ARMY BRAC 2005 IMPLEMENTATION COMPLEXITY MODEL

Major John K. Harris, Department of Systems Engineering, United States Military Academy
Dr. Gregory S. Parnell, Department of Systems Engineering, United States Military Academy
Second Lieutenant Sean Gardner, US Army, United States Military Academy
Second Lieutenant Brett A. Hoops, US Army, United States Military Academy
Second Lieutenant Randy R. Mounts, US Army, United States Military Academy

Abstract

Since 1988, the Army has implemented four Base Realignment and Closure (BRAC) rounds. The primary reason for BRAC is to reduce excess capacity at Army installations. This research focused on implementation of BRAC after the list is approved. First, we analyzed the historical data on prior BRAC rounds to identify installation complexity factors and obstacles to implementation. Next, we developed a management decision tool to assess installation complexity. This work was requested by the Deputy Assistant Secretary of the Army (Infrastructure Analyses), and the Total Army Basing Study (TABS) Group.

Background

The BRAC Commissions are appointed by the President to recommend base closures and realignment. Prior BRAC rounds were in 1988, 1991, 1993, and 1995. Congress enacted legislation in 2002 for a BRAC round to be complete in 2005. The BRAC Commission will be appointed in the spring of 2005. In May 2005, a new Army BRAC list will be signed into law by the President.

The closing of an Army installation is a difficult task, especially if significant environmental cleanup is required. The Army must ensure units maintain combat readiness as they move from one installation to another while caring for the well being of its soldiers and their families. Compounding the challenge is the impact of installation closure on civilian employees and local communities. Also, the property will be transferred to federal organizations or civilian developers. These organizations each have different concerns and timelines. The quicker the Army completes the tasks associated with closing an installation and transferring the property, the sooner the Army receives the economic benefits.

It is important to note that there is a difference between a base ("closure" or "realignment") and a base ("disposal" or "disposition.") The "closure" or "realignment" of an installation means that the mission at an installation has been transferred or has ceased. The "disposal" or "disposition" refers to transferring the ownership of facilities and land of an installation to another public or private organization.

In prior BRAC rounds, the Army's BRAC Office (BRACO) tasked with the mission of closing and disposing of Army installations initially used the time it took to close an installation as the main performance measure. They later used acreage as the primary performance measure. For instance, if an installation has a total of 100,000 acres and all but one acre is disposed then the installation is technically open. However, more than 99% of the total acres of that installation are disposed. Thus acreage has become the key performance measure. Including all BRAC rounds, the Army has disposed of 90% of the total acres.

BRAC 2005 involves new challenges and a greater expectation for improved implementation performance. The *BRAC 2005 Strategic Plan* developed by The Army Basing Study (TABS) office for Dr. Craig College, Deputy Assistant Secretary of the Army (Infrastructure Analyses), set a goal to 1) close or realign 60% of BRAC 2005 installations within three years or less and 2) achieve disposition of 60% of BRAC excess property within six years or less.

Exhibit 1. BRAC acres disposed (Actual vs. Hypothetical Expected Performance**)**

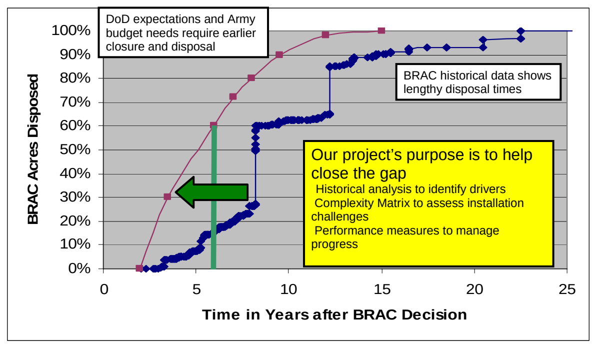
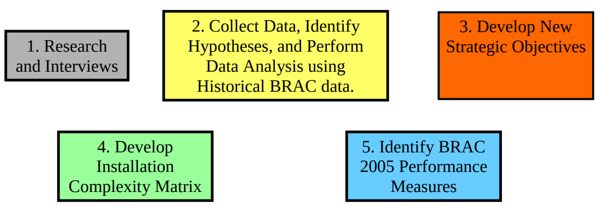


Exhibit 1 shows the challenges that the Army faces in the next round of BRAC. On average, it took the Army 8.2 years to dispose of 60% of the total acreage from the prior BRAC rounds. Keeping in mind, that just under 10% of the total acres has still not been disposed.

