Modeling Army Officer Promotions

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"What are the chances I'll get promoted?" "Where do I rank amongst my peers?" "What effect will my next evaluation have?" Officers ask such questions not because a random process determines promotions and standings, but because they seek to quantify and assess the apparent chaos that determines their future.

Every Army officer's performance file consists of copious evaluation reports, awards and schools. The system we use to determine promotability in boards may in fact, have stochastic (random) properties that can be modeled. The mechanism used by the US Army is the Officer Evaluation Report (OER), DA 67-9. A lion's share of the performance emphasis rests with the Senior Rater evaluation as the quantifiable measure. Essentially, there are just two common rating options: 1) Above Center of Mass (ACOM); or, 2) Center of Mass (COM). For this analysis I'll assume a Below Center of Mass rating takes a file out of contention.

Initial guidance from the Department of the Army to senior raters was to place approximately one-third of officers in the ACOM pile. The OER process itself limits a senior rater to no more than 49% ACOM reports in each grade for their population pool. Through April of 2002, 63% of reports received were COM for all ranks and all specialties [US Army Human Resource Command, Management Support Division, Information Paper].

While every performance file is multi-dimensional and unique, most analysis of board results point to the ratio of ACOM reports as a primary driver for selection. As the number of the new OERs increase in files, the Army expects that determinations will become less subjective.

I'm not a disgruntled Soldier disenchanted with the way we select our future leaders. For the last twenty years, I've been privileged to work with exceptional leaders and seen the very best of my peers excel. This article is a analytic view of the Army's Officer Evaluation system, and the main application of the proposed model is for the non-traditional tracks (that is, other than operations and command). I address further adaptation and modification of this model in the extensions section of this article.

Formulation. Assume that the discrete probability of getting an ACOM report from a senior rater is random and that each rating is independent from the previous report (I'll address why I interpret the process as random later. Treating each rating as a stochastic process with two distinct outcomes allows the overall number of ACOM ratings to be modeled a binomial probability distribution:

$$P_{(k\_out\_of\_n)} = \frac{n!}{k!(n-k)!}(p^k)(q^{n-k})$$

Where: p = probability of getting an ACOM
$q = 1 - p$ (or the probability of getting a COM)
n = the number of OERs
k = number of ACOM reports in a file

In order to solve for the different values in the equation, first I make an assumption about the value of p, the probability of getting an ACOM on each report. Without benefit of years of data, I have to make one key heuristic assumption. The Army target for ACOM is one-third of a senior rater's total population for each rank, and that rate cannot exceed 50% without a profile becoming invalid. I model education requirements and key (branch qualifying) jobs must be seen as simple pass-fail criteria — no key job or school means not eligible for promotion.

For the sake of argument, I'll choose an ACOM percentage in the upper range ~ say 48%. Conducting sensitivity analysis by varying the value of p between 0.33 and 0.5 shows some interesting outcomes. In particular, the distribution curve is fairly tight around the mean. I believe, however, that when looking at the last few Colonel and Lieutenant Colonel boards, using an ACOM probability of 0.48 is reasonable. I will also limit the analysis to just the new OER.

Example. What is the probability that an officer will receive 3 ACOM reports out of 7 OERS? If I assume that $p = 0.48$, then q is 0.52. Inserting the values in our formula shows that, in a large population, 29% of all officers with 7 OERs will expect to have 3 ACOM reports.

More critical to the assessing officer is the cumulative distribution, that is, what percentage of the population has <u>at least</u> k ACOMs out of n reports. This is accomplished by adding the probability of n of n, plus the probability of n-1 of n… through k of n reports. So in our above example, an officer with 3 ACOM reports should expect to be within the top 73.9% of his or her peer group.

The table below portrays the ranking percentages of k out of n using binomial probabilities with an assumed p of 48%, and adding the individual probabilities from the upper values through the lowest values of k. With the table, a rated officer can assess where they should expect to be within a peer year group, or enter the table using an assumed selection percentage and determine the number of ACOMs likely needed for selection. The process model table is

