Military Workforce Dynamics and Planning in the Italian AirForce

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ABSTRACT

In the past 15 years the Italian Armed Forces have undertaken a massive change process, trying to transform and modernize the military instrument of power. The abolition of conscription, the consequent "professionalization" of the workforce and a drastic reduction in the overall personnel strength are the main features of this endeavor. With regards to the latter aspect, Human Resource Management and Military Workforce Planning have become of crucial importance in the efforts to meet the requirements introduced by a State Law in 1997. January 1st 2015 is the deadline to reach the target personnel strength for each service and a newly defined internal balance of promotion rates and number of people in every rank. This paper aims at describing where does the Italian Air Force stand in terms of workforce planning and , limiting its insight to the "aircrews" service branch (pilots and navigators), will describe the impact of the above mentioned transformation. Additionally the goal is to explore potential management policies able to guarantee the achievement of the given objectives.

Keywords: Human Resource Management, Military Workforce, Workforce Planning, Career Advancement, Organizational Change, System Dynamics, Policy Modeling, Computer Simulation

1. INTRODUCTION

Military structures are typically closed and hierarchical: they are closed in the sense that there is only one entry point, which goes through recruitment; they are hierarchical because career advancements can only happen step-by-step, along the pyramidal rank chain. Given these conditions, our aim is to model one of such structures (the one of the Italian Air Force) in order to reproduce its dynamics and simulate the outcomes of possible scenarios. To this end we will introduce a "workforce planning tool" which will allow us to test system responses to changes instigated by management decisions (policy assessment).

Starting from the promotion rates allowed by a recent Italian law and the revised numbers of officers that can fill any rank position within the system, we will assess if and how the desired results can be achieved. Lastly we will look at some critical issues resulting from the constraints introduced by the State Law and, through the simulation of various scenarios, we will highlight the need for different managerial leverages other than the ones currently available to the Armed Forces.

2. CONTEXT

Military rank progression within the Italian Armed Forces is a process regulated by a State Law. The most recent update to the original 1955 norm (the so-called "Angelini Law"), is the Governmental Bill 490, passed in 1997, also known as the "New Officers' Advancement Law" (Nuova Legge di Avanzamento degli Ufficiali - NLAU).

This law prescribes that a new and more contained workforce balance will have to be reached by January 1st 2015. This date should officially close what the law addressed as a "transition phase" from the previous organizational structure. During such transition, each Service (Army, Navy and Air Force) has relative freedom to design and execute plans to achieve the target personnel strength. In particular a 30% (+/-) tolerance, with respect to the number of officers eligible for promotion granted from the previous norm (Angelini Law, abrogated in 1998), has been provided in order to allow for a smooth transition.

More in detail, with reference to the Italian Air Force (ItAF) aircrews, from the initial total personnel strength of 1235 officers (such is the last documented number in 2009) the 2015 goal is 1132 officers, as described in Figure 1.

