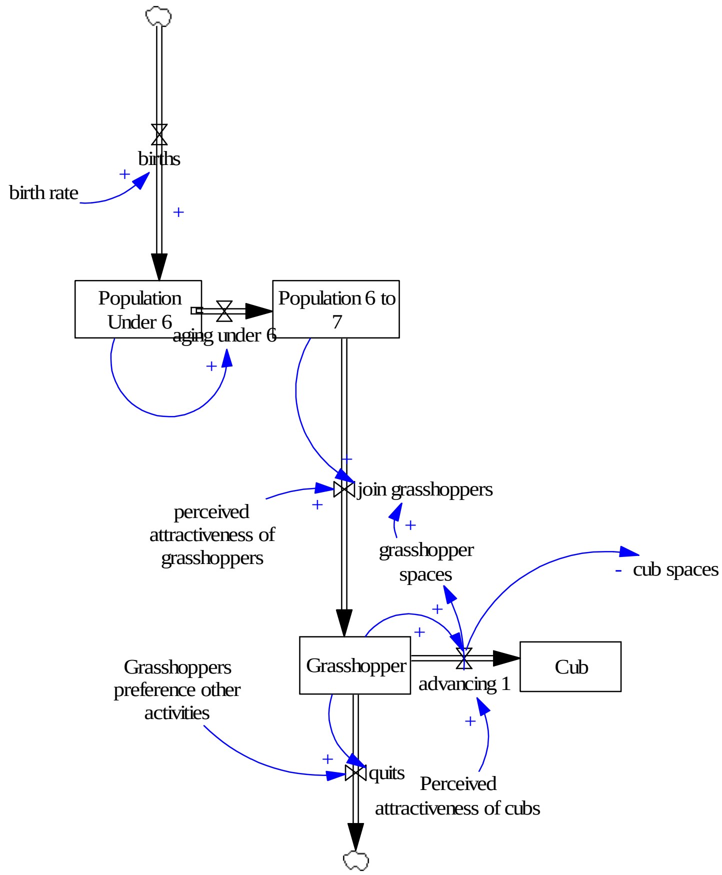


Fig. 4. Sample population chain for grasshopper scouts



The birth rate determines the number of people in the population under six years of age, with one sixth of this group moving on to be eligible for grasshopper scout membership each year. However, since the birth rate is dropping, the total number of children in this population segment will also drop. Since there are currently 475,000 people in this age group, about 79,000 are eligible to become grasshopper scouts each year. Currently, there are about 12,000 grasshopper scout spaces, and the problem has been finding leaders. Grasshopper scouts are very popular with the parents of 7 and 8 year olds, because they indicate they value both the activities in which their children participate, but also the free baby sitting services. Grasshopper scouts offer the opportunity for membership growth, and as can be seen in Figure 1, this age group has accounted for much of the membership growth in the SAHK in recent years.

Moving into the eligible population age group does not assure a child of the opportunity of joining a Grasshopper scout pack. Some children will not want to join because their perceived attractiveness of joining a pack is low. I some cases there may not be a pack near where they live or go to school. There will also be some who perceive Grasshopper scouts as attractive but the pack near where they live or go to school may not have sufficient openings. Open spaces are created in two ways. A large percentage of Grasshopper scouts advance and join Cub scout packs at age eight. Other leave scouting because they find other activities more attractive, cannot find a convenient cub scout pack, or find a pack with an open space.

Although not depicted in figure 4 the full model (Appendix A) includes similar dynamics for each of the scout age groups, with intake from the preceding lower age group, as well as drawing some members from the non-scouting general population. The population aging chain runs in parallel with the scout groups aging chain and this determine the total population pool not involved in scouting available for membership. Individuals also leave scouting, designated as "quits" in the model. This is driven by a preference for other activities, some of which are age related. Records indicate that the percentage of scouts that pass from the Scout age group to the Venture or Rover scouts is quite small. In part this is attributed to the fact that teenagers have a strong preference for school based activities and spending free time with fellow students, which is discussed in the section on preferences.

Boundary Conditions

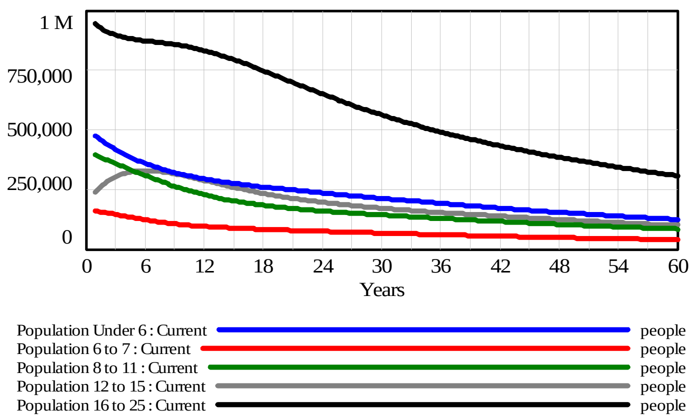
Scout membership is also affected by a number of factors that are not included in the model. Immigration has been left out because it is currently restricted, although it is logical for Hong Kong to allow more immigration, but it remains an emotionally charged issue. Including it would focus the model on immigration, and merely be of interest to show how many immigrants would be needed to stabilize the population.

