

# Understanding Social Barriers and the Diffusion of Acceptance of Women in the Infantry: A System Dynamics Approach

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**Abstract:** This study uses system dynamics simulation to explore structural and socio-psychological dynamics associated with the United States Army's gender integration initiatives for its infantry branch. In 2015, the Army's Training and Doctrine Analysis Center (TRAC) published the "Gender Integration Study" and the "Ranger Assessment Study," providing findings that helped shape the Army's gender integration initiatives across its combat arms branches. The focus of these and many other gender integration studies predominantly focus on whether gender differences, physiological and/or psychological, affect one's ability to meet requisite performance standards in combat arms branches. As an essential complement to the existing and ongoing performance-focused research, system dynamics modeling will provide a basis to assess social barriers that exist with the Army and American culture, inhibiting broad acceptance of women in the infantry.

**Keywords:** Infantrymen, Social Acceptance, Women in the Infantry, System Dynamics

## 1. Introduction

This study examines the structural and socio-psychological dynamics of the US Army's initiative to support gender integration into the Army's infantry branch. In doing so, the construct of this paper will follow the five-step system dynamics modeling process from Sterman (2010): problem articulation, formulation of dynamic hypothesis, formulation of simulation model, testing, and policy design and evaluation. This methodology is appropriate because the system of study is characterized by non-linear relationships, feedback structures, and time delays—the very components of dynamic complexity that are fundamental to system dynamics modeling (Sterman, 2010).

The foundation of this study relies on establishing an understanding of social acceptance within socio-behavioral systems. Literature on the subject acknowledges the difficulty of accurately measuring shifts in social acceptance; however, in some domains there are proxy measures that inform it (Fehr and Fischbacher, 2004; Rauhut and Winter, 2010). Tangible examples of changes in social acceptance exist in technology diffusion. The use of the social media platform Facebook has grown so immensely since its launch in 2004 that the Pew Research Center reports that as of November 2016, 68% of all U.S. adults and 79% of internet users use Facebook (Duggan, Greenwood, and Perrin, 2016). This major growth in the popularity of Facebook is a measured statistic of social change in the way people interact and exchange information digitally. A more abstract example exists in historic social change such as the acceptance of desegregation brought on by the Civil Rights movement. The proxy measure for this shift is evident in the decline in residential segregation over time (Massey and Hajnal, 1995). System dynamics helps inform the complexities in understanding concepts like social acceptance because it articulates the non-linear feedback structures that generate the behaviors therein. Too often, these complexities are over-simplified with linear representations (Sterman, 2000).

In order to understand how social acceptance is achieved, it is imperative to understand how social barriers inhibit social acceptance. By common definition, a barrier is a wall or obstacle that prevents movement. A barrier, in a social context, is an obstacle that prevents acceptance into a specific social group. This concept is demonstrated by Lucie, Moran, Tarrasch, and Yanovich when they state, "Each [combat branch is] a distinct, closed social system with a decades-old set of predefined social rules, a military unit (through its current and past members) may perceive the induction of female members as a

dangerous blow to its social status quo. Women therefore often confront rejection, alienation, prejudice, and discrimination within their units” (Lurie et al., 2010, p. 306). Both the perception and existence of this prevailing culture within combat arms branches are the social barriers that this study endeavors to understand through system dynamics modeling.

## 2. Problem Articulation

On December 3, 2015, the US Department of Defense officially announced that women in the Army may serve in the infantry, field artillery, and armor branches. By December 2016, three women successfully passed Ranger School, the Army’s premier leadership program. Despite the extraordinary success of both the policy change and efforts of the first women in Ranger School, gender integration is still the subject of great debate on a national scale, and its acceptance is long way from becoming the norm. By examining in depth the societal structures that create social barriers, the Army can break them down in order to promote the paradigm shift to accept women’s presence in combat roles. Because each combat branch has unique men to women ratios and inherently different cultures, this model will keep the populations disaggregated and only focus on women joining the infantry.