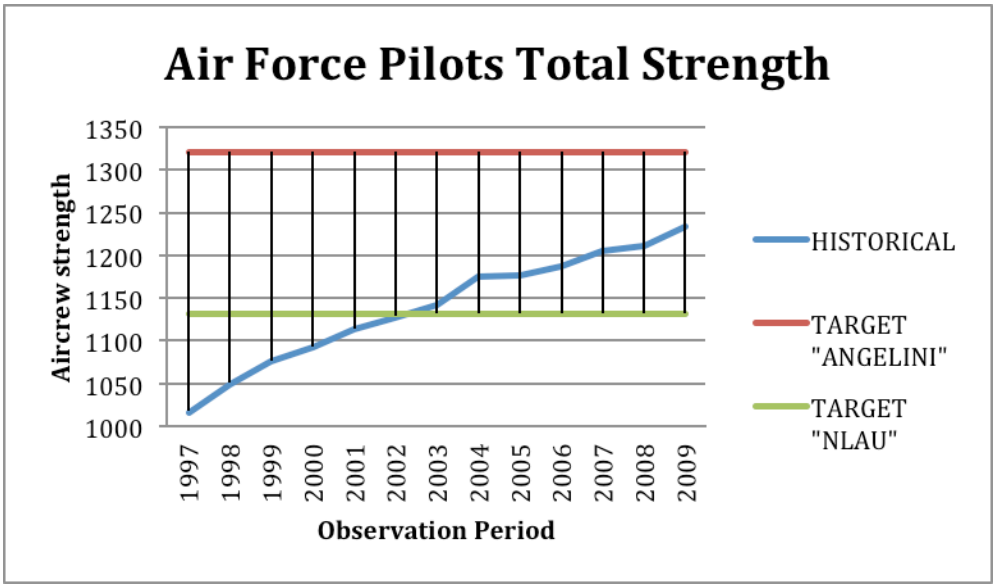

Figure 1: comparison of air-crews personnel strength goals

Furthermore, advancement within the ranks, previously a rather quick process for the Air Force aircrews, is now regulated by the progression scheme in Table 1, which also makes a comparison between the old and the new Law figures.

During the transition phase, to allow for a smoother evolution, the number of yearly promotions can be varied, according to specific needs, within the interval created by the lower and higher target values coming from the new and old regulations. Thus, for example, the number of Captains to be promoted can vary between 33 and 40.

Table 1: Progression schemes comparisons between the 1955 "Angelini" Law and the 1997 Law

Rank	CRITERIA		Years in rank		Annual promotion rates	
	Previous regulation	**1997 regulation**	**Previous regulation**	**1997 regulation**	**Previous regulation**	**1997 regulation**
Lieutenant General	-	-	-	-	-	-
Major General	Selection	Selection	1	3	2	2
Brigadier General	Selection	Selection	-	2	3	3
Colonel	Selection	Selection	1	5	5	5
Lieutenant Colonel	Selection	Selection	2	3-6-13	22	26
Major	Years in rank	Years in rank	-	4	-	-
Captain	Selection	Selection	2	7	40	33
		Years in rank		10		-
1st Lieutenant	Years in rank	Years in rank	2	5	-	-
2nd Lieutenant	Years in rank	Years in rank	-	2	-	-
Cadet	Years in rank	Years in rank				

To better understand these tables: upon ending the Academy period, after two years of officers' training, Air Force officers are incorporated within the service on a permanent employment contract, which means that, unless they either voluntarily request to be dismissed, reach retirement age or lose military status for physical or other reasons, they are going to remain in service. In other words they cannot be "laid off" during their career.

On top of this, for some categories, a minimum bound-to-serve time is imposed upon initial commission as officers. This is mostly applicable to those professionals whose training is particularly costly and/or whose qualified expertise has "market" outside the military world. Aircrews (and pilots in particular) are a typical example of this: when they graduate from the Air Force Academy and are nominated 2nd Lieutenant, a 16 year obligation to serve is signed as a precondition for promotion. When this time expires, Air Force pilots are "free" to leave the service, and many in the past have chosen to join civilian Airlines for the remainder of their working years.

During the years of booming Airline companies, the demand for civilian pilots was so high that, for a fully trained and proficient Air Force pilot, once free of obligations, it was very easy to be hired as a civilian airline pilot. In the early nineties the phenomenon had reached such a dramatic proportion that the Air Force had to introduce an incentive program to keep pilots from leaving. To give an idea of the proportion of such a situation, just consider that entire cores of executive officers from many flying units (mostly Lieutenant Colonels) were applying for voluntary dismissal, leaving operational Squadrons deserted of experienced pilots and, sometimes, commanded by young Captains. The policy adopted by the Air Force was to offer a retention bonus to those pilots that were willing to sign for an additional two-years period of service. The whole package was based (and still is…) on a maximum of five bi-annual bonuses, corresponding to an extension period of ten years, at the end of which, supposedly, 46-

plus years old pilots would no longer be a prime choice for civilian Airlines. The incentive campaign and the decreased request from the "market" of civilian companies turned into a success and, within a few years, the rate of early voluntary dismissal had returned to its “physiological” dimension. This incentive program was, in fact, a policy adopted by the Air Force in response to a typical workforce problem.

After a brief overview on the literary production in the field of workforce planning, we shall see how the military world has been trying to better its policy design in response to foreseen and unforeseen circumstances.

3. A PEEK INTO THE LITERATURE

In this paragraph, we will briefly explore what has been produced in the field of Military Workforce Planning and express the rationale behind our choice to refer to System Dynamics in order to address the organizational problems faced by the Italian Air Force.