Economic factors have also been excluded. A good economy might help scouting because there would be more people with the funds to get their children involved in scouting. On the other hand, it might lead to more two-spouse workers, and money for other activities that would affect membership negatively. It also was not apparent that it has a major impact on Hong Kong's birth rate when the economy is good, and might just accelerate the decline in population if the economy is bad. A further reason for not including it was because we could not identify a strong theoretical reason for doing so.

Population impact that affect the SAHK

The population dynamics affecting Hong Kong in general (Figure 3) are also mirrored in the population chain for each of the relevant age groups (See Figure 5). There is some slack, with respect to population decline, in the 12 to 15 and 17 to 25 age groups, but this just represents the residual of the aging process in Hong Kong, with slight increases and then a permanent and steady decline. Over the next sixty years all of these age groups will experience dramatic declines in their population. The model begins with a basic population model that has been adapted to Hong Kong's birth and death rate. Since the SAHK would obviously like to maintain high levels of membership, the decline requires them to recruit a larger percentage of people from each age group. Instead of having to fill 6,000 grasshopper spots from a population of 75,000, in sixty years the population pool will only have 20,500 six year olds advancing. This means that the SAHK would go from needing 7.5 % of to 29.2% of seven year old children to fill the places they have for Grasshopper scouts.

Fig. 5. Population for different scouting age groups.



The other age groups show similar dynamics. The Cubs scouts would be impacted the most seriously, with their pool of potential members dropping from 396,000 to 84,000, while the number of Grasshoppers advancing to Cub dropping below 1,900. They would need to recruit over 30,000 members from this small population pool. The only group not impacted would be the Ventures and Rovers, in part because their membership is so small relative to their population pool. However, as lower age scout groups have fewer members it is less likely that these will serve as a pool for older age scout groups.

A small population pool is reflected in the results. Figure 6 shows the input from the general population. The number joining Grasshoppers drops from 6,190 to 2,225 and the input from the general population joining the Cub scouts drops from 3,885 to 1,685. The declines are small for Scouts and Venture and Rover scouts, but these groups normally get most of their members from those advancing from lower age scout units.

The second and most important source of new members for the older age scout groups is from scouts who are already members and want to continue on in scouting. Figure 7 shows the model's output for Grasshopper scouts advancing to Cubs (advancing 1), Cubs advancing to Scouts (advancing 2) and Scouts advancing to become Venture and Rover scouts (advancing 3). The model's output suggests large drops in membership from what are currently considered the best source of new members. Grasshopper scouts advancing to Cub scouts will decline from 5,000 to 1,890 while the number of Cub scouts advancing to become Scouts will decline from 5,420 to 2,321.

Fig.6. Number joining scouts from general population.

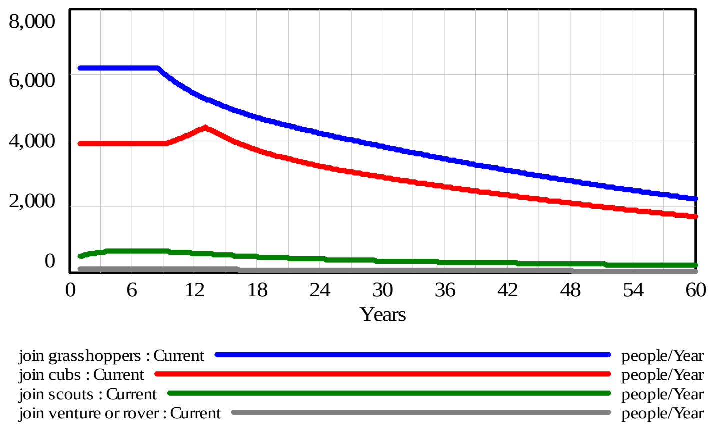
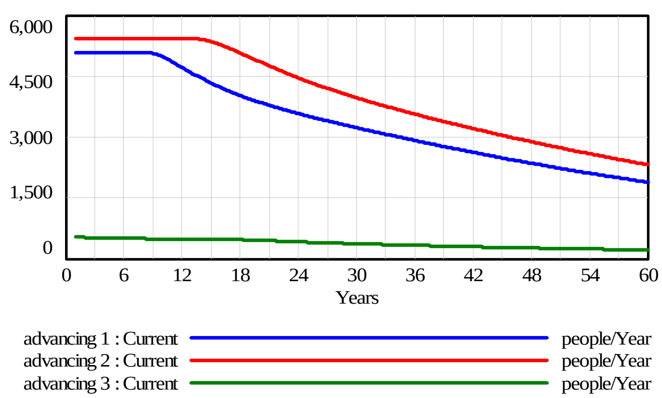


Fig. 7 Scouts advancing to the next age group.