To monitor the progress of women joining the infantry, the model will focus on three key variables. The *percentage of women in the infantry* is important as it reflects progress because as more women join the infantry, the percentage of women will increase. The *average duration of service within the infantry branch*, specifically the average number of months women serve in the infantry, may reveal how comfortable women are in the infantry. In the least, the duration, when compared to the average length women serve in the Army, may provide a metric to show the current state of change. In the simplicity of the model, the dynamics of the *average duration of service within the infantry branch* are not expanded as it may include the effects of many other variables such as family support and the lure of the civilian world. However, it is likely that the increase of *social acceptance* will have a positive effect on the duration of service. The dynamics of this variable should be explored in future work. The *social acceptance* variable is a measure of the normalization of women in the infantry. This variable reflects the paradigm shift that moves from the thought that it will never be normal to have women in the infantry, to all members of society believing women in the infantry is normal. Although it is unrealistic to assume all members of society will ever share the same opinion, the more who accept it, the better. This normalization includes acceptance on all social levels, the public, the government, and the soldiers. As social barriers decrease, the acceptance will increase. For the sake of this model, acceptance will occur when the women to men ratio in the infantry is steadily equal to the women to men ratio in the entire Army, 16%. The key variables expect to mimic an s-shaped growth pattern because once society adjusts to this change, more will women will join and serve longer until the infantry reaches a natural equilibrium (Sunstein, 1996). As is fitting considering the recency of the change in regulations, the model will evaluate how the current societal structure contains current natural barriers and its future effect on the integration of women in the infantry branch. Specifically, it will focus on the state of the system at the time of policy change through the next 30 years in order to examine short and medium term effects. As the Army moves beyond their initial phases and continues to assimilate women into the infantry, there are likely to be further policy and doctrine revisions to foster a smooth transition, and the results of this model aim to assist in the design of those revisions.

## 3. Formulation of Dynamic Hypothesis

### 3.1 Initial Hypothesis Generation

With current policy, the U.S. Army is encouraging women to join its combat arms branches but it remains that only few outliers accept the challenge to join. Once the few outliers prove their competence in the infantry, society will begin to change their mind to one of acceptance. After a period of time, society will acclimate to this new policy, causing acceptance to continue increasing, leading to an increase in women in the infantry. Until then, the Army will have to continue its efforts to recruit through media campaigns in order to shorten the delay that keeps women from moving from *women who qualify for service* population into the *women who desire to join* population. Although the current model holds *average duration of service within the infantry branch* constant, it is likely that as *social acceptance* increases, the duration of service will increase alongside it. This endogenous effect should be expanded as this model grows, as it may highlight a key relationship not yet explored.

### 3.2 Endogenous Focus

The endogenous focus of this model will be increasing the *service entry* and the *social acceptance*. These two variables help drive women to flow from *women who qualify for service* through *women infantry candidates* and into the *women in the infantry* population. Although *social acceptance* is not a direct rate, it directly effects the *infantry branch entry rate* into the *women in the infantry* population. The two rates come from within the two main loops, Paradigm Shift and Recruiting. Focusing

on what motivates these two variables will unveil the hidden issue that delays women from joining the infantry. The resulting patterns of women moving through the different populations will highlight which loop dominates the model, further accenting the underlying cause to the delay.

### 3.3 Causal Loop Diagram

The creation of a casual loop diagram allows a modeler to visually depict the structure of society that drives the population’s behavior. The casual loop diagram, displayed in Figure 1, explains the societal barriers keeping women from joining the infantry. The following section will walk through the loops of the model to explain each component and structure. To clarify, a positive link represents a positive value in the partial derivative governing a change in one variable with respect to the other. If the originating variable increases (or decreases), it will cause a corresponding increase (or decrease) to the variable it links. Alternatively, a negative link represents a negative polarity in this relationship, meaning that if the originating variable increases (or decreases), it will cause a corresponding decrease (or increase) to the variable it links. Furthermore, a reinforcing loop is a structure that contains variables that through their either positive or negative links circle back on each other and result in an overall reinforcement or amplification in the originating variable behavior. A balancing loop, however, is a feedback structure that propagates variation in any one variable within the loop and ultimately counteracts that variation.

