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PROVIDING INSIGHT INTO THE SUCCESSFUL PROCESS OF MILITARY BASE TRANSITION WITH A PERT SIMULATION MODEL

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ABSTRACT

Military base closures will affect more than 100 communities across the United States during the next five years. The potential for economic hardship is significant. However, the experience of communities where military bases have closed suggests that the efforts of individual communities during the transition can significantly affect the economic outcome.

A PERT simulation model is developed in SLAMSYSTEM to provide a tool for communities that illustrates recovery, takes the impact of job loss into account and gives insight into the implications for a manufacturing organization. An engineering analysis is applied to a problem that has previously been modeled strictly by economists.

The PERT simulation model combines the network modeling and continuous modeling concepts in SLAM. It allows the initial conditions and activity times in the base transition process model to control the governing equation for jobs created at a site. Data is collected through a survey of community representatives in communities where the transition is already completed.

It is determined that simulation modeling is a reliable method of understanding community influences on successful military base transitions.

1.0 INTRODUCTION

The analysis of the closure of obsolete or excess military installations and the transition of those properties to civilian use is at the core of this study. Local communities and forecasters expect a significantly negative impact from the closures. Many of the communities, especially the smaller ones, are dependent on the nearby military facility for their economic vitality.

Typically, the problem of the economic impact of the base closure on the community has been examined by economists. Unfortunately, the socio-economic models used until now, even with the aid of the Air Force's sophisticated modeling devices, are considered crude and imprecise as a planning tool (President's EAC 1979).

There is currently no method for estimating the "probable impact" with traditional economic multipliers that gives the community a feel for economic adjustment after a recovery effort (President's EAC 1979). Yet, little work has been done in this area after the 70's since no bases were closed in the 80's.

Results predicted by existing models are generally overstated. The worst-case scenarios tend to be frightening to the community. These predictions can add to the confusion and uncertainty of the base closure process (President's EAC 1979).

1.1 The Transition Process and Economic Recovery

Anecdotal evidence suggests that a process of transition that provides for some degree of recovery (Lynch 1970 and President's EAC 1991, 1990). The case studies describe the characteristics of a process driven by local initiative that successfully minimizes the expected impact of the closure and provides for growth in some communities.

The Office of Economic Adjustment (OEA) in the Department of Defense reports that in 100 communities 93,424 civilian DoD jobs were lost while 158,104 jobs are now located on the former defense facilities (President's EAC 1990). Military facilities have been converted to industrial parks, technical schools and colleges, airports and correctional facilities which all contribute to the economic vitality of the community.

The prospects of developing a model to quantitatively illustrate this process make this problem worthy of study.

1.2 Engineering Analysis In Contrast to Economic Models

This study is an attempt to apply engineering analysis to a problem traditionally viewed by economists. An analysis is done on communities in which bases were closed from 1963-1980 where the transitions are now considered to be complete.

A simulation model is developed using SLAMSYSTEM and Microsoft Fortran to simulate economic development in terms of jobs created at the former military site given basic initial conditions about the community and the site.

A PERT method is chosen for analysis (Malcolm, et al. 1959). The PERT model is appropriate for this process since information was available about the base closure process to determine an ordered sequence of events for the model .

1.3 Community Facing Closure: Declining Organization?

The community effort in economic development and job creation has left many of the communities in a stronger position after the transition is completed because the local leaders develop momentum in their development efforts (Lynch, 1970).

However, the study does not intend to imply that a job created in five years is of equivalent value to an existing job to be cut today. The loss of time is a loss of real income to the whole community (Leontief and Hoffenberg, 1961).

The communities face issues in the transition of military facilities to civilian use that can be likened to the difficulties faced by an industrial organization in decline. An organization in decline due to the erosion of an industry or the collapse of a market niche is similar to a community facing base closure in two ways.

Managers in the declining organization must struggle with competing tasks: managing the reduction of size of the business and effectively managing the remaining portion of the business (Sutton, et.al. 1986). In base transition, community leaders facing the closure also must struggle with competing tasks: managing the reduction in size of the local economy while ensuring that the remaining portion of the local economy remains viable.

American leaders usually lack the knowledge, experience and training needed to manage an organization in decline (Sutton, et al. 1986). A look at communities facing base closure should shed some light on the process of managing a declining organization.