*(See **PROMOTIONS**, p. 26)*

Number of OER's --->

ACOM	1	2	3	4	5	6	7	8	9	10
0	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
1	48.0%	73.0%	85.9%	92.7%	96.2%	98.0%	99.0%	99.5%	99.7%	99.9%
2		23.0%	47.0%	65.7%	78.7%	87.1%	92.3%	95.5%	97.4%	98.5%
3			11.1%	28.3%	46.3%	61.8%	73.9%	82.8%	88.9%	93.0%
4				5.3%	16.3%	30.7%	45.6%	59.2%	70.5%	79.3%
5					2.5%	9.2%	19.5%	32.0%	45.1%	57.3%
6						1.2%	5.0%	12.0%	21.6%	32.9%
7							0.6%	2.7%	7.2%	14.1%
8								0.3%	1.5%	4.2%
9									0.1%	0.8%
10										0.1%

Table. Cumulative standings within a population with a selected probability of p = 0.48

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valid for an individual officer entering at their count of OERs. A board must evaluate the larger year group with a varying number of reports.

For example, an upcoming LTC board is expected to select 70% of eligible officers in the primary zone of consideration. If the example officer has 8 OERs, 4 ACOM reports put them in good stead (top 59.2%), while 3 ACOM reports (top 82.8%) may place them at risk, as only about half of those may be selected. In the table, the black cells indicate at-risk profiles, white cells show high probability of selection, while the gray cells portray the "bubble" at a 50% selection rate. This bubble is very close to the expected value of ACOM reports and illustrates where officers may fall above or below the cut line.

The graph in Figure 1 shows a cumulative probability for officers with 10 reports in their file and the likely impact of entering the curve at different selection rates. If the primary zone promotion rate is estimated to be 70%, this percentage intersects our distribution curve between four and five ACOM reports out of 10. I interpret this to mean that officers with 5 (50% of their number of reports) or more ACOM reports are more than likely to be selected. Officers with four (or 40% of their number of reports) are at risk, meaning some will be selected while others in that same category may not. If the curve is correct, having less than 4 ACOM reports makes it unlikely those officers will be selected for promotion without an extraordinary narrative and complete file.

The graph in Figure 2 demonstrates the approximate normality properties of the distribution of ACOM reports when $p = 0.48$. Also notice the tightness of the distribution around the center, with 65% of the probability of the population having 4, 5 or 6 ACOM reports out of 10.

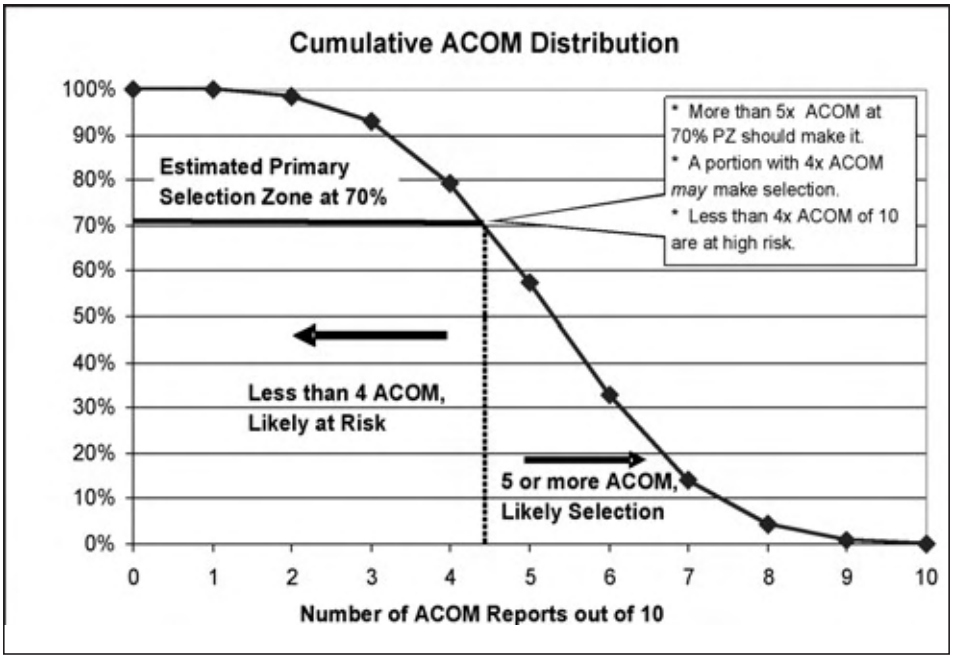

Figure 1. Cumulative probability of having at least k ACOM out of 10 reports.