Methodology

In order to get a better grasp of the difficulty of disposing an installation, we broke the processes into several steps. We first collected data and conducted research on past BRAC rounds. We also interviewed several key Army leaders and had panel meetings with personnel involved in the BRAC process. Step 2 resulted as a need to assess prior performance of previous BRAC rounds to get and accurate picture of past BRAC implementation performance, determine the likelihood of meeting the goals outlined in the *BRAC 2005 Strategic Plan*, and determine what were the drivers in historical BRAC implementation processes.

Exhibit 2. BRAC 2005 Implementation Methodology



Step 3 was developed from affinitizing the objectives from the *BRAC 2005 Strategic Plan* and the interviews/research conducted in Step 1. After research and interviews were conducted and the drivers of prior BRAC rounds were assessed then the installation complexity matrix in Step 4 could be developed to provide a management tool that would help decision makers assess the degree of difficulty in realigning, closing, and disposing an installation. Finally an Engineering Management approach was taken to develop the Performance Measures for BRAC 2005 implementation. The time it took to dispose an installation and time to dispose acreage are both lagging performance measures that measure a task once it is complete. Based on the first four steps in the methodology, additional performance measures were developed under four areas: 1) Responsibility, 2) Planning, 3) Implementation, and 4) Completion. Although additional Performance Measures for BRAC 2005 implementation were developed, they will not be addressed in this paper.

Research and Interview Findings

As our team tackled the task at hand, we began the process by interviewing key stakeholders, BRAC implementation project managers, and numerous subject matter experts on the BRAC process to include environmental and legal experts. Additionally, several other analysts who have reviewed the BRAC implementation process were also interviewed. Dr. Craig College, our client, laid the ground work by setting a goal to 1) close or realign 60% of BRAC 2005 installations within three years or less and 2) achieve disposition of 60% of BRAC excess property within six years or less. Dr. College recognized that his office needs a tool to assess the complexity of closing installations if they will be successful at meeting the increased expectation to dispose of installations in a shorter amount of time.

The Deputy Assistant Chief of Staff for Installation Management (ACSIM) and the Director of the BRAC Office (BRACO) noted that acreage was the dominant performance measure when assessing BRAC implementation performance. The Deputy ACSIM also highlighted that in this round of BRAC the law has changed so the Army would be able to sell the property instead of conducting a no cost conveyance which was essential giving the property away. And then in many cases the Army remained responsible for the bill for environmental clean-up. Additionally, the Deputy ACSIM pointed out that the number of Local Reuse Authorities (LRA) was an indicator that it would be difficult to transfer the bases' assets and land. A LRA is local government agency consisting of local businesses and citizens who are responsible for planning a base's reuse (ICMA, 2002). Fort Ord (located near Monterey, CA) is an example of an installation with a long disposition time and the LRA had very differing views on how the community should use the land. If a LRA has differing views as in the case of Fort Ord, then the ensuing debate will add to the time to dispose of an installation. Finally, the Deputy ACSIM noted that to realign a mission and dispose of an installation costs money, but the Army did not always provide sufficient early funding for the BRAC process in prior rounds.

Mr. Patrick O'Brien, Director, Office of the Secretary of Defense (OSD) Office of Economic Adjustment emphasized that all branches of service need to do a better job at supporting the communities surrounding an installation selected for closure.

An interview with Beth Lachman and David Oaks, analysts from the RAND Corporation, proved to be very beneficial. They suggested looking at the number of congressional districts, the percentage of employment that an installation provides, and consider the resale values of the installation as well as the resale value of key assets on the installation are all critical factors. They additionally pointed out that installations that already have privatized utilities may be easier to resell since it already meets state utility requirements. They also suggested the use of a complexity matrix to use as a decision tool to show the challenges in realigning and closing an installation.

A former BRAC project manager in the BRAC Office from 1992 to 2003 stated that the Army should develop performance based contracts for its project managers. There is no incentive to finish on schedule. A successful BRAC project manager will work themselves out of a job. Interviews with a panel of current BRAC project managers supported the need for incentives. Additionally, they stated that one of the key factors of success was a stable transition team. There was a need for training for project mangers, a BRAC 101, since BRAC implementation has many unique skills and knowledge required only while a project manager is in that job. They also stressed the need to have one common document to tie together the environmental characterizations of an installation.

The BRAC Office environmental panel supported the environmental characterization issues brought up by the project managers but were more specific on the difficulties of disposing an installation that had Munitions of Explosive Concern (MEC; formerly referred to as Unexploded Ordnance, UXO) as well as ground water plums, per chlorate, arsenic and other contaminants.