The impact of the decline in the inflows from both the general population and advancing from lower units is reflected in fairly dramatic declines in membership for all age groups of scouting, as depicted in Figure 8. Grasshopper scouts show a decrease from 11,937 to 4,447, Cubs from 33,358 to 14,255, Scouts from 13,381 to 6,461 and Venture/Rovers from 5,501 to 1,084. While the decline in membership is dramatic, the SAHK would still be serving over 26,000 members, which is fairly significant if the population dropped to projected levels. Thus, their proportion contribution to the city's youth might not change. The key factor would be the degree to which the SAHK planned and adjusted for this expected change.

Fig. 8. Membership in Grasshopper, Cub, Scout and Venture/Rover

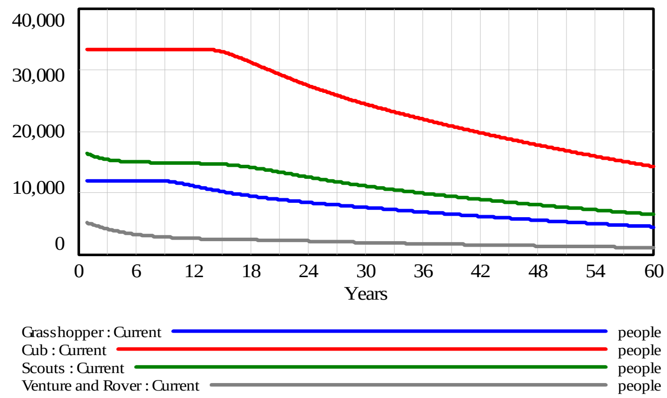
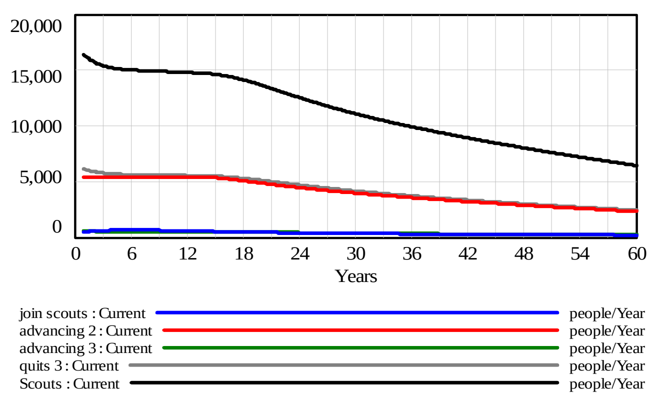


Figure 9 shows the combination of inflows and population for Scouts and includes members joining from the general population (join scouts), members advancing to join from Grasshopper scouts (advancing 2), those who leave scouting (quits 3) and those who move on to become Venture/Rover scouts. In terms of proportions, the results here are similar to those for the other age groups in scouting.

Fig. 9. Combined dynamics for Scouts



Validation

The validity of the model was supported by documentation and data provided by the SAHK. These included copies of their annual reports, which outline their activities, goals, and current membership. In addition, the SAHK has appointed a number of task forces over the past decade and we had access to these reports. Finally, one of the authors recently completed a doctoral dissertation related to the efforts of the SAHK to increase its efficiency, effectiveness, membership and training. We were also able to discuss our model and findings with a member of the SAHK's governing board, and make adjust or additions as needed.