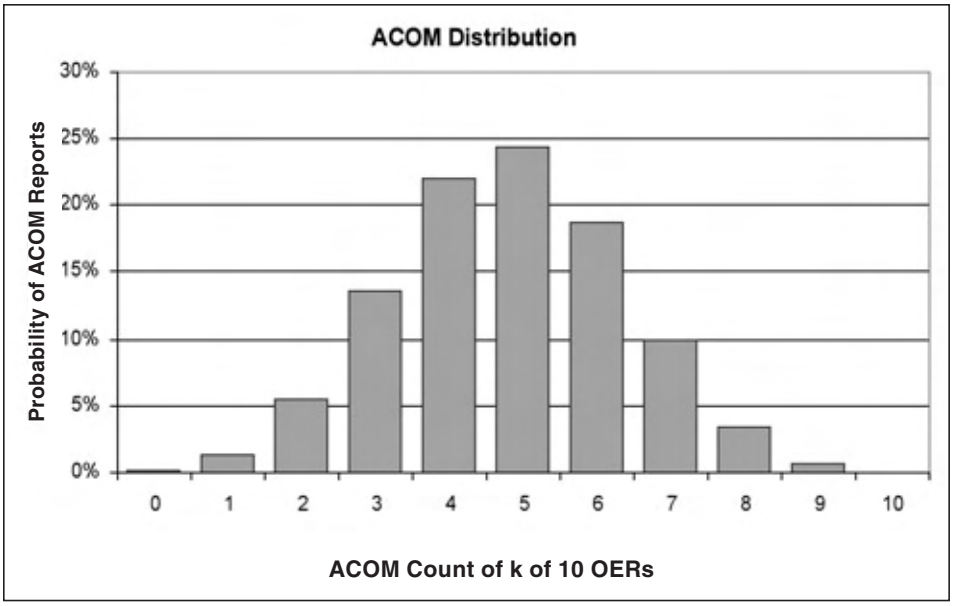

Figure 2. Probabilities of k ACOM reports out of 10 OERs

Analysis and Insights. I am not arguing that promotability is simply random and unrelated to performance. But, officers have no control over who their senior raters are, nor do they have influence over timing considerations and degrees of flexibility in a senior rater's existing profile. While specific individual efforts reflect performance ratings over time, how I rank among our peers on a leveled playing field is the only element that can be quantified.

Examining the cumulative table allows the rated officer (say, me) and my senior rater to not only assess current position within a group, but more importantly, to show the impact of the next rating. Can I absorb another COM? What is the net affect of this rating on my total file? Of my next three reports before my promotion board, how many must be ACOM in order for me to stay competitive at given promotion rate?

This methodology is probably not accurate enough to make a precise assessment of where I am in my career. But what the model can do is: 1) allow assessment of where a performance file ranks amongst peers; and, 2) show the impact of subsequent OER ratings on that ranking. Referring back to the table, a 5 of 7 officer is likely in the top 20% of his/her peer group. If that same officer receives 2 additional COM reports (becoming 5 of 9), the overall strength of that file drops to the top 45%.

If all things are determined equally, and our 48% probability of getting an ACOM holds true, even having 5 ACOMs of 10

reports will not guarantee promotion at a fifty percent selection rate… in fact, 5 of 10 ACOM is just above the *expected* value! This bore true again on the FY04 Colonel selection board, as many on the 50% selection rate in the Institutional Support Career Field were not selected. Looking at an OER *k* count of 10 reports on the cumulative probability graph, at the targeted 50% selection rate, having 6 of 10 ACOM files should secure a promotion, while less than half of those with 5 ACOM reports will be promoted.

Another insight is that COM reports drag down a file. As a result, officers may seek to avoid short duration reports to reduce the probability of receiving an additional COM report.

Sensitivity of the Model. Suppose that the ACOM probability were closer to 0.35. Then, having 5 of 7 ACOM reports would mean that officer is in the top 5.6% of their peer group, and would likely below-the-zone candidate rather than in the top one-fifth.

At Colonel selection time, a large percentage of those that believe they will not be promoted may choose to retire. This would skew the peer pool of officers to those on the right side of the curve. It is possible, however, that equal numbers of those with solid promotion potential may also choose to retire. Specialties containing a small number of candidates, coupled with the small number of quantifiable reports, make this sort of analysis highly variable. However, , the FY03 and FY04 Army COL boards for functional area 49's (operational analysts) showed that having at least 50% ACOM reports resulted in selection at a just over 51% promotion rate (10 of 19 selected in FY03, 7 of 13 selected in FY04).