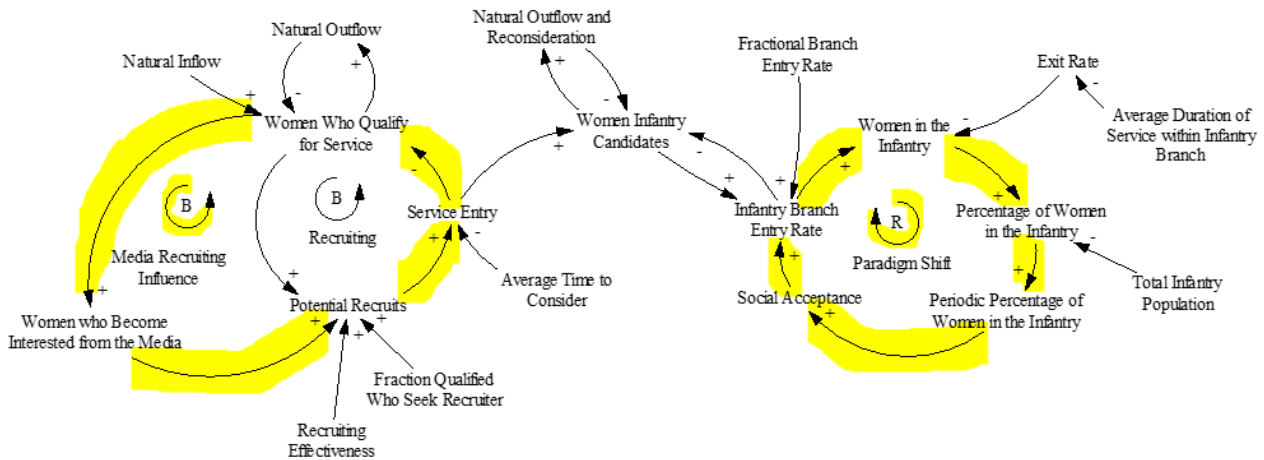


Figure 1. Causal Loop Diagram

The main reinforcing loop of the model is the Paradigm Shift loop. Seen in Figure 1, this loop shows that as the *percentage of women in the infantry* increases, the *social acceptance* of women in the infantry will increase, which will then lead to more *women in the infantry*. There is a delay in this loop that represents that society will only accept women in the infantry once the percentage remains steady. This idea stems from a report in the *Columbia Law Review*, in which the author theorizes that breaking down social norms will become more popular when the defiance of said norm becomes less costly and more beneficial (Sunstein, 1996). This supports the paradigm shift loop that as *percentage of women in the infantry* remains steadily increasing over time, the society will see the cost of this social change as decreasing and therefore begin to accept a new social norm: women in the infantry. The *periodic percentage of women in the infantry* variable represents this delay. The Paradigm Shift loop incorporates *social acceptance*, a key endogenous variable, that once effected will change the course of the social acceptance process.

The main balancing loop in this model are the Media Recruiting Influence loop in Figure 1. The Media Recruiting Influence loop mimics the Bass diffusion model, where the adoption of a product increases through both an increase in potential adopters and through an increase in advertising effectiveness (Sternan, 2000). Likewise, this loop depicts that more women will consider joining through both an increase in the potential population pool and through media and recruiting effectiveness. One important aspect of this loop is the delay that represents women taking some time to explicitly express interest in joining the infantry. The *average time to consider* variable represents this delay. The loop closes with an inverse that as the *service entry* increases, the *women who qualify for service* will decrease.

## 4. Formulation of Simulation Model

To model the normalization of women in the infantry, it is important to understand and acknowledge the breadth of the issue. However, as discussed in model boundaries, bounding the problem is essential to emphasizing the core issues at hand.