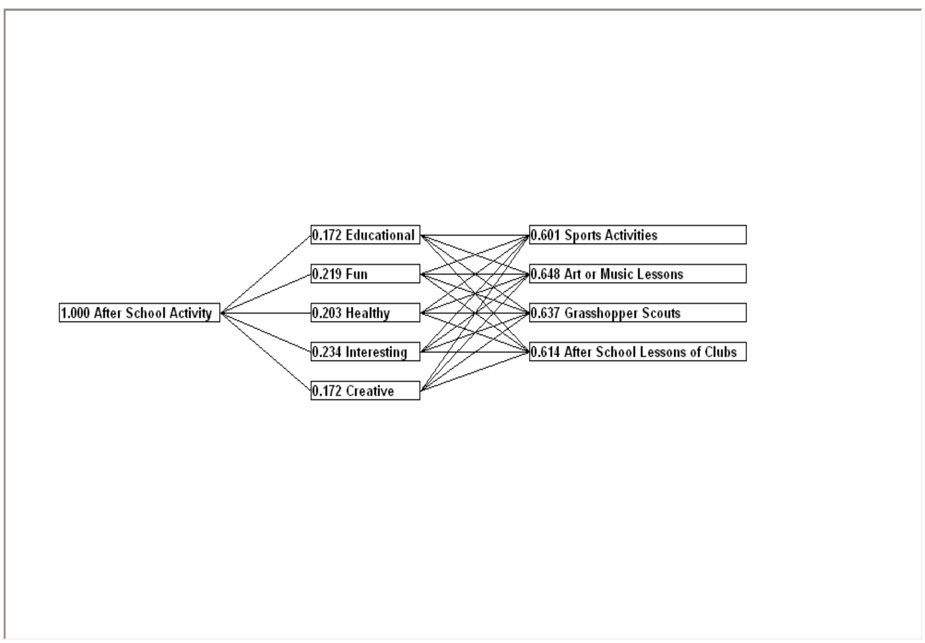
The Hong Kong government conducts a population census every five years, to which we had access. In addition, they collect annual information related to deaths, births and marriages. Thus, we had high quality data with respect to the population levels in each of the age segments.

The model was checked for unit consistency and several adjustments were mode to ensure that there were no negative flows in the scout membership stock variables. The time step was reduced to ensure that the results were not distorted. The model was not fully checked for extreme conditions, in part, because we plan on adding policy input variables to the model.

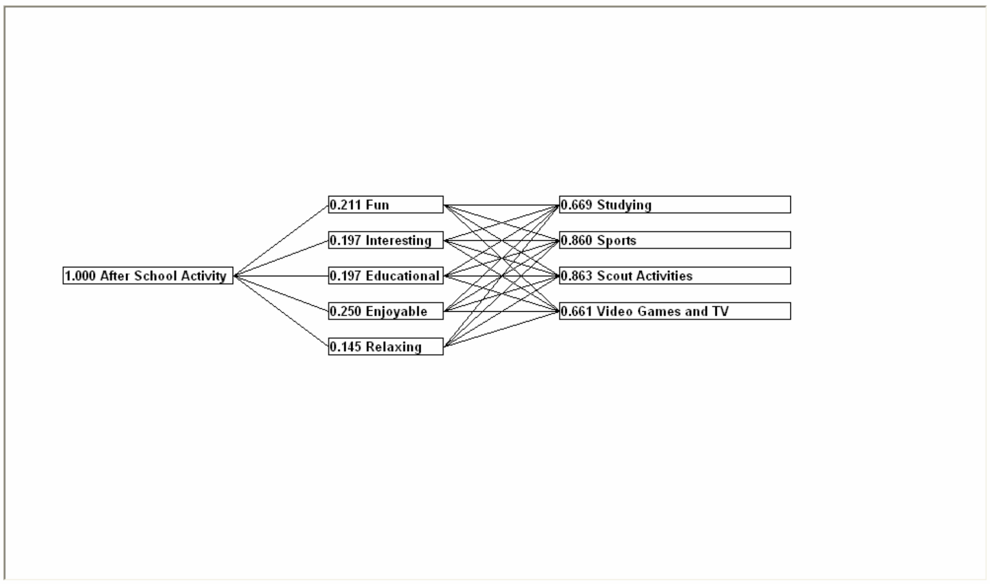
Possible Policy Prescriptions

There are two options for the SAHK. One is to accept population decline as inevitable and to plan for reduced levels of membership. This is not a very attractive option. The second option is to construct and develop activities that are likely to attract more youth to scouting. In an effort to determine if this was feasible, we developed a multi-attribute model of the preferences of youth in the different age groups of scouting. To do this we first asked members in each of the different scout age units "which activities do you do after school and on weekends," and "what are the criteria you use to select an after school activity." We then went through the responses to identify the activities and criteria that appeared most often.   If you look at Figure 10 below, you will see that Grasshopper scouts list educational, fun, healthy, interesting and creative as their criteria. They are then asked to assess each of the activities (sports, art or music, Grasshopper scouts, and clubs on each of the criteria, using a four point scale. The higher the preference score the more valued the activity. The same is true for the criteria, which higher scores where the higher score indicates they value one criterion more than another.