2.0 OBJECTIVES

The purpose of this work is to provide a model for communities facing the current round of base closures that will help them cope with local economic dislocation and disruption. More specifically, the three project objectives are:

1. To provide a tool for the community that illustrates the recovery yet takes the economic impact into account. It should highlight, in a quantitative manner, the successful mechanism that previous communities have developed for the transition of military bases to civilian use.

2. To provide an engineering analysis that yields reliable results in contrast to the existing economic models currently used for planning in the face of base closure.

3. To provide insight into the problem of how to manage a declining organization as well as show implications for a manufacturing organization.

3.0 ASSUMPTIONS

The model is developed to deal with the local economic development of the base closure process and assumes that there is an expanding national aggregate demand. The cycles in the economy over the length of time of the transitions are considered to be small and are not included in the model. This assumption is justified through studies of the economic impact of base closure and disarmament (Lynch 1970, Leontief and Hoffenberg 1961).

The model is stochastic, or random, in that the arrival at each state in the network portion is random and independent of the previous state of the model (Shannon 1975).

It should be noted that the selection of the facility to be closed is outside the scope of this study.

4.0 THE MODEL

In this model the PERT network controls the governing equation, an exponential. It illustrates the concept of using continuous equations to simulate a physical system (Forrester 1971). This type of model takes advantage of the strengths of SLAM in that the network and the continuous models can be combined (Pritsker 1986).

4.1 Definition of the Network Model using PERT

The community respondents were asked to circle the choice that best represented their response to a multiple-choice question asking how long it took to complete each of the following:

1. The investigation of the environmental cleanup required.
2. The restoration and environmental cleanup.
3. The DOD closure activities for the base.
4. Initial communication between the community and the different agencies of the Economic Adjustment Committee.
5. Joint planning for reuse with any agencies of the EAC.
6. Resources to be provided for proper study of reuse by the EAC and the state alternatives and any improvements needed to effectively market the property.
7. Acquire the property from the Federal Government.
8. Organize and draft a community plan for reuse.
9. Implement the community plan of action.
10. Complete the zoning and improvements that were needed.
11. Complete the marketing of the property for reuse.

Estimates of the range of choices for the activity times were obtained from OEA documents (OEA 1991). The choices ranged from "0-1 month" to "7 years or more" for all eleven activities.

Each of the eleven represent an activity in the PERT model. The sequence and paths that each of these activities are shown in the PERT model in Figure 1.

4.2 The Continuous Model

A two stage governing equation is used in the simulation.

$$(1) \qquad J_T(t_1+t_2)= J_1(t_1)+J_2(t_2)$$

The graph of Figure 2 illustrates the employment gain observed for the Donaldson Air Force Base in Greenville, South Carolina. An exponential equation is chosen to simulate this growth pattern for each of the two stages.

In the first stage jobs were created using the capacity constant IC, determined from the initial conditions of the community and base. The speed of response t_1 is determined from the time to complete the property acquisition.

$$(2) \qquad J_1(t_1)= IC * (1 - \exp(-t_1 /\tau_1)$$

for

$$0 < t_1 < t_{property\ acquisition}$$

where

$$IC= \ln \frac{(Population * Acres)}{(Civilian\ Jobs\ Lost + 1/2\ Military\ Jobs\ Lost)}$$

and

$$\tau_1 = 4 * t_{property\ acquisition}$$

Intuitively, one would expect that the economic prospects or growth capacity would be better and the impact less drastic in an urban area, when more land and facilities were available to the community for development, and when the direct number of jobs lost due to closure is lower.

The second stage began when the property acquisition activity was completed. In this stage jobs were created using the capacity constant CI determined by the community influence ratio while the speed of response t_2 again was determined by the time to complete the property acquisition.

(3) $$J_2(t_2) = CI * (1 - \exp(-(t_2 - t_1)/\tau_2))$$

for

$$t_{property\ acquisition} < t_2 < t_{end\ of\ process}$$

where

$$CI = 625 * \frac{(t_{market\ property} + t_{zoning\ and\ improvements})}{(t_{organize\ \&\ plan\ for\ reuse} + t_{implement\ the\ plan})}$$

and

$$\tau_2 = 4.5 * t_{property\ acquisition}$$

The physical translation of the constants for the speed of response τ_1 and τ_2 is that the faster that the property can be acquired from the federal government, the faster the transition can be made to civilian use. The idea behind the community influence capacity constant CI is that the potential for job creation is better if the community spends more time "doing" and less time "talking about it".