Model Extensions. This model does not account for the strength of writing in evaluations, the rank of senior raters, the level of difficulty of key positions held, the officer population size, branch qualifications and a host of other factors. Nonetheless, over a period of several years, raters and positions, this very basic probability model may be sufficient for evaluating promotion potential within the current system.

There are some obvious extensions that could be added, such as individual file trends. Timing of an individual report may also be critical, particularly if it is the most current evaluation that a board sees.

It may be interesting to look at individual probabilities by grade and within different branches or career fields. For example, I could assume that Lieutenant Colonel OERs are twice as important as Major OERs to a board. By weighting each of the probabilities, I could calculate such a composite probability:

> 2 of 5 MAJ OERs at $p = 0.48$ charts at 78.7% (this officer was likely on the bubble for promotion to LTC)
>
> 3 of 5 LTC OERs at $p = 0.48$ charts at 46.3%.
>
> For the COL board, this example officer's combined standing is = 0.33(0.787) + 0.67(.463) ~ or within the top 57.0% of the pool.

If the selection rate is approximately 50%, this officer is again on the bubble, but is in better standing if the LTC reports are weighted. Using different ACOM probabilities for each rank can further extend this analysis.

This same weighting process may work for those in the operations and command track, where Branch Qualifying (BQ) reports are definitely weighted more heavily. Another effect that likely exists for those on a command track is that their value for *p* may be much higher, as the competition for key positions is much tighter. For example, in the most recent Infantry Battalion Command board, 17% of eligible officers were selected, and nearly all BQ reports of the selected were ACOM. Officers in command jobs tend to be "fast trackers," and are more visible and known than their staff peers. Selection for Colonel, Senior Service College, and commands may require a that an officer have nearly all ACOM reports in key jobs to stay in the top 5-10%.

Further analysis of the statistics compiled by Army's Human Resource Command in September 2004 demonstrates that the true distribution of the more senior year groups may in fact be bimodal, meaning that there are two distinct populations within one year group. The smaller population resides at the top with a pure ACOM profile. This subset is further accentuated in that by the time a group reaches the Colonel primary zone, many of those in the lower echelon of the population pool have retired. In the FY04 promotion boards, 13% of Majors and 21% of the Lieutenant Colonels had pure ACOM files going into the promotion board. Consequently, one population stays at the very top of a year group with all ACOM reports, while the second population has a mixed ACOM profile. Overall, the portrayed binomial model should remain sufficient for overall primary zone consideration, as those on top already know where they are, and a higher *p* value (closer to 0.5) takes this into account for the middle values where the majority live.

It is unclear what effect the strength of quality senior rater comments on COM reports or on reports that will not have a block-check (a new Army policy for Lieutenants and Captains) will have. The number of 'useable' reports with quantifiable senior rater evaluations for each pool of officers will remain small. At maximum for Colonel, only the last 10 years of reports will play a factor in selection. For Lieutenant Colonel, the count could be as few as 3 or 4 quantifiable reports.

Additionally, I did not consider quality enumeration of the senior rater narratives. This is where the senior rater's narrative quantifiably places the rated officer amongst her peers, e.g., "Major Smith is in the top three of the fourteen Majors in the Brigade". While such comments have a degree of influence on the board members, especially for the group of promotion packets in the middle, they are discounted here simply because they can not be quantified nor compared. I also did not consider the "bounce" effect of the last report in a file.

Conclusion. At first glance, it appears that my major insight was that the percentage of ACOM reports had to be at least that of the non-selection rate. The true benefit my model, however, is that it allows career war-gaming based on the strength of the performance file.

The use of binomial probabilities in the current officer promotion system cannot absolutely predict the promotability of a given officer. But, with some very basic assumptions, an Army officer can assess his general position amongst his peers. The probability tables may also provide a general guide as to the impact of the subsequent OER ratings on an officer's performance file. The table can also be recalculated using any assumed value for *p*.

I am not suggesting that promotion boards are using a comparative numeric model or system. Instead, I propose that we can

*(See **PROMOTIONS**, p. 28)*

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model systematic behavior of the boards using a number of assumptions and a very simple probability model. While this methodology may not be accurate at the individual level, it does provide an empirical estimate of standings within a peer group. Key jobs, extraordinary performance, and quality leaders and mentors should always raise an officer's stock.