Fig. 9. Hierarchy graph with accumulated weights for Grasshopper scouts



The process was repeated for each of the scout groups and the preferences for Scouts are depicted in Figure 10. The older age and concerns of the Scouts is reflected in their preference for studying, sports and video games. The results for Scouts also show that sports and Scout activities are highly valued relative to studying and video games. Thus, to attract more youth to scouting, the planning of activities have to focus on criteria that youth value in an outside of school activity, or include other activities that already are seen as important. In addition, since preferences are not constant over time, the preferences of members would need to be reassessed periodically. It would probably also be useful to collect data on youth not involved in scouting as a way to generate additional membership.
Fig. 9. Hierarchy graph with accumulated weights for Scouts



Conclusions

While the results here indicate that Hong Kong may have a dramatic population decline, the decline may also be more modest. The current model can be updated as rates of immigration, births or deaths change. This is especially critical for each of the age groups served by scouting. One of the things not addressed in the current model, but planned for subsequent models, is the inclusion of leaders, and the factors that influence the number of individuals willing to serve as leaders. While some leaders remain active in scouting after their children are no longer involved, but the percentage is low. Finding ways to increase this percentage is extremely important.

One of the key aims of the SAHK is attracting young people to their programs and retaining them as they move from Grasshopper scouts to Cub scout, and from Cub scouts and Scouts and then on to Rover scouts and Rover scouts. Figure 9 shows that the retention dynamics projected for each of the scouting sections based on the current rates of retention. However, as the population decline begins to affect the actual population in the lower age scout sections the actual number of individuals moving on to the next section will decline. The only place that will not be affected is at the Venture/Rover scout level, but this is because the rate of retention is already so low with respect to Scouts moving on to become Venture/Rover scouts.

The dynamics suggest that the solution is to attract more into scouting from outside scouting, but this is extremely difficult to do at older ages. In addition, as was discussed earlier, parents of scouts provide the major source for new leaders, and as the population of scouts declines it will put a strain on the number of volunteer leaders, making it very difficult to make dramatic quality improvement in the various scout sections. Enhanced quality is what will be needed to attract members from outside scouting, and this will be difficult to accomplish.

The data has now also been collected that allows the impact of new activities specifically identified as popular and to design new activities that contain the criteria that the current members value. The impact of these could also be incorporated into a more elaborate model

The population decline in Hong Kong is not unique. Japan, Singapore many countries in Europe and Russia are also experiencing declining birth rates. System dynamics provides a tool for organizations, such as the SAHK, as well as other governmental and business organizations to examine how these population trends will impact on their goals, especially any related to growth. Part of our future research agenda is to also include policy variables, such as immigration, to test the implications of using this as a policy lever.

References

Amburgey, TL, Kelly, D., Barnett, W.P. 1993. Resetting the clock: The dynamics of organizational change and failure. *Administrative Science Quarterly* 38(1): 51-73.

Carroll, GR. 1987. *Publish and Perish: The Organizational Ecology of Newspaper Industries*. Greenwich, CT: JAI Press.

Dundas, K, Richardson, P. 1982. Implementing the unrelated product strategy. *Strategic Management Journal* 3(4): 287-301.

Faust, LJ, Jackson, J, Ford, A, Earnhardt, JM, Thompson, SD. 2004. Models for management of wildlife populations: lessons from spectacled bears in zoos and grizzly bears in Yellowstone. *System Dynamics Review* **20**(2): 163-178

Forrester, JW. 1969. *Urban Dynamics*. Waltham, MA: Pegasus Communications.

Ford, A. 1999. *Modeling the Environment: An Introduction to System Dynamics Modeling of Environmental Systems*. Washington, D.C.: Island Press.

Gardiner, PV, Edwards, W. 1975. Public values: multivariate-utility measurement for social decision making. In *Human Judgment and Decision Processes*, MF Kaplan, S Schwartz (Eds.). Academic Press: New York; 1-37.

Gardiner, PC, Ford, A. 1980. Which policy run is best, and who says so? In *System Dynamics*, AA Legasto, JW Forestor, JM Lyneis (eds.), TIMS Studies in Management Science 14: 241-257.

Hall, RI, Menzies, WB. 1983. A corporate system model of a sports club: using simulation as an aid to policy making in a crisis. *Management Science* **29**(1): 52-64.

Keeney, RL, Raiffa, H. 1993. *Decisions with Multiple Objectives: Preferences and Value Tradeoffs*. Cambridge: Cambridge University Press.

Mak, WM. 2003. *Organizational Learning: The Case of the Scout Association of Hong Kong*. Doctoral Dissertation, University of Hull.

Meadows, DL, Behrens, WW, Meadows, DH, Randers, J, Zahn EKO. 1974. *Dynamics of Growth in a Finite World*. Cambridge, MA: Wrigth-Allen Press.