Several of the people we interviewed, the project mangers panel, and the environmental subject matter expert panel all stressed that 1) an early environmental baseline characterization was essential to start the process right, 2) early funds need to be programmed and budgeted, and 3) an early start to Military Construction were essential to the success in implementing a base realignment, closure, and disposition. These are just a few key factors that delay the closure and disposition process and prevent the Army from benefiting from the annual recurrent savings associated with closure and disposition of an installation. Additionally, many gains could also be made by assisting the formation of a LRA and assisting the LRAs to develop their reuse plan. It is important to note that the BRAC Office does not control how quickly a LRA is established or how quickly it develops its reuse plan. But these two steps are also critical in the disposition process.

From our interviews, we learned that many stakeholders and subject matter experts had preconceived notations about why the disposition process took so long. For instance, many people stated that 1) larger installations take longer to dispose of the property, 2) installations with a large amount of buildings measured by total square feet will take longer to dispose of the property, and 3) installations with MEC take a long time to dispose of the property. There were several other hypotheses that stakeholders and subject matter experts believed; however, they did not have any analysis of the data to support their belief that certain factors actually drove the time to dispose an installations property. Our next task was to determine if the data from the four previous BRAC rounds supported these hypotheses.

Data Analysis Findings

We analyzed the data we obtained through our process of data collection, research interviews, and meetings. Our objective in this section was twofold. First, we wanted an accurate picture of past BRAC implementation performance. Second, we wanted to determine what drivers most impacted the performance of historical BRAC implementation. The primary tool that we used for this analysis was Microsoft Excel and our raw data was mostly provided by the Army's BRAC office. In the end, we were able to gain an accurate picture of past performance, but found that it was very difficult to identify specific quantitative factors that greatly affected the implementation process.

We used two key performance objectives extracted from the BRAC 2005 Strategic Plan and given to us by Dr. College as our measures for evaluating past rounds. These objectives are to close 60% of the identified installations within 3 years and to dispose of 60% of BRAC excess property within 6 years of initiation. In Exhibit 3 below, one can see that these objectives have never been met in past BRAC rounds.

Exhibit 3: Number and Percent of Installations Closed and Disposed per BRAC round

BRAC Round	# of Installations	# Closed 3 yrs	% of Total Inst. In Round	Median Closure Time	# Disposed 6 yrs.	% of Total Inst. In Round
1988	28	0	0%	5.59	12	43%
1991	6	0	0%	3.80	3	50%
1993	4	1	25%	4.10	2	50%
1995	33	11	33%	3.45	17	52%
Cumulative	71	12	17%	4.38	34	48%

Based on the historical record, the BRAC 2005 implementation team faces a difficult challenge. They must find ways to significantly improve past performance. Additionally, we found that the shortest time to dispose an installation was just over 3 years while the average time to dispose an installation is 8.2 years. Furthermore, there are installations from the 1988 BRAC list that are still not closed resulting in a disposition time of over 15 years and counting.

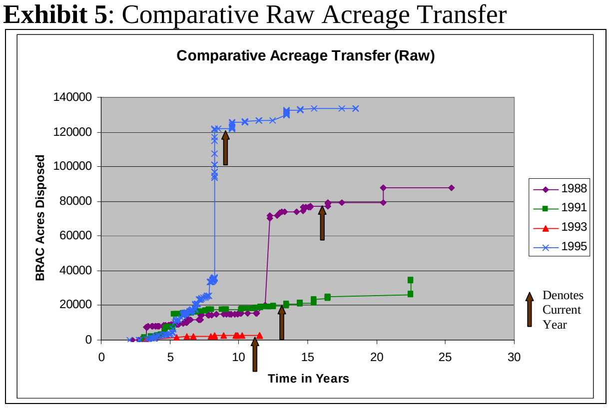
For disposition measures, however, it is often inaccurate to look only at data on a total installation basis. At many identified installations, the land is usually broken down into smaller parcels that may be more or less difficult to dispose. Thus, if one installation consists of 100,000 excess acres of property and all but 10 of those acres have been disposed, then disposition at that installation is still incomplete. Cases like this give an inaccurate representation of the data; the fact that the installation is over 99% disposed should be recognized. Therefore, past measures of disposition progress have been primarily based upon the number of excess acres disposed. Exhibit 4 shows a breakdown by round of how long it took the Army to achieve 60% and 80% of the excess acreage. Again, the goal is to achieve 60% disposition within 6 years. As the third column indicates, this has only happened once, and that was for a round that had very few acres. The last column in Exhibit 4 shows that the Pareto effect certainly applies to acreage disposition. For each round, nearly, if not more than, half of the acreage in each round may be disposed by simply disposing of one or two parcels of land. From this, we learned that the BRAC team should focus on disposing of the largest parcels of land first.