4.3 Rules Affecting the Governing Equation

Economic growth was severely limited when either of the following two conditions occurred:

1. If the sum of the Organize and Plan, and Implementation of the Plan activities are completed in less than one year.

2. If the Implementation of the Plan begins prior to completion of the Initial Communication with the agencies of the EAC.

When either of the two conditions hold, the capacity in (2) is limited to 25% of IC, the initial conditions constant, and in (3) to 10% of CI, the community influence constant.

4.4 The Dependent Variables

The dependent variables Job Ratio and Job Differences were studied in addition to Jobs Created where

Jobs Created = Jobs Created at a Site
Job Ratio = (Jobs Created / Job Lost)
Job Differences = (Jobs Created - Jobs Lost).

All three of the dependent variables considered in this study were for the economic conditions at the former military site The information is published in the OEA document on base reuse from 1961-1990 (OEA, 1990).

The simulated dependent variable, Jobs Created at a site, is a very micro measurement of the economic activity in a community. However, the local employment rate and unemployment rates include a geographic region that is too broad to be of use in the initial local recovery analysis. Any dependent variable that included those values tended to cloud the effect of the recovery effort.

5.0 DATA COLLECTION

An attempt was made to contact community representatives in 97 communities of former military facilities (the OEA Sample "100") by phone. In 67 of those communities someone was stated to be familiar with the closure and willing to participate in the study (69%). A multiple choice questionnaire was sent to the 67 representatives and 48 were completed before analysis (49%).

The responses from the 32 (the Study Sample "32") highest self-rated respondents, based on their post-survey section score, were used when constructing the sampling distributions to be used in the PERT model. A qualified person was able to estimate the duration of all nine activities used in the process model at only 16 sites. These 16 sites are the basis for the two decision rules that govern the equation for jobs created.

6.0 ANALYSIS

The simulation model was developed and run on a 486/SX25 using SLAMSYSTEM and Microsoft Fortran in Microsoft Windows 3.1. The initial conditions, which include the size of the base in acres, the population of the community, and the number of jobs lost, are the input for the model.

The capacity constants IC and CI, the speed of response constants τ_1 and τ_2 and the magnitude of the effect of the rules on the capacity constants were finalized through iterations of the model.

The simulation produces the statistical results of 32 runs. Nine different built-in random number seeds are used when sampling the different activity times. Statistical analyses are performed using SAS software on the engineering computer network at Purdue.

Correlations using Cronbach α were used to determine the reliability of the survey. Distributions for activities were tested for normality using the Shapiro-Wilk statistic. Analyses used to test for reliability of the simulation output include a two sample t-test for differences in means and the chi-squared test to detect differences in the distributions between samples.

7.0 RESULTS

The SLAM model provided information in the output reports essentially through the use of collect nodes in the network located beyond each of the activities. This enabled collection of statistics when the activity was complete.

The resulting output shows the mean, standard deviation, minimum and maximum values and the number of observations for the nine activities. It shows