### 4.1 Structure Specifications

There are three core structures that drive the behavior of this system. Understanding that each structure results in a specific behavior will allow the modeler to validate the analysis of the model. The first is the aging chain that moves the female population from *women who qualify for service*, into *women infantry candidates*, and finally into *women in the infantry* population. The other primary outflows are the *natural outflows*, *reconsideration rates*, and *exit rate*. This structure results in a behavior that takes a population and advances it either forward or out of the system.

The second structure is the partial Bass diffusion model that makes up the Media Recruiting Influence loop. The Bass diffusion model provides insight into diffusion of products or technologies through two main influences, social exposure and advertisements. The model illustrates their effects on a potential user population. The Media Recruiting Influence loop imitates the adoption from advertising portion of the Bass diffusion model in that it capture the effect of media influence on potential adopters (Serman, 2000). This structure results in a behavior of depleting a potential user/adopter population by increasing the exit rate from this pool.

The last structure is the pipeline delay present in the flow through the *women in the infantry* population. This structure represents that Army personnel move through a sequential process, which requires them to exit in the same order of entrance after a given period of time, such as their legal commitment obligation (Serman, 200). This structure results in a standardized movement of people through the *women in the infantry* population.

### 4.2 Estimations and Assumptions

In this model, only the exogenous variables resulted from estimations. Each estimation's accuracy is critical to insure a valid model. The later sensitivity analysis tests assumptions and brings to light which exogenous variables carry more weight in the model than others. Table 1 below lays out each justified exogenous variable and displays the initial parameters of exogenous variables that will undergo further scrutiny in the sensitivity analysis (marked with \*).

Table 1. Parameters with Validation

Variable	Value (and units)	Description/Source
Natural Inflow	369,510 (People/Month)	Amount of people who become eligible for service consideration on a monthly basis (Howden & Meyer, 2011)
Fractional Attrition Rate 1	.71 (Dimensionless)	Percentage of people not qualified for service (Feeney, 2014)
Fraction Qualified Who Seek Recruiter	.01 (Dimensionless)	Percentage of people who are qualified <i>and</i> seek a conversation about joining the service (Feeney, 2014)
Total Infantry Population	73,500 (People)	(Molinaro, 2010); (Wood, 2016)
Average Duration of Service within Infantry Branch	36(Months)	Average duration of service for infantry branch, accounting for service obligation and attrition to other branches, etc. (Department of Defense, 2013)
Fractional Media Influence*	0.01(Dimensionless)	Influence major media campaigns have in swaying considerations of service among qualified members
Recruiting Effectiveness*	.10 (Dimensionless)	Influence recruiters have in swaying consideration of service among qualified members
Average Time to Consider*	12 (Months)	Time it takes for a person to learn about their qualification and/or contemplate their desire to join
Fractional Attrition Rate 2*	.95 (Dimensionless)	Represents women who join other Army branches (Department of Defense, 2013)
Time to Adjust Perception*	6 (Months)	Time required for layperson to change his/her concept of women in service based on duration that current stats have held true

### 4.3 Stock and Flow Diagram

Using the three root structures to serve as foundation, the causal loop diagram from Figure 1 converts into a stock and flow diagram as seen in Figure 2.