Exhibit 4. Total time to dispose of 60% and 80% of the total acres per round

BRAC Round	Total BRAC Acreage	Years to 60% Disposal	Years to 80% Disposal	Drivers
1988	87,997	12	12	Jefferson Proving Ground (50,385)
1991	34,535	15	23	Two Ft. Ord parcels (14,773)
1993	2,664	6	6	Tooele Army Depot (1,621)
1995	133,750	8	8	Sierra Army Depot (57,633)

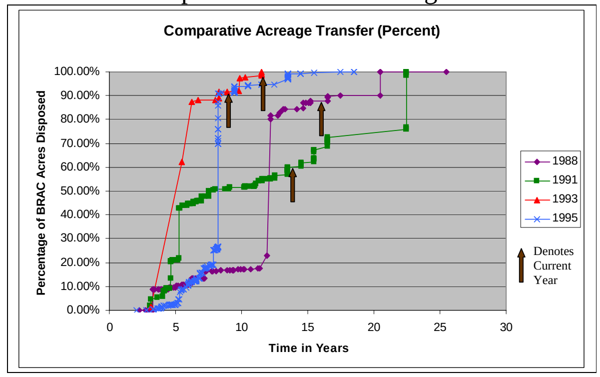
Exhibit 5 shows the disposition data per BRAC round in raw acres while Exhibit 6 shows the disposition data in percentage of excess acres for each of the respective rounds.

Exhibit 5: Comparative Raw Acreage Transfer



The data is aggregated to time zero based on the date the BRAC round was signed into law. It should be noted that any data points beyond the arrows shown for each round represent planned disposals that have not yet actually occurred. Therefore, that data is still subject to change.

Exhibit 6. Comparative Percent Acreage Transfer



Next, we used linear regression to identify the most important drivers. We used Microsoft Excel and Mathematica as our primary software. As stated earlier, our goal was to identify specific factors that significantly affect the success or performance of the BRAC program. Key measures of effectiveness include time to closure, time to disposition, and various cost factors. Our methodology was to first identify those factors that we thought might be significant. Many factors were brought to our attention in the research and interview process. Next, we requested data concerning all of these factors from the BRAC Office. Finally, we applied the data to our pre-established hypotheses with the use of linear regression charts and bar charts.

We computed an R^2 value for all linear regression plots and used visual inspection to analyze characteristic data in the qualitative bar charts.

Overall, we found it extremely difficult to identify single drivers that significantly affected BRAC implementation performance. R^2 values were consistently very low and qualitative comparisons for various installations also led to very little distinguishing variables. A summary of our hypotheses and the results we obtained are shown in exhibit 7.

Exhibit 7. Prior BRAC Rounds Data Analysis Hypothesis and Findings

Hypothesis	Data Analysis	Finding
The amount of environmental cleanup lengthens the disposition time.	Actual Environmental Cost vs. Actual Disposition Time	$R^2 = 0.02$
The amount of environmental cleanup lengthens the disposition time.	Estimated Environmental Cost vs. Actual Disposition Time	$R^2 = 0.01$
As environmental cost increases, disposition cost increases.	Actual Environmental Cost vs. Total Cost to Disposition	$R^2 = 0.14$ (removing one outlier $R^2 = 0.32$)
The amount of MEC (UXO) increases the disposition time.	Actual MEC Acreage vs. Actual Disposition Time	$R^2 = 0.12$
The amount of of MEC (UXO) increases the environmental cost.	Actual MEC Acreage vs. Actual Environmental Cost	$R^2 = 0.87$
Larger installations have longer disposition times.	Actual Acreage vs. Actual Disposition Time	$R^2 = 0.0002$ (completed dispositions)
Installations with more square footage take longer to close.	Starting Square Footage Inventory vs. Actual Closure Time	$R^2 = 0.07$ (wrong hypothesis)
Some EPA Regions have longer disposition times.	EPA Region vs. Actual Disposition Time	No sufficient correlation.
Some MACOMs have longer disposition times.	MACOM Owner vs. Actual Disposition Time	TRADOC Dispositions take less time than others.
The type of installation impacts the closure time.	Installation Type vs. Actual Closure Time	Administrative and industrial installations take longer to close than others.
The type of installation impacts the disposition time.	Installation Type vs. Actual Disposition Time	Family housing locations are quicker to dispose than other installation types.
The type of installation impacts the actual cost to disposition.	Installation Type vs. Actual Cost to Disposition	Major training areas cost more for disposal.
Superfund sites have higher environmental costs associated with them.	Superfund Site vs. Actual Environmental Cost	Superfund sites incur more environmental costs.