The approaches that are usually used worldwide in order to address Human Resources management fall into the following main categories:

- Markov chain models
- Simulation models
- Optimization models
- System Dynamics

With the exception of System Dynamics, all the other techniques share the limit of “being linear approaches, not capable of capturing the dynamic nature of real world processes, which are inherently non-linear” (J. W. Forrester, 1994)

In 1961, Forrester pioneered the application of System Dynamics (SD) to study policy setting in the field of workforce planning. He used a typical production supply chain as a case study for the application. Later on, Coyle (1996) used SD to determine the number of trainees and consultant to hire from the job market. In a similar fashion, G. Winch resorted to SD in order to create a model to manage the key skills that the staff from an organization had to acquire over a certain period of time. Lastly, Sterman (2000) proposed another study on workforce planning introducing factors such as the learning curve, job training and education, developing the new concept of “Workforce Supply Chain” which became, over the following few years, the reference model in the field of Workforce Planning.

Most of these studies were approached mainly by the private sector until McLucas (2000) highlighted the following reasons for the lack of SD diffusion within the military world:

- scarcity of aggregate data;
- high expectations on the overall level of analytical detail which SD was unable to deliver;
- reluctance on the leadership’s part to accept results in the form of “insights” rather than hard data;
- the habit to attribute predictive power to any deducted conclusion, which, alas, SD was not providing.

Despite these limitations, in 2002, McLucas himself argued that System Dynamics could be more effective in solving military workforce problems. This new awareness seemed to be confirmed by a subsequent conspicuous list of documented cases of application of SD to military workforce problems, in such organizations as NATO, the US DoD and the Norwegian and Australian Departments of Defence (Coyle & Powell,

2005). In particular, two different SD models developed by the Norwegian DoD have had the merit of highlighting a consolidated *modus operandi* in the field of military modeling and simulation. The first of these models was a "performance analysis tool" whose aim was to assess the impact on the whole organization of some feedback loops deriving from specific budgetary constraints (Bakken, 2000). The second model explored managerial policies in the field of recruitment and career progression (Bakken, Hosby, 2005). One of the main outcomes of this approach was that "the modeling and simulation approach significantly supported the identification of corrective measures, reducing the risk of failure during the implementation phase", thus allowing to assess the outcomes and impacts of public (though in the military sector) policies. The main reason for the success of such an application was said to reside in the level of detail of the model. Thanks to this, a better analysis could be performed, results were found to be within the tolerance level, and therefore acceptable, and, most importantly, the model was able to coherently predict system behavior, to the point that it has been often referred to as one of the landmarks in the field of military workforce planning.

One of the limits of the early attempts at the application of SD to military workforce problems (mainly on recruitment, progression, dismissal) was the exclusion of "soft" and "intangible" variables, such as motivation, work pride, knowledge, etc. Those models were in fact mainly focused on "hard" measurable variables, creating but a mere demographic model of the existing organizations. A typical example of such limited horizon is the workforce Aging Chain, as described in Sterman's book Business Dynamics (2000), which was based on the early "Urban Dynamics" model developed by Forrester in 1969.

It is only over the last decade that a more comprehensive approach has been used in defining the main variables of social systems and behavioral elements as "Job Satisfaction" (Holstrom & Elf, 2005) and meritocracy (Tabacaru, 2006) have appeared in the models. A recent effort by Cavana, Boyd and Taylor (2007) have helped produce qualitative models of the New Zealand Armed Forces that include a wide variety of intangible variables.

This approach is of extreme interest and helps explain how some crucial performance variables such as job satisfaction, productivity, key competences, training, etc. are influenced by managerial choices. This new sensitivity and wider approach could help build those "better managerial systems" envisioned by Forrester in 1969.

4. WORKFORCE PLANNING

The growing need faced by worldwide organizations to be leaner, more reactive and adaptive to an ever-changing reality, has caused a renewed interest in workforce planning. Factors such as longer life expectancy, workforce ageing, increased competition, mismatching between required and available competences are just some of the challenges which human resource planners are daily confronted with.