Meadows, DH, Meadows, DL, Randers, J. 1992. *Beyond the Limits*. Post Mills, VT: Chelsea Green Publishing Company.

Putman, R. 2001. *Bowling Alone: The Collapse and Revival of American Community*. New York: Simon & Schuster.

Senge, PM. 1990. *The Firth Discipline: the Art and Practice of the Learning Organization*. New York: Doubleday

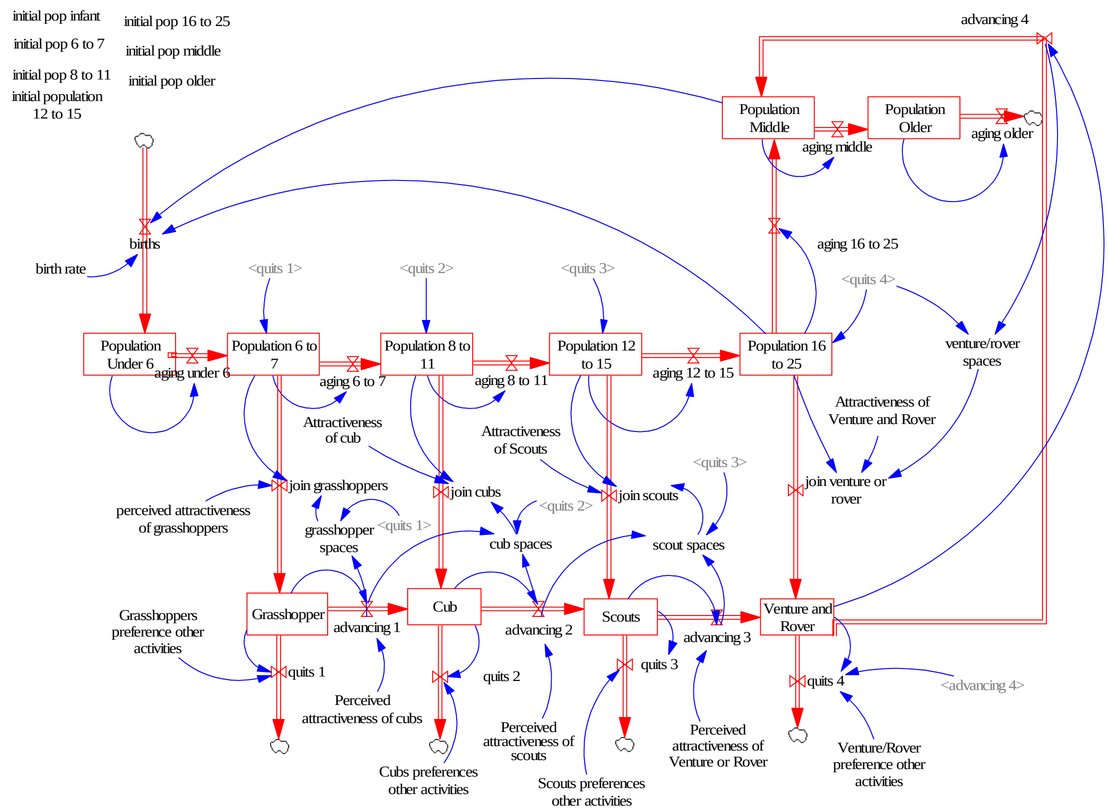
Sherwood, D. 2002. *Seeing the Forest for the Trees: A Manager's Guide to Applying Systems Thinking*. London: Nicholas Brealey.

Sterman, JD. 2000. *Business Dynamics: Systems Thinking and Modeling for a Complex World*. Boston: Irwin McGraw Hill.

Sterman, JD, Booth Sweeney, L. 2002. Cloudy skies: assessing public understanding of global warming. System Dynamics Review **18**(2): ?????.

VonWinterfeldt, D., Edwards, W. 1986. *Decision Analysis and Behavioral Research. Cambridge*: Cambridge University Press.

Appendix A Full Model



Appendix B - Equations

(01) advancing 1=(Grasshopper/2)*Perceived attractiveness of cubs
Units: people/Year
One half of total population are assumed to be positioned to advance each year since this is a two year program.

(02) advancing 2=(Cub/4)*Perceived attractiveness of scouts
Units: people/Year
One quarter of cub scouts are eligible to advance to scouts each year.

(03) advancing 3=((Scouts/6)*Perceived attractiveness of Venture or Rover)
Units: people/Year
The number of scouts that reach their final year of eligibility is much lower than 25% of total, so the pool eligible to advance is divided by 6, which represents about 16.6% of the total pool of scouts.

(04) advancing 4=(Venture and Rover/9)
Units: people/Year
9 years in this group and 1/9 leave each year because of aging.