We learned from this process that there is really no single factor that ultimately drives closure time, disposition time, or costs. We attempted also to do a multi-variable regression analysis with the data, but found that this was also difficult because of holes in the data and small sample sizes. Many qualitative factors could be represented in the multiple regression models such as EPA region, number of congressional districts near the installation, or Major Command (MACOM) owner. For example, we suspect that having spent munitions of explosive concern (MEC) present could easily combine with other factors to extend and complicate costs and disposition time. Of past installations, however, only 12 actually had MEC present. Therefore, it is very difficult to combine that data with another factor like the EPA region because then we only have 12 data points to spread across 10 EPA regions. Other aspects are difficult to categorize and may ultimately drive the BRAC implementation process. Therefore, we were not overly surprised to see only weak correlations based on strictly mathematical analysis.

Our research and interviews showed that the BRAC program and its implementation are very complicated. There are countless qualitative factors such as personnel assignments, organizational structure, political, and local community impacts, to name a few, that have just as much, if not more, impact on performance. The qualitative factors we could include proved to be insignificant from a mathematical perspective. We also found that each installation is very unique and any overarching BRAC program analysis must involve someone who is very familiar with individual installations and what happened at them. These are some of the many reasons why we saw it necessary to develop a complexity model that used both qualitative and quantitative factors from our research, interviews, and data analysis in order to determine how difficult it would be to implement the BRAC decisions at any installation.

Complexity Model & Strategic Objectives

The idea of an installation complexity matrix originated from Beth Lachman, Ellen M. Pint, and David Oaks (2003) in their Lessons Learned from the Implementation of Previous BRAC Decisions report. The BRAC installation complexity matrix allows BRAC decision makers to take an installation and overlay it on the complexity matrix to determine the degree of difficulty in realigning, closing, and disposing of the base. One axis consists of complexity attributes that characterize installations while the other axis consists of the installations themselves. Where an attribute intersects with an installation, an evaluation of that particular function is given for that particular installation. This evaluation can be given in either a quantitative method, qualitative method, or a combination of the two. Exhibit 8 shows an example of RAND's matrix.

Exhibit 8. Example RAND Complexity Matrix

Key characteristics of the installation	Cameron Station	Fort Ord
Number of jurisdictions that base touches?	Low	High
Economic dependence of the community on the installation?	Low	Medium
Military and retiree populations?	High	Low
Diverse stakeholders with interest in the property?	Low	High
Amount of UXO on the property?	Low (None)	High
Environmental issues?	Low	High
Number of acres?	Low	High

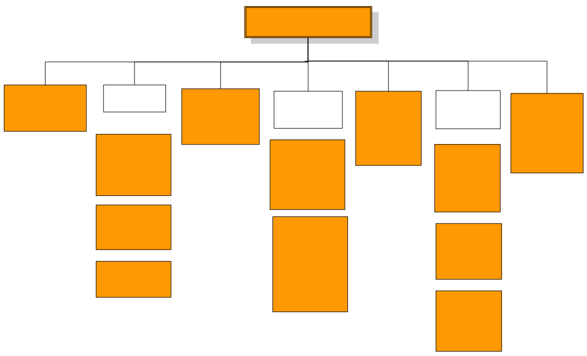
The complexity matrix is an analytic tool that offers decision-makers a number of different uses:

- the matrix will provide senior leaders an overall assessment of the difficulty of BRAC 2005 implementation,
- improve senior leaders' understandings of the unique challenges of each installation,
- help senior leaders assign the most experienced or best-performing personnel to the most challenging installations,
- provide senior leaders a basis for allocating existing resources across an installation,
- help explain the need for additional resources on extremely difficult installations,
- identify the need for training programs on installations that might have unique or extremely difficult problems and inexperienced personnel.

In order to develop the complexity matrix, we had to decide what functions or measures would be used to evaluate installations. We developed the measures from our research, interviews, meetings, and our data analysis. We performed an affinity diagramming exercise to group the potential measures from our research and interviews to identify the most important complexity attributes. We also used our research and the affinity diagramming exercise to develop a new portion of the strategic plan.

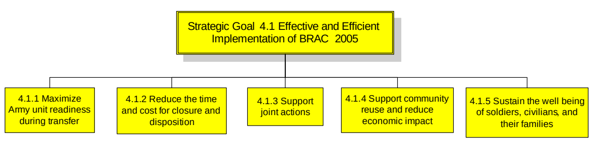
Our research effort focused on section 4.1 of the Strategic Plan for the Army Implementation of BRAC 2005: Effective and Efficient Implementation of BRAC 2005. Exhibit 9 shows that there were initially twelve different performance objectives or goals and sub-goals for the effective and efficient implementation of BRAC 2005.