This is true for both private and public companies and the policy of "the right man, in the right place, at the right time" has become a guiding philosophy for all planners. Such approach makes for a more effective personnel management, which in turns eventually allows for downsizing and re-location of key individuals within the organizations, while increasing the overall workforce competence. It is not the aim of this work to discuss whether just focusing on workforce planning is the ultimate key to a success of an organization, rather to analyze how a good workforce management through a proper planning can be achieved.

According to Sullivan (2002), this is "the golden age of workforce planning". Whilst some organizations have been using this method since 1960, this last decade has

witnessed an explosion of interest (and applications), to the point that it has become one of "the most common topics amongst scientists" (Sullivan, 2002). Despite this renewed interest, though, workforce planning still carries many difficulties for those organizations willing to implement it: Laabs (1996) described it as "one of the highest business challenges of today".

Amongst several general definitions, the simplest and probably the most commonly used states that "workforce planning allows achieving the right personnel strength, filling the right positions, with suitable competences, at the time when they are needed". A more complete definition highlights some procedural elements, describing it as "a process with which an organization estimates the required demand for work, and assesses its size and nature along with the supply sources that will satisfy such demand" (Reilly, 1996).

The concept of workforce planning is relatively new. It has originally been associated with Human Resource Planning, a more quantitative and mechanistic approach to workforce management. But in recent times it has moved away from such an "unflattering neighbor" and has introduced a new connotation to the concept of personnel strength. Far from the legacy mechanistic view, it entails a more qualitative view of the workforce and its competences. Under these terms, workforce planning can be seen as a process that aims at matching personnel needs, tailored around company objectives, with demand for future available capacities. In other words, there is a direct link amongst decisions dealing with personnel, business plan and financial resources. This way, workforce planning helps keeping the management efforts correctly focused on the long term perspective, in a constant endeavor to foresee what will happen, when it will happen and, most of all, *how* it will happen. This allows for pre-emptive corrective measures that will require, in the long run, fewer resources than if decisions were to be taken on the spur of the moment.

Thanks to this focus, workforce planning enables management to achieve eight important objectives:

1. a reduction in personnel costs, without impacting on productivity;
2. to identify and prepare future leaders for structural changes;
3. to guarantee a constant supply of qualified personnel in key roles;
4. to keep a flexible workforce structure;
5. to have internal flexibility to match people expertise with job requirements;
6. to invest in the education of selected talented employees;
7. to recruit people with the right mix of skills;
8. to increase productivity.

The following figure illustrates how the workforce planning process can be incorporated within a generic company structure (Reilly 1996).

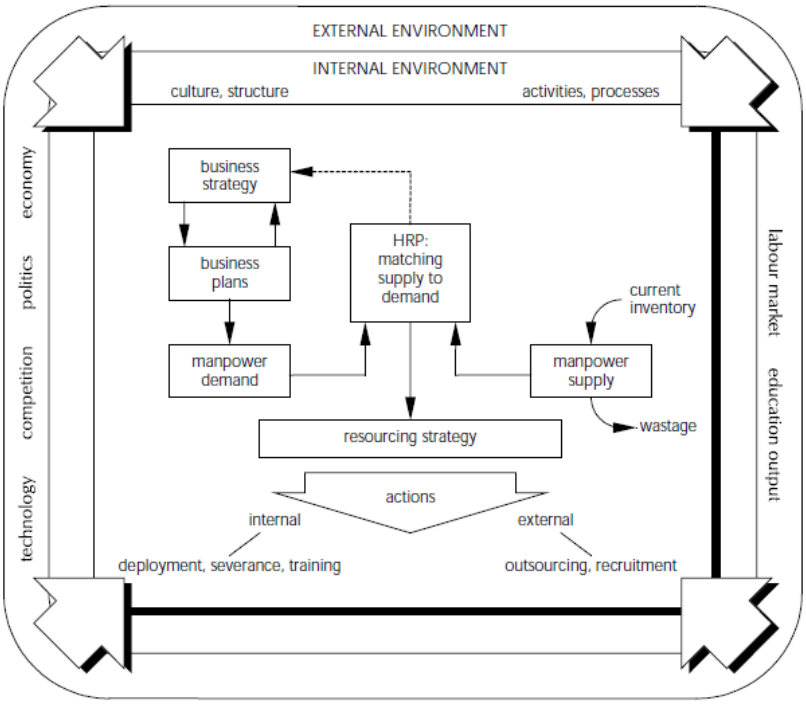

Figure 2: Workforce planning process model (Reilly, 1996)