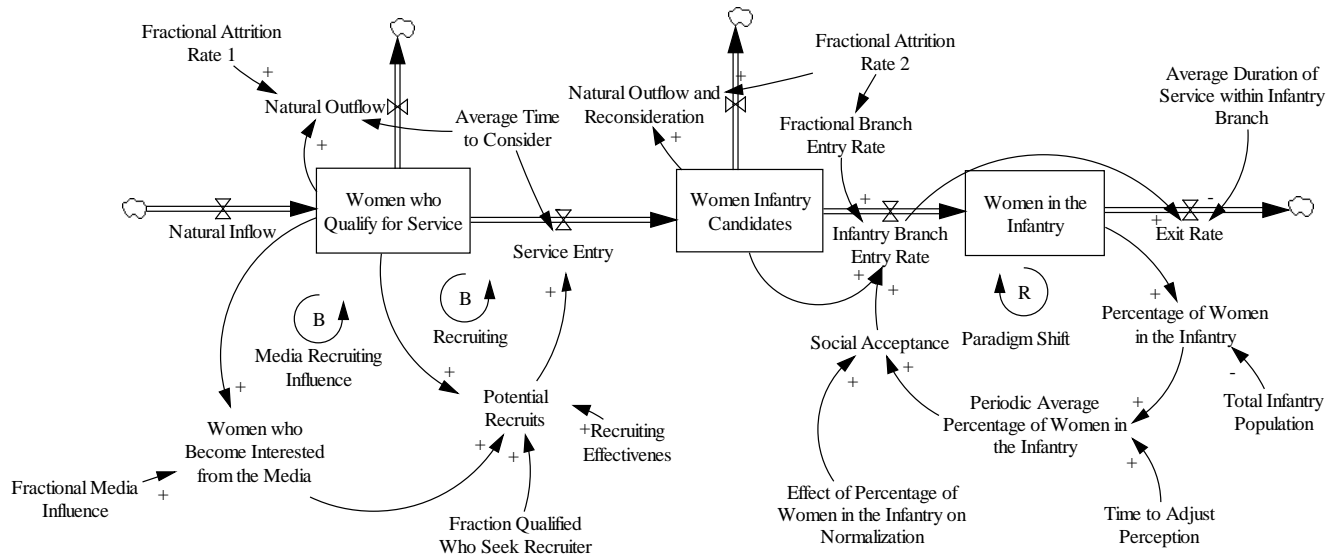


Figure 2. Stock and Flow Diagram

The reinforcing loop from Figure 1 transforms into Figure 2 to represent the two populations, *women infantry candidates* and *women in the infantry*, effected by the Paradigm Shift loop. The first increases through the *service entry* but decreases through the *natural outflow*, *reconsideration rate* and *infantry branch entry rate*. The reinforcing Paradigm Shift drives the *infantry branch entry rate*, which will increase the *women in the infantry* population.

The second main piece of the stock and flow diagram, derived from Figure 1, is the balancing loop that transforms into Figure 2 to represent the population of *women who qualify for service*. The *women who qualify for service* population increases through the *natural inflow* and decreases through the *natural outflow* and *service entry*. As mentioned in the discussion of the balancing loop, the Recruiting balancing loop drives the population, in turn decreasing the *women who qualify for service* population.

## 5. Testing

Due to the inability to accurately estimate all initial conditions, it is important to analyze the effects of each variable. This analysis occurs through the discussion of the reference mode's behavior and sensitivity.

### 5.1 Model Verification: Generating Reference Mode Behaviors

The most important reference modes to discuss are the three key variables: *percentage of women in the infantry*, *average duration of service within the infantry branch*, and *social acceptance*. The *average duration of service within the infantry branch* is modeled as an exogenous variable and is calibrated by accounting for service obligation and attrition to other branches, etc. (Department of Defense, 2013). The effects of this variation in this variable are unquestionably significant to the *population of women in the infantry*, however further validation and study are required to understand the sources governing the value of this variable over time.

A reinforcing loop coupled with a balancing loop results in an s-shaped growth of the variable. The balancing effect of the pipeline delay and the reinforcing effect of the Paradigm Shift loop result in an s-shaped growth of the *percentage of women in the infantry* and *social acceptance* variables. The reference modes and growth structure, are displayed in Figure 3.