Exhibit 9. Current Performance Objectives for section 4.1 of the Strategic Plan for the Army Implementation of BRAC 2005



After conducting our research, we developed a new 4.1 of the Strategic Plan for the Army Implementation of BRAC 2005, based upon what we determined were the most important performance objectives or goals. This new plan includes five performance objectives.

Exhibit 10. Suggested revised Performance Objectives for section 4.1 of the Strategic Plan for the Army Implementation of BRAC 2005.



Objective 4.1.3 in Exhibit 10 was emphasized as a future goal and was not emphasized in past BRAC rounds. Additionally, Mr. Patrick O'Brien, Director, OSD Office of Economic Adjustment, placed a great deal of importance on the need for 4.1.4 as a goal. Otherwise, the goals are not too different from the original strategic plan except that the new plan is broader and encompasses a number of the supporting goals. However, these revised performance objectives are directly traceable to our research, interviews, and meetings. These revised performance objectives became evident from affinity diagramming exercise. In addition, community reuse and the well-being of personnel are included in later parts of the Strategic Plan for the Army Implementation of BRAC 2005; however, we took an even broader strategic view of implementation that included those issues and addressed them in objective 4.1.4 and 4.1.5.

We used each of these goals developed for the revised section of the strategic plan to organize both the complexity attributes and the performance measures. This enabled us to group similar complexity functions and similar performance measures. Recall that performance measures will not be discussed in this paper; however, it is worth mentioning that the process to this point was critical in developing the performance measures that will assess the BRAC 2005 implementation process.

At the conclusion of our affinity diagramming, we developed thirty eight different complexity attributes. These ranged from the type of mission being realigned or closed to the quantity of lead-based paint at an installation. We used multiple objective decision analysis to develop our complexity model (Kirkwood, 1997). We input all thirty eight attributes into Logical Decisions to develop our first model. One of the Logical Decisions views is a matrix view which is exactly what RAND had in mind with their complexity matrix with installations on one axis and complexity attributes on the other. Logical Decisions also allowed us to assign weights to each attribute which helped in the overall installation evaluation. Logical Decisions is a very useful tool because an analyst is able to compare a single attribute from various installations, look at sensitivity analyses, and perform other analysis that would be difficult to look at in a simple matrix. Logical Decisions is a decision aid that requires an understanding of multiple objective decision analysis, which is a limiting factor.

Many of the thirty eight attributes that we developed fall within broader categories. Because this is the case, we were able to identify the most important and broadest functions and narrow the thirty eight down to ten. The ten attributes are listed under the performance objectives they are grouped with, and the units used to measure them are as follows:

4.1.1 Maximize Army Unit Readiness
1. Type of Mission Realigned (qualitatively variable)

4.1.2a Reduce the Time and Cost for Closure and Disposition w/o Environment
2. Estimated Closure and Disposition Cost (millions of $)
3. Acres to be Disposed (acres)
4. Appraised Land Value (millions of $)

4.1.2b Reduce the Time and Cost for Closure and Disposition w/ Environment
5. Estimated Environmental Clean-up Cost (millions of $)
6. MEC Acres (acres)

4.1.3 Support Joint Actions
7. Type of Joint Mission Coming to an Installation (qualitatively variable)

4.1.4 Support Community Reuse and Reduce Economic Impact
8. Urban/Rural (population density)

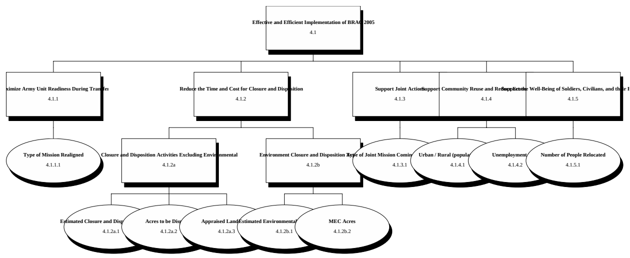
4.1 Effective and Efficien
Implementation of BRAC 20
1.1 Planning to Implementation transition for TABS offices (31 May 05)
1.2 Plans and execution
1.3 Effective implementation of joint service recommendations (31 Dec 05)
1.4 ID RC needs and process
1.2 a Plans complete for phasing out base ops and support services (31 May 06)
1.4 a ID RC installation specific needs and expectations (30 Sept 05)
1.2 b 80% '05 closure or realignment within 3 years
1.4 b Establish a process to accomplish RC objectives such that disruption of Army personnel is minimized (30 Sept 05)
1.2 c 60% '05 disposition within 6 years

9. Unemployment Rate (rate)

4.1.5 Support the Well-Being of Soldiers, Civilians, and their Families

10. Number of People Relocated (number of people)

Exhibit 11. Simple Complexity Model built in Logical Decisions



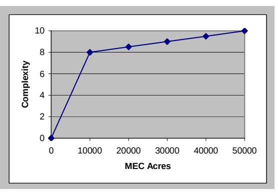
Each of these ten functions was also put into Logical Decisions to develop a simple model similar to the thirty eight attribute model. Exhibit 11 shows the simple model built using logical decisions. In order to condense the complete model, we made assumptions such as under 4.1.2b, the presence of any of the ten contaminants we mention will drive up the estimated environmental clean-up cost, so these attributes would fall under that one attribute. While an expanded model using all 38 attributes may be more thorough, the simple model is more understandable and serves our purposes well.