Figure 2 shows how Workforce Planning is related to the strategic components of the organization and how it is affected by *external stimuli*. In such a structure, it is therefore the company strategy that guides the workforce process, in response to the environmental changes; the many feedback loops represented in the scheme seem to confirm this statement. The dynamic behavior that arises from the interaction of the various elements (strategy, environment, workforce) has a dual potential outcome:

- workforce planning decisions may be the result of strategic vision (this would be the case of long term planning)

…or…

- strategies are formulated after that the adaptation required by sudden environmental changes has been implemented (ex-post rationalization).

Whatever the case, the important aspect is that the interrelation amongst strategy, environment and workforce must be carefully understood in order to plan ahead when possible and react effectively, when needed.

4.1 - Implementing a Workforce Planning process

As previously mentioned, Workforce Planning is emerging as an evolution from the doctrine of Human Resources Management, where "recruitment, reallocation and retirement" were the only variables considered. Workforce Planning must necessarily start from a strategic perspective, in which a long-term outlook on organizational policies and business plans is taken into consideration. The structure is then analyzed and confronted with the environment so to be able to draw hypothesis on future trends. This allows the organization to align "human capital" policies with its business plan, to fulfill its mission through the employment of "the right people, with the right competences, in the right positions and at the right time".

In simple terms this means being able to:

- identify current and future personnel strength required to offer newer and better services;
- assess present workforce with regard to expected needs;
- determine personnel shortage or redundancy in light of future needs;
- compare future job profiles with existing ones;
- establish, monitor and assess suitable change strategies.

Implementing this process requires seven main steps.

STEP 1*: Define and/or re-assess the organization's strategic vision*

A thorough analysis of company strategic goals should be the starting point. This will affect the main aspects of the Workforce Planning cycle, allowing an answer to some fundamental questions:

- what are the required competences?
- what kind of expertise is needed for each single job position?
- what is the expected production level?
- how is the labor going to be divided?
- what are the logistic requirements?
- what are the working hours?
- who are the target customers?

Changes in any of the previous variables, evidently, will severely affect the workforce planning process.

STEP 2*: Analyze the operational environment (inside and outside the organization)*

Organizations operate within wider social systems. Every relevant aspect of these systems, will have an impact on the workforce planning. Critical items such as demography, social contracts, political beliefs, economical constraints, available technology will influence the availability and quality of potential employees.

STEP 3: *Model the existing workforce structure*

Understanding the characteristics, capacities and distribution of the existing workforce is necessary to outline the path towards the desired behavior, aiding, in turn, to determine the most effective change strategy.

STEP 4: *assess future needs and act for their fulfillment*

Such an evaluation requires the leaders to think (sometimes re-think) about the way the organization will run the business in the future. This can be a complex analysis, software based or, more simply, a qualitative appraisal. What counts is the quality of the assumptions (if we hold true the saying: "bad hypothesis, make bad theories").

STEP 5*: identifying existing gaps*

Gap analysis helps assessing deficit or surplus between current personnel strength and future demand. How deficits are filled and surpluses are reduced is the core of the workforce strategy.

STEP 6: *carry out a compensation strategy*

After identifying existing gaps (deficits and surpluses), a coherent plan towards defined target values needs to be developed.

STEP 7: *assess the effectiveness of adopted strategies and update them as necessary (policy cycle)*

This final step is aimed at determining whether we are generating the desired effects or not. Any shortcoming could be the result of wrong assumptions and hypothesis, bad correction policies or a combination of both.

These steps are not strictly consequential (even though common sense would suggest so), however they represent a helpful roadmap towards the creation of an effective workforce strategy.

4.2 - Military Workforce planning

Modern societies' prevailing traits, as change and adaptation, have naturally had an impact on the implementation of any national Security and Defense policy. Faced with the problem to counter an incredible variety of woeful and adaptive adversaries (e.g.: international terrorism, etc.), the Armed Forces have been dealing with a pressing need to make their structures leaner, more flexible and capable to anticipate changes required by quickly evolving scenarios. Managing human resources has therefore become an activity of strategic importance, crucial in creating an effective instrument of power, capable to do more with (consistently) less.