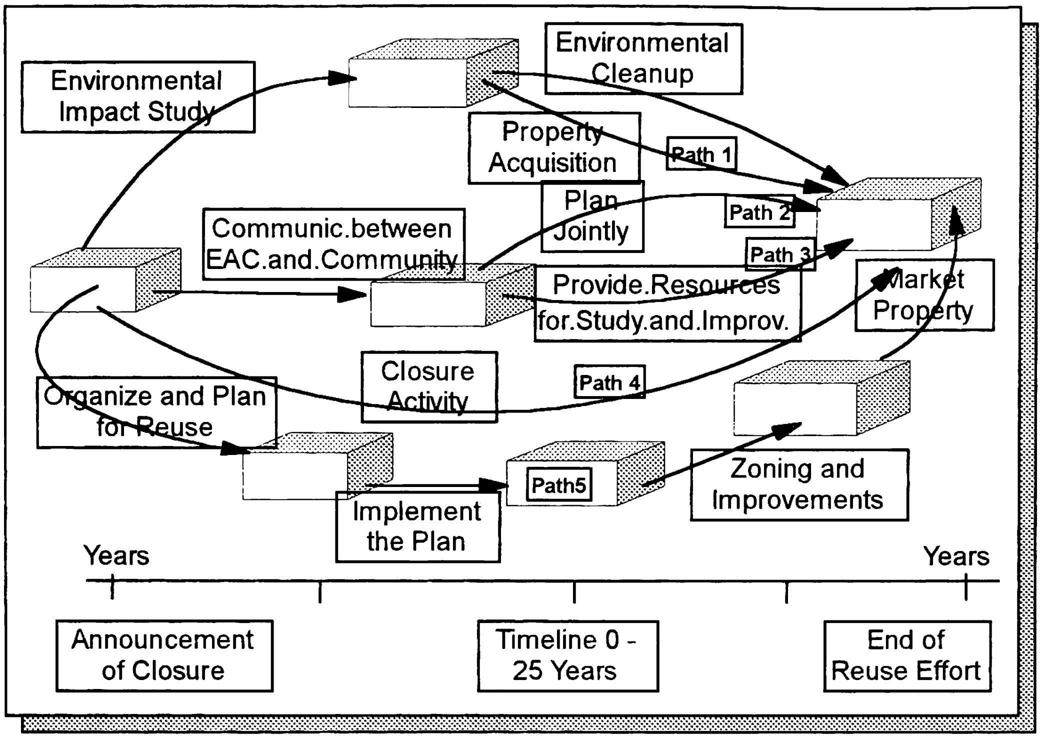

Figure 1 - PERT Model for Simulation - Parallel Sequences of Activities in the Base Transition Process

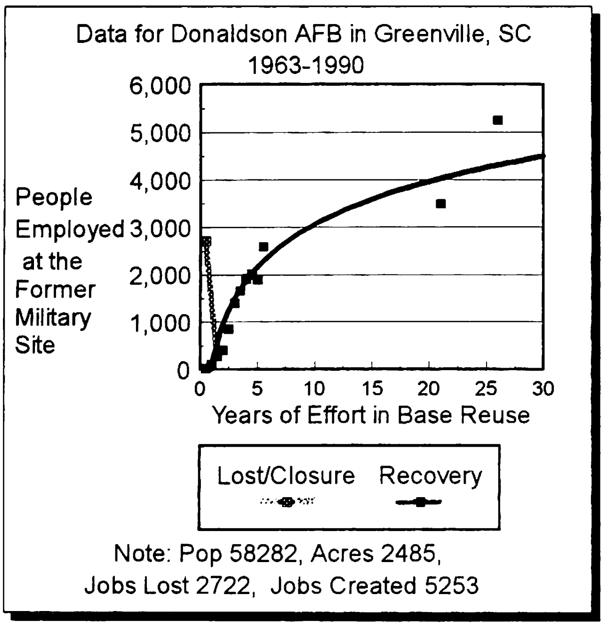

Figure 2 -Graph of Employment Lost and Gained vs. Years of Effort in Base Closure

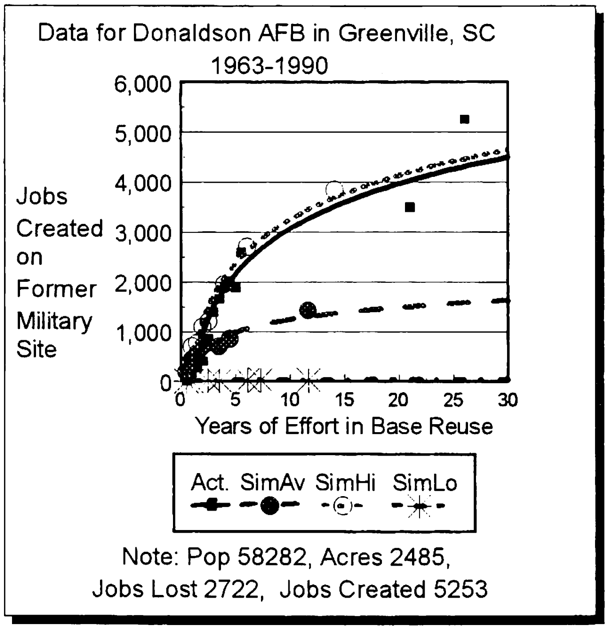

Figure 3 - A Comparison of Simulated and Actual Job Creation Results vs. Years of Effort in Base Reuse

the two capacity constants, the two speed of response coefficients and the two values to signal if the decision rules will cause a limit of the capacity of the governing equations. The output also shows the time of the end of the simulation and the number of jobs created in total and in each of the two stages.