Final Complexity Model in Excel

In order to develop a more understandable and usable model, we converted the condensed model from Logical Decisions to Microsoft Excel. Just like the Logical Decisions models, the Excel model uses multiple objective decision analysis (MODA). For each complexity attribute, we looked at the maximum and minimum scores possible for any installation, and then developed a function that represented the complexity of those scores. For instance, just the mere presence of MEC at an installation will automatically drive up the disposition difficulty; however, after that initial MEC is identified, the difficulty will continue to increase but at a much more gradual pace resulting in a piecewise linear function. Exhibit 12 below is an example of the MEC acres complexity function.

Exhibit 12. Complexity Function for MEC

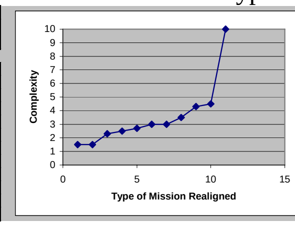
Reduce the Time and Cost for Closure and Disposition		
Evaluation Measure	MEC Acres	
Acres	x	Complexity
	0	0
	10000	8
	20000	8.5
	30000	9
	40000	9.5
	50000	10
Evaluation Measure description.		
Evaluation measure sources:		
Type of evaluation measure		



Whenever possible we developed the complexity function using our data analysis insights. Our interviews, meetings, panels, and research also played a pivotal role in developing these functions. For the complexity function to support the type of mission realigned, depots and labs have a small complexity score based on our data analysis. Recall that many stakeholders and subject matter experts had the preconceived notation that depots and labs were difficult to dispose; however, our data analysis did not support this hypothesis. Thus, the qualitative variables depots and labs in exhibit 13 had a resulting lower complexity score.

Exhibit 13. Complexity Function for Mission Type

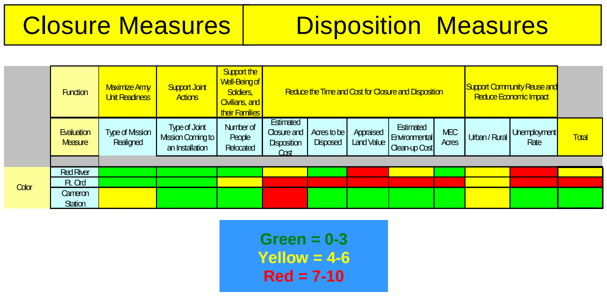
Maximize Army Unit Readiness		
Evaluation Measure	Type of Mission Realigned	
Mission	x	Complexity
Minor Training AC	1	1.5
Minor Training RC	2	1.5
Housing	3	2.3
Depot	4	2.5
RDT&E / Labs	5	2.7
Major Training AC	6	3
Major Training RC	7	3
Medical	8	3.5
Administration	9	4.3
Industrial	10	4.5
Transport	11	10
Evaluation Measure description.		



All ten complexity functions were developed in a similar fashion as the two shown in exhibit 12 and 13. Each of these functions is used in the matrix on the x-axis while different installations are used on the y-axis. Each function is weighted at the top of the matrix, and the scores for each attribute of each installation are included underneath the levels and complexity for each attribute. Similar to the model developed in Logical Decisions, we can present the complexity matrix in three forms ranging from a complex matrix that shows each scoring step to a simple matrix that shows only the qualitative output.

The simple matrix in Exhibit 14 is the same as the complex matrix except that it is condensed down to remove the complexity levels, scores, weights, and value calculations from the users view. We also had a suggestion to create two matrices: one for closure and one for disposition. For our model, we grouped those strategic objectives that support closure and those that support disposition. The headings for these are on the simple model, and this also explains why they are not in numerical order based on the updated strategic plan.

Exhibit 14: Simple Complexity Matrix



In the matrix, installation scores data are typed into the matrix. The values are calculated using the scores, the complexity functions, and the weights. The numerical complexity value is then colored according to its complexity. Green is least complex, yellow is more complex, and red is most complex.