Biography

*LTC **David D. Briggs** is the Chief of Operations Research/Systems Analysis for US Army Europe. He holds two M.S. degrees in Industrial Engineering from the University of Central Florida (Operations Research and Simulation) and an M.S. in Business Administration from Boston University. His previous analysis assignments include US Transportation Command, Combined Forces Command, Korea and Assistant Professor, Department of Systems Engineering at the United States Military Academy.* ✪

MORS PRESIDENT

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being led by Col **Greg Reuss** and COL **George Stone**, with technical leadership from **Steve Stephens** and LTC **Scott Schutzmeister** will make great strides in bringing "new" agent-based and adaptive techniques to bear on the challenges of analysis for stability operations. The second meeting on *Homeland Security-Homeland Defense Decision Support* being led by **Tom Denesia** and Immediate Past President **Andy Loerch** hits squarely on the head of expanding communities. My thanks to these great MORS leaders for fulfilling the intent of my initiatives…even before I wrote them down!

Final Thoughts

At this halfway point of the MORS year…a year dedicated to both looking back and looking forward, we are well on our way to meeting both our looking back (40th anniversary celebration) and looking forward (expanding spheres in sponsorship, communities, and techniques). Please plan to join us at the events of the remainder of this MORS year…check the MORS website for up-to-date information. ✪

GROWING IN MORS

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The Vice President for Professional Affairs is responsible for the Education & Professional Development, Heritage, Prize and Publications committees. Finally, the Secretary owns the Membership and Electronic Media committees.

Board members engage in activities by getting personally involved in ongoing activities, but also pursue new initiatives. Directors try to attend as many Special Meetings as possible, selecting at least one annually to play a proactive role. They work with a set of MORSS working groups or composite groups during their tenure on the board. Finally, they participate in committee work.

All Directors have a shared responsibility for the total functioning of MORS — the symposia, publications, special meetings, and awards. All Directors work with MORS members and the Military Operations Research community at-large to help recruit speakers and participants for meetings, write articles for *PHALANX* and papers for the *MOR* journal, and solicit papers for the annual David Rist prize.

The bottom line is that being a MORS Director is fun, as well as being a professional growth experience! Being a MORS Director can provide one of the richest and memorable experiences in one's career. As Board members press forward to take on new challenges for the Society, their results go a long way to keeping military operations research relevant.

Now that you've learned about the MORS Board of Directors, how can you grow in MORS to this next level? You need to be nominated to the Board by two current Directors. A nomination form is completed by the nominating Director which includes information about your current status (active duty, government civilian, civilian analyst), MORS background, Military Operations Research experience, and reasons why you should be elected. Quite a few quality candidates are presented to the Board each year, and it is not easy to get elected. Therefore, I recommend you gain experience in all aspects of MORS (annual symposium, special meetings and committees), as well as presenting and publishing your work.

MORS Fellows

After their time on the Board, many Directors stay involved with MORS. Some remain on the Board as Advisory (non-voting) Directors, while others take a year or so off then are nominated and elected back to the Board (a group known as "retreads"). Also, a select few are elected as Fellows of the Society. Because of significant, long-term contributions to the Society, certain individuals are selected by the Board of Directors to hold the title of Fellow of MORS. Fellows are elected for life. Selection as a Fellow honors and recognizes significant contributions to the Society. The nominee must have demonstrated long standing, significant, and dedicated service to MORS — the overriding criteria for selection. Expertise in military operations research or short-term contribution to the Society and its activities is not sufficient. Indications of meeting the criteria include, but are not limited to, some combination of MORS leadership, programs, administration and participation.

No formal responsibilities are imposed on MORS Fellows, and they do not constitute a committee reporting to any MORS officer. However, the Fellows constitute a valued resource for the Society. In the past, they, as individuals, have provided senior-level counsel to the Society. They have been advisors to Committees of the Society and to officers, Board Members, and staff. Their involvement in activities of the Society should be appropriately solicited as needed.

Summary

As with getting involved with the Military Operations Research Society for the first time, there is a similar, continual theme for growing in MORS: you can volunteer and contribute at the MORS Symposium, with special meetings, and in standing committees at all levels — from new volunteer through the Board of Directors, all the way to becoming a MORS Fellow. We hope you will seriously consider making this organization stronger by participating with us. If you have any questions about volunteering for the annual symposium, special meetings, or standing committees, please feel free to contact **Kirk Michealson** (kirk.a.michealson@lmco.com, 757-935-9501), ask any board member, or the MORS Staff. We look forward to having you connect with one of our teams. ✪