The results from the SLAM output of the 1024 total runs (the Sim. Sample "1024" 32 for each of 32 initial conditions) are summarized and shown in this section.

7.1 Reliability of the Survey Data

The Cronbach α coefficient is a commonly used as a measure of test-retest survey reliability (Cody and Smith 1991). It is an alternative measure to the comparison of two data sets using the Pearson's Correlation coefficients (R values). When α>0.7, the survey is generally considered reliable. In this instance, the α=0.81 for test-retest reliability. When testing two different respondents within the same community a comparison of the data sets yields α=0.88. These measures verify the reliability of the survey data only. Analysis of the reliability of the model output is also considered within this section.

7.2 The Sampling Distributions for the PERT Model

Distributions for the nine activities were tested for normality using the Shapiro-Wilk test statistic. All nine were found to reject normality (W<0.05). The histograms of the distributions were observed. Eight of the distributions appeared to be Gamma distributions while a histogram of the Market Property data resembled a beta distribution.

The α and β parameter values used for the distributions in the simulation are listed in Table 1 and were estimated through iteration.

7.3 Finalizing Rules and Constants From Survey Data

As an initial search for trends in the base closure process, the data is regressed against three different dependent variables: Jobs Created, Job Ratio and Job Difference. It is not clear which is the preferable dependent variable, so all three are used to try to gain insight into the process.

Using stepwise regression, one variable (a different variable for each) showed significance at the p<.01 level when measured against each of the three dependent variables. In the first case, the length of time marketing the property accounted for 37% of the variance (R^2=0.37, p=0.002) in predicting the number of jobs created at a site.

Second, the amount of time spent in zoning and improvements accounted for 44% of the variance (R^2=0.44, p=0.005) in predicting Job Ratio. Third, property acquisition accounted for 41% of the variance (R^2=0.41, p=0.007) in predicting the Job Difference.

Visual inspection of the data showed that the community influence ratio (CI) was higher in communities that had more successful economic outcomes.

These results showed that the more time spent marketing the property, zoning in preparation for the needs of incoming potential employers and improving the community, indicated a higher likelihood of economic success.

These results represent the influence the community can have on the economic outcome. These findings were a significant influence when defining the model rules and constants.

In addition, the results of a regression analysis that showed that the initial conditions constant IC explained 20% of the variance (n=32, R^2=0.20, p=0.01) when determining jobs created. This quantitative result helped to justify its inclusion in the model. It should be noted that this value is not influenced by the community.

PERT Paths	Distrib. Type & Param. Dist.,α,β	$\bar{x}$ and σ of 1032 Sim. Runs (Yrs.)	$\bar{x}$ and σ of Paths at 32 sites (Yrs.)	% Diff. of Means
Path 1 Property Acq.	Γ 2.6,1.0	$\bar{x}$ = 2.6 σ = 1.6	$\bar{x}$ = 2.3 σ = 2.0	+13%
Path 2 Init.Commun. Plan Jtly. Reuse	Γ 2.4, 0.35 Γ 3.0, 0.9	$\bar{x}$ = 3.5 σ = 2.0	$\bar{x}$ = 2.8 σ = 2.2	+25%
Path 3 Init.Commun. Provide Res.	Γ 2.5, 0.95	$\bar{x}$ = 3.3 σ = 2.1	$\bar{x}$ = 2.6 σ = 2.2	+27%
Path 4 Closure Activity	Γ 2.8, 0.95	$\bar{x}$ = 2.5 σ = 1.5	$\bar{x}$ = 2.2 σ = 2.1	+14%
Path 5 Org. and Plan Implement Plan Zoning & Impr. Market Property	Γ 1.55, 1.2 Γ 1.95, 1.1 Γ 2.4, 1.1 β 0.5, 0.5	$\bar{x}$ = 12.6 σ = 9.1	$\bar{x}$ = 9.9 σ = 6.7	+27%

Table 1 - A Summary of PERT Path Times and Distribution Parameters in the Military Base Transition Process

7.4 Testing the Model

Figure 3 shows a comparison of the simulated output and the actual job creation over time at Donaldson AFB. Visual inspection of the results tend to justify the choice of the governing equation.