Military workforce planning embraces the whole "lifecycle" of the Armed Forces human capital, from recruitment, through promotions, to retirement, in an effort to ensure a balanced distribution of capacities and competences across the full array of military ranks. Reaching this very delicate balance is the main driver in creating a structure capable of performing the tasks given to the Armed Forces. Alas, reaching this balance, as we will see later, is a very hard target to get to.

As stated in our introduction, military structures are characterized by only one entry point (recruitment) and by just one way out (retirement). It has also been highlighted that the progression through the ranks could only take place one step at the time, along the chain of military ranks. This leads to the first important insight that differentiates military human resources management from other organizations:

1. **Existing workforce deficit cannot be filled with external resources.**

As previously said, service time within the armed forces, for officers and non-commissioned officers, is not pre-determined. Permanence in service is the default status and individual can leave the Armed Forces only under the following conditions[1]:

- reaching retirement age;
- losing military status (physical fitness, disciplinary measure following conviction in a judiciary trial);
- voluntary early dismissal, provided all applicable obligation time have expired (such is the case for aircrews and the 16 year bound-to-serve time which is imposed upon initial commission as 2nd Lieutenant).

This leads to a second, and very important, conclusion:

2. **Existing workforce surplus cannot be reduced using lay-offs policies.**

Military population is divided in classes each one defined by specific attributes such as rank, seniority, service branch, age, etc.

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[1] On particular conditions (over 40 years of service and/or 5 years to the retirement age) an early retirement package can be offered, provided enough financial resources are in place

These classes are mutually exclusive so that:

3. **One military person can only belong to one class at a specific time.**

As far as promotions are concerned, two mechanisms (or flows) are in place at the moment. They apply to different ranks in different times (as it will be described later), and in particular:

- **Pull Flow**: individuals are promoted only when there are vacancies in the next rank pool (compensation mechanism);
- **Push Flow**: people are promoted upon reaching specific pre-requisites (years in rank, passing selections, attributions, etc.), regardless of vacancies in the next rank pool (seniority promotion).

This leads to the final conclusion that in the Armed Forces

4. **Sometimes, workforce gaps in the ranks (deficit and surpluses) cannot be avoided.**

Because of these four constraints, the use of a suitable model becomes a matter of crucial importance for the purpose of military workforce planning. And the next chapters will take us through the process of building a model capable of first describing and then forecasting the workforce planning requirements. As previously mentioned, our analysis is limited to the Italian Air Force aircrew officers.

5. BUILDING THE MODEL

The aircrews officers career starts at the Air Force Academy, where they enter after passing a selection phase. Each year the Human Resource Management Division, decrees the number of available position and a national public competition is announced. The candidates are then convened in chosen locations to go through the complete selection phase. After 2 years of Officers Training, and parallel university education, they are promoted from cadet to 2nd Lieutenant. This is also the time when the 16-years bound-to-serve contract is signed by the young officers.

Some of the founding criteria of the workforce process within the Air Force have already been described earlier in this document. In this regard, the Air Force can be considered an "internal labor market" (Boxall, 2003) due to its closed and hierarchical nature and to the class systems that characterize the personnel structure. Among these class, Air Force aircrews (and pilots in particularly) belong to a category which is peculiar for three main reason: the costliness of their training; the fact that they are strictly engaged in the core business of the Air Force (operational flying); and, lastly, the fact that they are destined to fill the great majority of the strategic position within the higher echelons of the Air Force and the Joint Staff.

We start our analysis by referring again to the Air Force aircrews' personnel strength figures over the period 1997-2009 (the blue line in Figure 1, already introduced earlier). By comparing this historical time series with the target values given by the law (both the old and the new target levels are depicted) we can notice a constant and growing surplus of officers with respect to both regulations (the red and green lines). Also worth noticing is the very irregular trend (sometimes decreasing, mostly increasing) displayed throughout the observation period.

If one considers that during this period, addressed by the law as a "transition phase" to achieve the related reduction in numbers due to the new introduced limits, the overall number of aircrews should have diminished (while it has grown…), it is evident that a more structured and effective approach to workforce planning is required.