Each complexity attribute was given a weight based upon the importance of that attribute and the variation of the attribute. These weights were then used to determine an overall installations complexity value. For instance, MEC acreage was given a lot of weight while mission to be realigned was not, so if one installation had a complexity of 10 for MEC acreage and another had a 10 for mission to be realigned, the installation with the 10 for MEC is going to be more complex because it is weighted more. This weight comes into effect in the "total" column of the installation evaluation by doing a sum of the weights times the complexity value.

Each attribute was given a weight based upon our data analysis. For instance, our regression analysis showed that MEC acreage was very likely to drive up environmental costs ($R^2 = .86$), so MEC acreage was weighted more than any other attribute because we did not have those kind of results for any other attribute. Our data also showed that transport missions were the most difficult to dispose of while something like a depot or a lab was a lot easier. This is contrary to a lot of comments made during some of our interviews, so we weighted the attribute "mission to be realigned" a lower score than most of the other attributes. During our research process, many people also emphasized some attributes as being more important than others, so this also weighed heavily into the weights we assigned to the different attributes. These factors are all taken into account for the overall make-up of the complexity matrix developed in Excel. The tool is simple to use but still uses the rigor of multiple objective decision analysis to perform the complexity calculations that are transparent to the user.

Conclusions

From our research, we learned that the BRAC 2005 implementation team has a daunting challenge to meet the increased expectation to realign and dispose of an installation. The historical record shows that the shortest time to dispose an installation took just over 3 years. The average time to dispose an installation is 8.2 years. There are installations from the 1988 BRAC list that are still not closed.

Through our research, interviews, panel meetings, and data analysis, we were able to identify key factors that increase the time to dispose of an installation. More importantly, we were able to incorporate these factors into a complexity model that can be used as a management decision support tool to help identify the difficult and more challenging base closures and dispositions.

The installation complexity model has several purposes. 1) It can provide senior leaders an overall assessment of the difficulty of BRAC 2005 implementation. 2) It can improve the understanding of the unique challenges of each installation. 3) It can be used as management tool to help assign personnel to the most challenging installations. 4) It can provide a basis for allocating existing resources. 5) It can help explain the need for additional resources. 6) It can identify the need for training programs.

The use of a complexity model developed in this research has the potential for use in other areas of Engineering Management. The Complexity Model is flexible enough that it can be used with various problems tailored to the key functions. Additionally, it can provide Engineering Managers with an analytical decision support tool that will provide insight to the complex problems they face ultimately allowing them to make more informed resource allocation decisions..

Acknowledgements

There were several people involved in the success of this research. Our client Dr. Craig College, Deputy Assistant Secretary of the Army (Infrastructure Analyses) provided valuable insight. Additionally, COL Baker, Director of the Army BRAC Office and COL Tarantino from the Total Army Basing Study (TABS) Group ensured we had access and the resources necessary to ensure success. Mr. Joe Matore (from the TABS office), Mr. Rob Dow (from the TABs office), and Mr. Bill O'Donnell (from the BRAC Office) were very instrumental in providing background to BRAC implementation issues, providing resources, providing data, and arranging for our interviews and panel discussions. Thank you very much for your assistance.

Disclaimer

The views expressed in this paper are those of the authors and do not reflect the official policy or position of the United States Military Academy, the United States Army, the Department of Defense, or the U. S. Government.

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About the Authors

Major John K. Harris received his M.S. in Systems Engineering from the University of Virginia. He holds a B.S. from the United States Military Academy in Operations Research. He is currently an Assistant Professor in the Department of Systems Engineering at the United States Military Academy at West Point. He teaches system simulation, computer aided systems engineering, and engineering economics.

Dr. Gregory S. Parnell received his Ph.D. in Engineering-Economic Systems from Stanford University. He is the Class of 1950 Chair of Advanced Technology and a Professor of Systems Engineering at the United States Military Academy at West Point. He teaches decision analysis, systems design, multi-objective decision analysis, and operations research. He is also a Senior Principal with Innovative Decisions Inc., a decision analysis consulting firm. His research and consulting involve decision and risk analysis, systems engineering analyses, resource allocation, research and development (R & D) portfolio analysis, and system architecture analysis.

Second Lieutenant Sean Gardner graduated from the United States Military Academy in May 2004 with a B.S. in Engineering Management. He was commissioned in the US Army as a Field Artillery Officer.

Second Lieutenant Brent Hoops graduated from the United States Military Academy in May 2004 with a B.S. in Engineering Management. He was commissioned in the US Army as a Field Artillery Officer.

Second Lieutenant graduated from the United States Military Academy in May 2004 with a B.S. in Engineering Management. He was commissioned in the US Army as an Infantry Officer.