A summary of the path completion times is shown in Table 1. The data for the marketing the property showed that 44% of the respondents chose "7 or more years" as the length of time the community marketed the property. Prior to the study it was not clear that there was potential that the communities that had closed bases in the 60's and 70's could still be marketing the property, but some of the communities with continually improving economic conditions still were marketing the property!

Though the duration of the critical path is longer than the stated actual sample "32" time for path 5 by 27%, it appeared that this allowance made the model more realistic. The survey, though consistent, understates the length of time of the process. Actual calculations are not available due to the limitations on the scale used in the survey.

7.5 Reliability of the Simulation Results

Common methods for determining the reliability of simulation output include a test for the difference in means and a test for the difference in distributions (Law and Kelton 1991). The summary of the results of these two tests are shown in Table 2 and Table 3.

The results in Table 2 show that a difference in the means of the samples can not be detected using two sample t-test. Therefore it is concluded that the means of the number of jobs created at each site are statistically equivalent for each of the samples: the study sample "32", the simulation sample "1024" and the OEA sample "100"

Summary of Simulation & Sample Data - Jobs Created					
Samples	N	Mean	σ	Min	Max.
Sim.sample"1024"	1024	1416	1366	3.4	8554
Study Sample"32"	32	1526	1622	3.0	6000
OEA Sample"100"	97	1687	1997	3.0	13100

Summary of t-tests to Check for Differences in Means in Jobs Created					
t-test sample pairs	Prob. >| F |	σ^2	T	p>|T|	Means Diff?
Sim "1024" vs. Study "32"	0.15	Equal	-0.38	0.71	No
Study "32" vs OEA "100"	0.19	Equal	0.68	0.65	No
Sim."1024" vs.OEA "100"	0.00	Un-equal	-1.31	0.19	No

Table 2 -Two Sample t-Test to Compare the Means of Simulation Model to Actual Data

The strength in the chi-square test generally lies in having at least five values in each category and having an even frequency of the measured value in each category (Law and Kelton 1991). It would be preferable to break the "under 500" category into more than one category. However, when that is done, the smoothness of the distribution breaks down and in the study sample "32" there would not be at least five data points in each cell. In such a case, the output of chi-square test on SAS gives a warning for the lack of sufficient data in each cell.

If one accepts the groupings for the chi-square test with an unbalanced cell as shown in Figure 4, then the test shows that a difference in the distributions can not be detected. It is then concluded that the distributions in each of the samples are statistically equivalent. The summary of these results is found in Table 3.

Figure 4 shows the similarity of the distributions of the frequency that amount of jobs was created. The results are shown for the simulation sample "1024", study sample "32", and the OEA sample "100". They help justify the final constants, the decision rules and the impact of those decision rules on the governing equation.

Summary of Chi-Squared tests to Check for Differences in the Distributions for Jobs Created				
Chi-Squared sample pairs	Df	χ^2	Prob	Distrib. Diff?
Sim "1024" vs. Study "32"	6	2.27	0.89	No
Study "32" vs OEA "100"	6	2.10	0.91	No
Sim."1024" vs.OEA "100"	6	1.69	0.95	No

Table 3 - Chi-Squared Test to Compare the Distributions of Simulation Model to Actual Data

The results of Table 2 and Table 3 showing no difference in means and no difference in distributions confirms, first, that the study sample "32" is representative of the OEA sample "100". Second, it gives a strong indication of the reliability of the simulation when compared to the actual economic outcomes at the former military sites. Figure 4 seems to provide a nice illustration of the goodness of fit of the three samples.

7.6 Implications for a Manufacturing Organization

The findings of the study of successful base closure transitions have implications for the process of managing declining organizations as well as manufacturing organizations in general. Two concepts that are suggested for managing declining organizations are confirmed through these findings:

1. Seek new product lines and new customers (Sutton, et al. 1987). Time spent marketing the property (R^2=0.37, DV=Jobs Created) included seeking new employers and new industries for the community. That appears to be similar to the seeking of new product lines and new customers which is suggested of declining organizations.

2. Examining success encourages imitation while examining failure encourages invention (Sutton, et al. 1987). Creating economic growth within a community utilizes the creative talents of community leaders. This creativity is a characteristic that is needed for the invention encouraged in declining organizations.