(05) aging 12 to 15=Population 12 to 15/ 4
Units: people/Year
The rate at which people move out of this age group and into the next group on the assumption that that each age group is the same and equally divided over four years.

(06) aging 16 to 25=Population 16 to 25/ 10
Units: people/Year
Total is divided by average time in the this age group of 10 years

(07) aging 6 to 7=Population 6 to 7 / 2
Units: people/Year
Population is divided by two on the assumption that the age groups are evenly divided and that one third leave each year.

(08) aging 8 to 11= Population 8 to 11 / 4
Units: people/Year
The total is divided by 4 to account for the fact that one fourth of this group departs each year because of their age.

(09) aging middle= Population Middle / 20
Units: people/Year
20 years represents the total years in this segment. Deaths have not been included in this segment nor has immigration.

(10) aging older=Population Older / 33

Units: people/Year
33 years represents the time in this age group for those achieving normal life expectancy in Hong Kong,

(11) aging under 6=Population Under 6 / 6
Units: people/Year
One sixth of the people in this group leave each year. No allowance is made for deaths because they are not sufficiently large to have an impact on scouting.

(12) Attractiveness of cub=0.02018
Units: percentage
This represents the percentage of the total eligible population that is not advancing from grasshoppers that would like to join the cub scouts. Currently this represents 100% more people than for who their is space.

(13) Attractiveness of Scouts=0.002
Units: percentage
This is based on the actual percent of non-cubs who join and become scouts.

(14) Attractiveness of Venture and Rover=0.0001
Units: percentage
Very few people join at the venture and rover stage, and almost all scouts in these units have previous scouting experience.

(15) birth rate=0.01431
Units: fraction/Year
This is based on the birth rate for the total population of 7.3 births per thousand total population being adjusted upward to reflect the proportion of the population in the 16 to 45 age group. Further declines in the rate seem unlikely given the already low birth rate.

(16) births= birth rate*(Population 16 to 25+Population Middle)
Units: people/Year
Assumes that almost all births occur with parents in the 16 to 45 age group.

(17) Cub= INTEG (+advancing 1-advancing 2-quits 2+join cubs,33358)
Units: people
The initial population of cub scouts is positively affected by an annual inflow of grasshopper scouts and negatively impacted by cubs advancing to scouts and quits.

(18) cub spaces=MAX(0, (advancing 2+quits 2-advancing 1))
Units: people/Year
This represents the number of spaces that are available to the general population.

(19) Cubs preferences other activities=0.01857
Units: percentage
Represents the total preference for other non-scouting after school activities.

(20) FINAL TIME = 60
Units: Year
The final time for the simulation.

(21) Grasshopper= INTEG (join grasshoppers-quits 1-advancing 1, 11937)
Units: people
The current population of grasshoppers minus those either advance to cubs, choosing not to advance or quitting before having to make the advance or not decision.

(22) grasshopper spaces=MAX((0), (advancing 1+quits 1))
Units: people/Year

(23) Grasshoppers preference other activities=0.01863
Units: percentage
Represents the cumulative preference for other non-scouting after school activities as determined using a multi-attribute approach.

(24) initial pop 16 to 25=944337
Units: people
This includes 8 years at 102,271 people per segments, which is based on the average for this age group, and one year at 123,169 which is the average size of the 25 to 34 age group. Assumes uniform distribution within the age group.

(25) initial pop 6 to 7=158489
Units: people
This group spans two years, so the initial value is 79,244 * 2. Uniform distribution is assumed with this age group.

(26) initial pop 8 to 11=396220
Units: people
The assumption is that the population is uniformly distributed.

(27) initial pop infant=475464
Units: people
Assumes that the population between 0 and 14 is uniformly distributed. There are 1,109,417 people in this segment in the latest census. Initial value is set at 79,244 x 6 years.

(28) initial pop middle=2.34584e+006
Units: people
This group includes all those individuals in the 26 to 34 age group, which is 8 years * 123,169 people. It also includes the 1,360,487 people in the 35 to 44 age group.

(29) initial pop older=2.20951e+006
Units: people
Includes all individuals 45 and above.

(30) initial population 12 to 15=237732
Units: people
This initial value represents three years at 79,244 persons, which is the uniform average population in the age group between 12 to 15 and one year at the 102,272 population for the age group between 15 and 24 according to the latest Hong Kong census.

(31) INITIAL TIME = 1
Units: Year
The initial time for the simulation.

(32) join cubs=MIN((Population 8 to 11*Attractiveness of cub),cub spaces)
Units: people/Year
More would like to join the cubs but spaces are limited to quits and those who advance minus grasshoppers who advance. Thus the general population generates a pool that would like to be cubs subject to this constraint. The function ensures against negative joins.