The scheme in Figure 3 highlights the main aspects of our study and, at the same time, defines the boundary of the analysis.

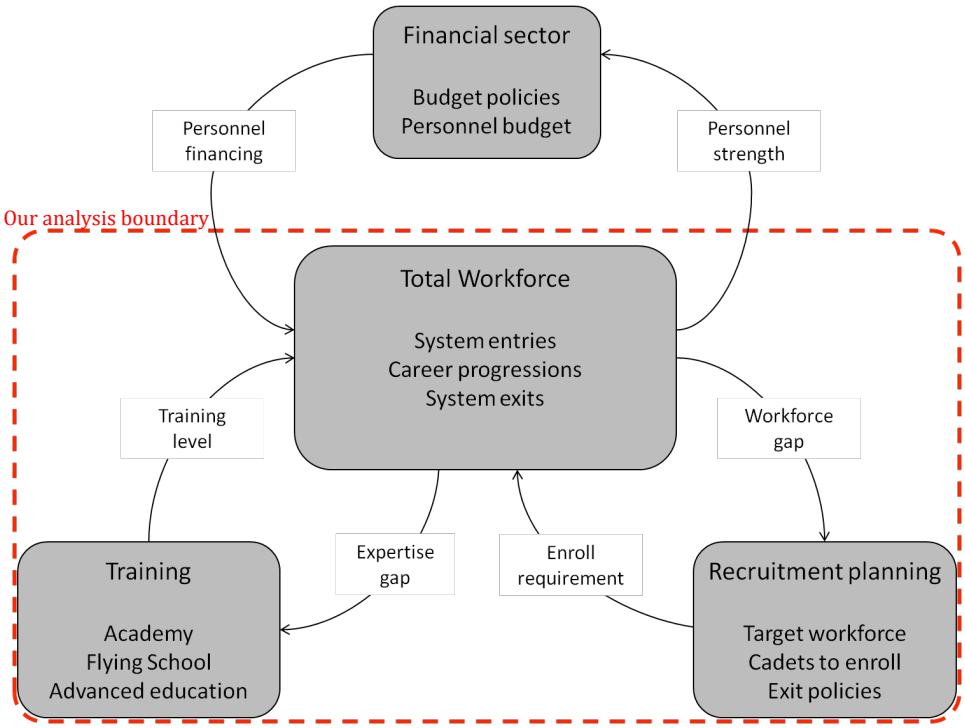


Figure 3: Causal loop structure and System boundaries

As we can see, the financial aspects have been intentionally left out of the model at this stage of our work due to the fact that, although they surely influence the whole system, they are, for the most part, out of the control of the Armed Forces. In this regard, they can be considered as part of the external environment but they might be eventually included in future developments of our model.

The internal environment has been further divided into three sub-systems

- **RECRUITMENT PLANNING**: this sub-system determines personnel hiring policies, directly impacting on the workforce structure and therefore it is the model core;
- **TRAINING**: although this would include all the training aspects of the officers' careers (initial, basic, intermediate and advanced training), in this model we'll focus solely on the initial training held at the Air Force Academy (the first two years after recruitment);
- **WORKFORCE**: this sub-system incorporates all the elements of the progression along the ranks hierarchy (including retirement).

The key variables in the sub-systems have been depicted in Figure 4, along with the main feedback loops that dictate the system behavior.