Two concepts suggested for manufacturing organizations are confirmed through these findings:

1. Work on continuous improvement of the product and the organization (Golomski 1993). Zoning and Improvements (R^2=0.44, DV=Job Ratio) appears to have served the community in the same way it is thought that continuous improvement enhances successful manufacturing organizations.

2. Reduce time to market for new products to achieve competitive advantage (Itoh 1991). Faster property acquisitions (R^2=0.41. DV=Job Diff.) allowed faster transition to civilian facilities. This appears to have allowed the competitive advantage that is afforded a company that can reduces time to market.

8.0 DISCUSSION

8.1 How is the Model Applicable Today?

Data was collected for the environmental impact study and the environmental cleanup activities, but the nature of the closure process with respect to environmental issues has changed for the current round of closures. The two environmental activities are included in the current model, but were given zero time values in this PERT model.

Interviews with the community representatives showed that the environmental activities did not affect the process for closures or the economic outcomes in the 60's and 70's. The environmental issues became an influence during the 80's for all military facilities in transition, past and present.

The environmental activities do affect the transition of properties in communities of base closures now and should be included in the model to allow it to be applicable to today. It is felt that the two environmental activities are placed properly in the model shown in Figure 1. This allows easy adaptation of the model to the current round of closures by just adding in information on the distributions of those activities to forecast the economic recovery for the current round of closures.

The data for the current round of base closures would be easier to obtain for the most recent closures, but their impact on the community is more difficult to determine since the transitions are still in process.

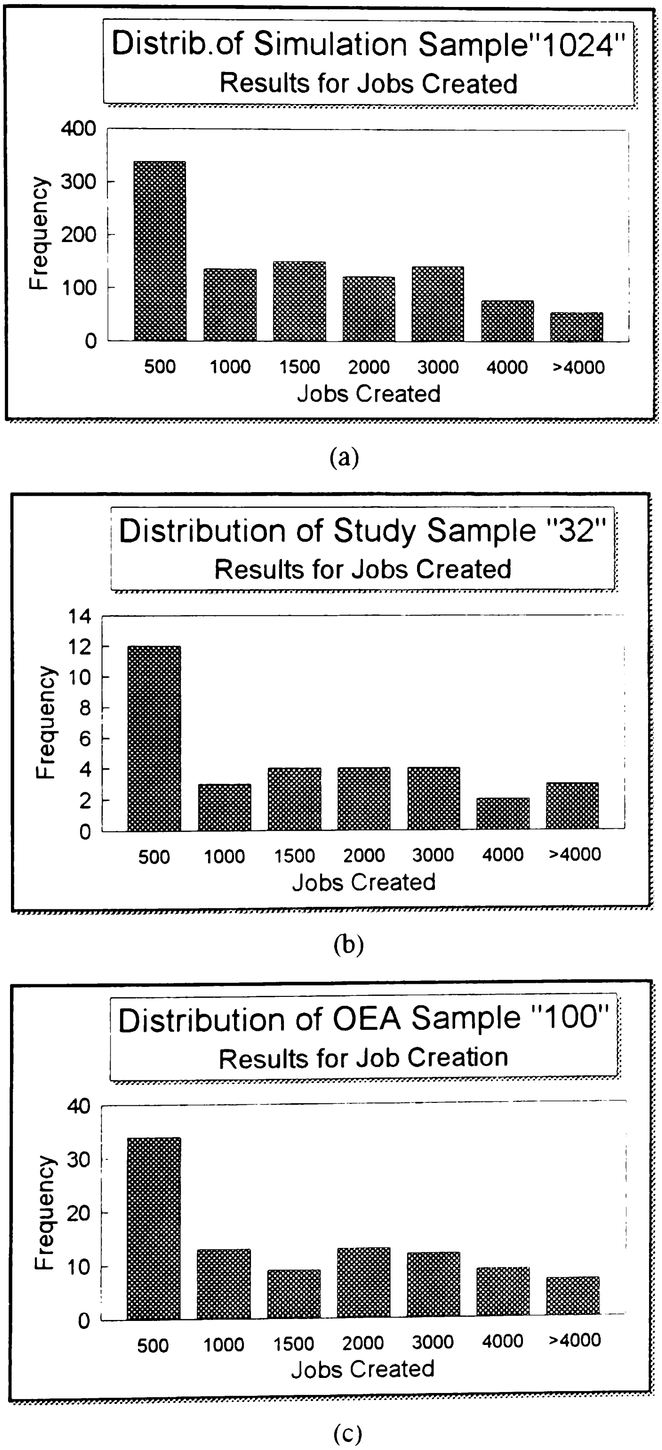

Figure 4 - A Comparison of Distributions From the Simulation Model and Sample Data

8.2 Does the Study Sample Represent the Population?

The statistical analyses of the previous section have shown that the simulation sample "1024" is representative of the study sample "32". It has also been shown that the study sample "32" is representative of the OEA "100" sample.