(33) join grasshoppers=MIN((perceived attractiveness of grasshoppers*Population 6 to 7), (grasshopper spaces))
Units: people/Year
The number of people in this age group that join the grasshoppers will be determined by how attractive they think this unit of scouting is. An arbitrary scale has been used to rate attractiveness between 0 and 1.

(34) join scouts=MIN((Attractiveness of Scouts*Population 12 to 15),(scout spaces))
Units: people/Year
The min is used to ensure that no matter how attractive becoming a scout is seen by those currently not in the movement that there is a constraint on entry based on those leaving the scouting movement or moving on to the next stage while accounting for movement up by cub.

(35) join venture or rover=MIN((Attractiveness of Venture and Rover*Population 16 to 25),("venture/rover spaces"))
Units: people/Year

(36) Perceived attractiveness of cubs=0.85
Units: percentage
This represents the percentage that actually choose to advance. This is a constant and has been stable for many years.

(37) perceived attractiveness of grasshoppers=0.057
Units: percentage
The parameter incorporates the total demand for grasshopper spaces, which is 100% more than the available number of spaces. Thus, the preference for joining has bee set at 5.7% which corresponds to this estimate. Since spaces are location bound, the preference estimate has been set as a constant.

(38) Perceived attractiveness of scouts=0.65
Units: percentage
Currently about 65% of cubs chose not to move on to Scouts and this number has been stable for many years.

(39) Perceived attractiveness of Venture or Rover=0.2
Units: percentage
Currently 80% of scouts still in the system chose not to move on to next stage.

(40) Population 12 to 15= INTEG (aging 12 to 15+aging 8 to 11-join scouts+quits 3,initial population 12 to 15)
Units: people
This level variable represents the population that is eligible to join the scouts.

(41) Population 16 to 25= INTEG (aging 12 to 15-aging 16 to 25-join venture or rover+quits 4,initial pop 16 to 25)
Units: people
Represents the population eligible to join either the venture or rover scouts that has not yet joined.

(42) Population 6 to 7= INTEG (+aging under 6 - aging 6 to 7-join grasshoppers+quits 1,initial pop 6 to 7)
Units: people
This is the age group that is eligible to join the grasshopper scouts who have not yet joined.

(43) Population 8 to 11= INTEG (aging 6 to 7 - aging 8 to 11-join cubs+quits 2,initial pop 8 to 11)
Units: people
The group of people eligible to join the cub scouts who have not joined.

(44) Population Middle= INTEG (aging 16 to 25 - aging middle+advancing 4,initial pop middle)
Units: people
This represents the population 26 to 45.

(45) Population Older= INTEG (aging middle - aging older,initial pop older)
Units: people

(46) Population Under 6= INTEG (births - aging under 6,initial pop infant)
Units: people
This represents children too young to enter scouting.

(47) quits 1=(Grasshoppers preference other activities*Grasshopper)+(0.15*(Grasshopper/2))
Units: people/Year
The total population of grasshopper scouts is affected by the attractiveness of other activities while those 15% who do not advance to cubs also represent quits.

(48) quits 2=(Cub *Cubs preferences other activities)+(0.35*Cub/4)
Units: people/Year
The first section of this equation repesents loss of cubs to other activities, which affects the entire cub population. The second part represents the 35% of cubs that do not advance to scouts.

(49) quits 3=(Scouts preferences other activities*Scouts)+(Scouts/4*0.9)
Units: people/Year
The first part of the equation represents the entire population of scouts and is the percentage of scouts attracted to other activities. The second part represents the .80 percent of scouts who reach the age limit and do not continue on to become Venture or Rover scouts.

(50) quits 4=(Venture and Rover*"Venture/Rover preference other activities")+advancing 4
Units: people/Year
About 12% of the base quits each year in most cases because other activities are more attractive for this age group.

(51) SAVEPER = TIME STEP
Units: Year [0,?]
The frequency with which output is stored.

(52) scout spaces=
MAX((0),(advancing 3+quits 3-advancing 2))
Units: people/Year

(53) Scouts= INTEG (+advancing 2-advancing 3+join scouts-quits 3,16381)
Units: people

(54) Scouts preferences other activities=0.15
Units: percentage
Represents the total preference scores for other non-scouting activities.

(55) TIME STEP = 0.25
Units: Year [0,?]
The time step for the simulation.

(56) Venture and Rover= INTEG (advancing 3-advancing 4+join venture or rover-quits 4,5105)
Units: people

(57) "Venture/Rover preference other activities"=0.02279
Units: percentage
Represents preference for non-scouting free time activities.

(58) "venture/rover spaces"=MAX((0),(advancing 4+quits 4))
Units: people/Year