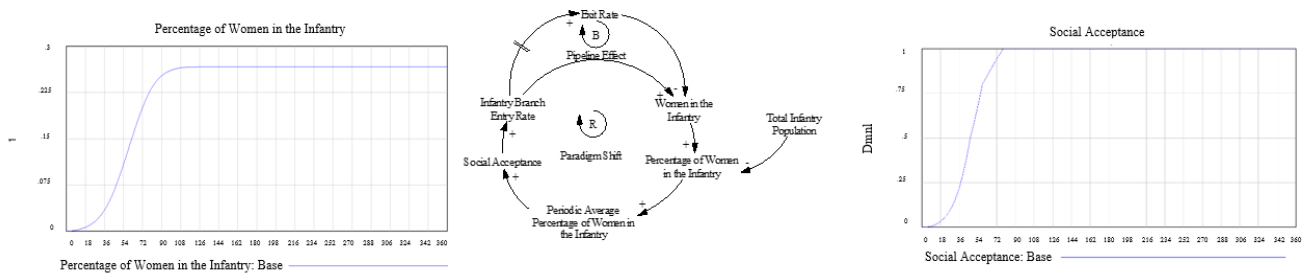


Figure 3. Reference Modes and S-Shaped Growth Structure

Both reference modes are exactly as expected because it will take time for *societal acceptance* to take off, but as it becomes more acceptable for women to join there will be an influx until the population of women in the infantry meets its goal saturation, which is the ratio of women to men in the broader Army population.

### 5.2 Model Robustness

To help validate the model, it is important to test it under extreme conditions to ensure the model behaves properly. Manipulation of *natural inflow*, *average time to consider*, and *recruiting effectiveness* provide three tests of the robustness.

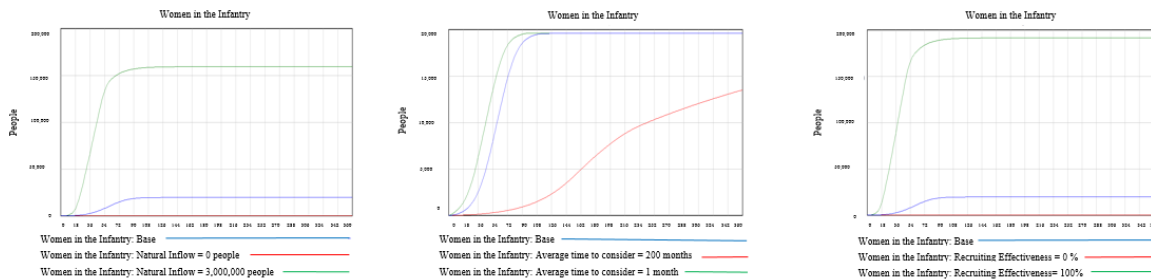


Figure 4. Robustness Test Results

Figure 4 depict the results of the three tests. When the *natural inflow* is set to zero people, the graph displays the appropriate behavior because the amount of *women in the infantry* remains zero. However, once the *natural inflow* is set to 3,000,000 the exponential growth occurred sooner because more women moved through the aging chain.

With the *average time to consider* set to one month, the model behaves appropriately, with an immediate exponential growth due to almost no delay in consideration. Inversely, with *average time to consider* set to 200 months, the exponential growth occurred much later. In this case, it does not occur within the thirty-year time span.

With *recruiting effectiveness* set to 100%, the growth occurred shortly while when it was set to 0%, there is no growth within the 30 year time span. This manipulation is appropriate because if the recruiting system cannot influence people to join, there will be no incoming soldiers. Likewise, if everyone who went to the recruiters joined, there would be many more people entering the population.

### 5.3 Sensitivity

The sensitivity of the model's invalidated estimates is necessary to determine the inaccuracies of the model. To test the sensitivities, it important to see the growth effects of the *women in the infantry* population by changing each variable to a number both lower and higher than the base estimate. Figure 5 shows the sensitivity results of *average time to consider* and *fractional attrition rate 2* variables. Due to the ranging effects of the sensitivities, it is critical to narrow down the exogenous estimations to increase the accuracy of this model's results. Not depicted are the results of *fractional media influence*, *recruiting effectiveness*, and *time to adjust variables*. Each of the three sensitivity analyses provided further understanding that the manipulation of each variable had minimal effects on the results.