However, it is not clear that the "OEA 100" sample is representative of the population of more than 200 closed bases. The OEA states that the contacts listed in the document *Civilian Use of Former Military Bases* are from the communities that had the best working relationship with and were the most willing to maintain contact with the OEA. The OEA acknowledges that this sample may be biased toward success. A less biased sample in this instance may have shed more insight on "what not to do" in the closure process. It is possible that a rule may have been added to the model for "what not to do".

The study sample "32", however, did allow achievement of the project objectives since the focus of the study was on successful communities and the sample did include at least a fair share of successful communities.

8.3 Randomness of the Simulation Sample

The Sim "1024" output would be more random if the random number seeds were not reinitialized before each of the 32 sets of initial conditions. Not reinitializing before each set of initial conditions would have provided a slightly higher standard deviation for the "Sim 1024" sample for jobs created. Such a change may cause the standard deviations of the "Sim 1024" and the "OEA 100" samples shown in Table 2 to be statistically equivalent. However, this would cause no difference in the overall conclusion about the model.

The two sample t-test with unequal variances takes this into account. The distributions showing frequencies and jobs created in Figure 4 as well as the means in Table 2 should likely still have been statistically equivalent.

8.4 Why a Predictive Model Is Not Suitable By Itself

Though the survey data is reliable for the section on sequence and duration, a predictive model using regression analysis by itself is not reliable. Information for each activity is collected in only one question for each activity. The results of initial regression analyses, as shown in Section 7.3 are used only as a guide to define some rules for the governing equation. In addition, only results obtained at a relatively high statistical significance are considered ($p < 0.01$).

8.5 The Statistical Results Prove the Model Reliable

The statistical analyses show that the results of the means and distribution of jobs created for the simulation sample "1024" are not statistically different from the study sample "32" and the OEA sample "100". This tends to confirm the our thoughts regarding the reliability of the model.

8.6 Is This A Valid Model of the Transition Process?

The statistical reliability of the simulation results were easier to check than the logical validity of the network model. The determination of the ordered sequence of events for the PERT model came from the OEA flow chart of the Base Closure Process. However the sequence of the events and the different paths were not easily verified through the survey responses given the breadth of information that was to be elicited for other portions of the study.

8.7 Insight Comes from the Modeling Process

The results of the simulation may confirm that the mechanics of a model are correct. However, the coding of a simulation model does not provide the insight into the base transition process. The insights that helped the modeler determine the sampling distributions, the governing equations, and the decision rules used in the model came from developing an understanding of the process. This understanding was developed by talking to the respondents, studying trends in the data, and thinking about the process.

Since many of the concepts used in this model are applicable to the current round of closures, it is important that the insights gained from the development of this model be disseminated to those communities currently facing base closure. Each community should not need to repeat this effort to gain the benefits of the project

This model tends to confirm our understanding of the process and establishes that there are aspects of the process that are quantifiable.

9.0 CONCLUSIONS

1. A simulation model has been developed that quantitatively illustrates the successful mechanism that communities have developed for the transition of military bases. It effectively illustrates the recovery in terms of jobs created while taking the economic impact as well as site and community attributes into account.

2. The simulation model provides an engineering analysis of the base transition process in contrast to existing socio-economic models that rely exclusively on multipliers to estimate the economic impact. The time perspective is not well illustrated through the use of economic models and the potential impact is often overstated.

The new model gives an indication of how long it takes for the transition process to take place and for the impact of both the closure and the recovery efforts to run their course. The results provide a high degree of reliability when using a statistical analysis to compare the simulation results to the actual results.

3. The basic findings from the community's base transition process model could be qualitatively applied to management of a declining organization and manufacturing organizations as a whole.

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