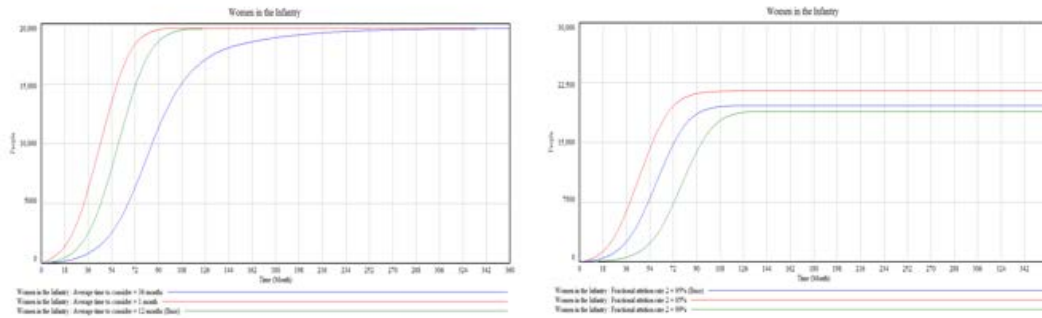


Figure 5. Sensitivity Analysis Results

## 6. Policy Design and Evaluation

### 6.1 Policy Design

In creating policies to effect the model, it is important to analyze the potential effects of a potential policy on variable values. The first policy suggestion requires funds to create a more effective media campaign in order to increase the amount of women who are legitimately interested in joining. By increasing the media effectiveness to 50% *social acceptance* will begin roughly two years earlier. The second policy to focus on improving the *recruiting effectiveness*. By improving the recruiting process, there are similar results to the media campaign policy where *social acceptance* will move forward two years when the effectiveness is increased to 50%. It is essential that the Army and the U.S. Government do everything in their power to speed up the social acceptance of women into the infantry to prevent the failure of the integration program if women continue slowly enter the infantry branch.

### 6.2 Evaluation

This model provides only a foundation and requires further validation before expansion. Two specific variables, *time to adjust perception* and *duration in service*, need further substantiation so that they may work into the model as endogenous variables. It is accurate to assume that both variables will increase as *social acceptance* increases.

Key factors that need exploration include the legacy support to women in these combat jobs, influence from word of mouth, and the effects of policy discrepancies on society and on the chain of command. Legacy support derives from prior service family members, prior infantrymen, or prior service friends who help influence women to consider joining the infantry. As exposure to the prior service populations who push them to consider joining increases, more women will consider joining. For example, a father who is a former Army ranger may encourage his young daughter to join the infantry or go to Ranger school if he believes she has the ability to do so successfully. This plays into the word of mouth portion of the Bass diffusion model where the spread of popularity through verbal narratives begins to influence the potential population pool's decision (Sterman, 2000). Effects of policy discrepancy may also be an influential reason that society struggles to accept women in the infantry. If the public, or even current service members, believe that women are getting unequal or outright unfair treatment, or if regulations change substantially to favor treatment of women over men, then civilians and military alike will have a harder time accepting the policy. By gaining a better understanding of the effects of policy discrepancies, the Army can focus on finding policies for integrating women that do not compromise fair treatment and mission needs. Another impactful understanding is likely to result from disaggregating the population pool of potential female service members. Female soldiers can join the infantry from numerous sources such as high school and civilian populations, current enlisted or commissioned populations, or directly from commissioning sources. By examining the individual pools of potential service members, the Army would gain a greater understanding of the complexities defining the social barriers that influence a woman's desire to join. With these suggested additions, this baseline model would expand to incorporate the underlying structures that contribute significantly to the diffusion of acceptance of women in the infantry and would better inform gender integration initiatives that help achieve the desired effect.

## 7. Conclusion

The encouragement and social acceptance of women into combat arms is essential to providing the Army with diverse leaders and soldiers. Current societal structures prevent this encouragement and support from occurring and are slowing the process of integrating women into combat arms. By changing the narratives of society to encouragement, the barriers can slowly, but surely, diminish. In the meantime, the government, and more specifically the Army, must focus on increasing their advertisement campaigns and recruiting effectiveness as this will help mitigate one of the two main sources of delay. The rate at which social acceptance occurs is dependent on the pace with which the percent of women in the infantry increases, progressing the idea of women serving in infantry units to more of the norm rather than the exception.

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