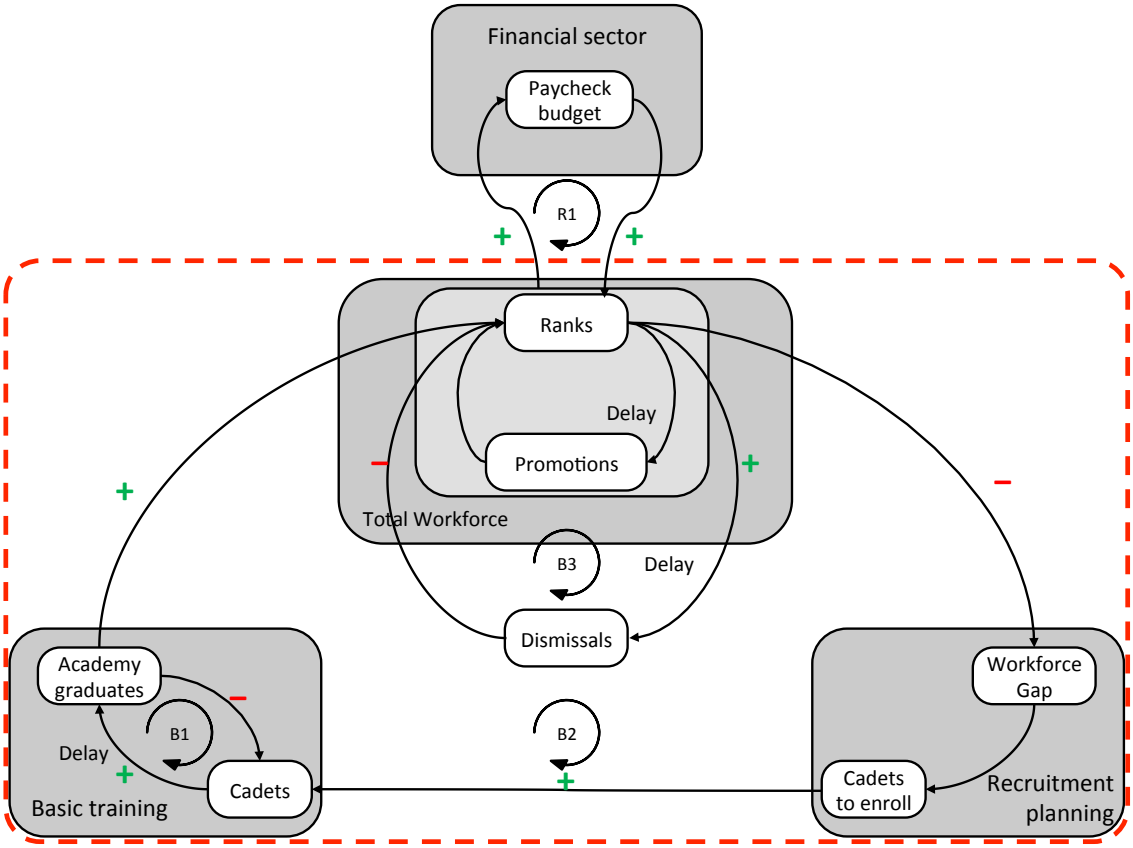


Figure 4: Main variables and feedback loops

Figure 4 depicts a "first-order model" whose behavior is determined by three main balancing feedback loops, presenting different delay rates. Although the number of feedback loops is somewhat smaller than similar first-order models describing workforce planning processes (Holstrom & Elf, 2005), the resulting behavior presents a degree of complexity that make System Dynamics the best choice to explore potential solution to the problem.

In order to understand the dynamic behavior of such a model, in the following we will describe the individual *feedback loops* that we evidenced during our system's analysis.

- **"BASIC TRAINING" BALANCING LOOP (B1):**
  Academy training is the entry point of the system. This loop shows the ways in which the initial training programs impact the "in-flow" rate of officers within the system. A 2-year delay characterizes this loop, which correspond to the time from recruitment to commission as officers.

- **"PROMOTION - DISMISSAL" LOOPS (B3):**
  Personnel progression within the system takes place through a single mechanism, which is the promotion to the next rank. No shortcuts and/or side admission are provided, under any circumstance. Through this mechanism, the single stocks of officers in each rank will fill and empty cyclically, following a delay that corresponds to the minimum years in each rank required by the law. Promotion through the ranks will, eventually, lead to dismissal, commonly through retirement, although other modalities are in place, such as early voluntary dismissal. The overall loop, in fact, works just like a standard "population decline model" (Maani &

Cavana, 2000). In Figure 4, such a mechanism has not been explicitly depicted with reference to the whole aging chain, rather it has just been done qualitatively (loops B3 is just that), in order to maintain the main causal-loop diagram simple, and also because the dynamics internal to the workforce "box" can be represented just as a simple delay from input to output, with the outflow representing the aggregate of all outflows in the aging-chain. In particular, the promotions rate has to be intended as a promotion from generic rank N-1 to rank N, which in general thus decreases the total workforce in rank N-1, in turn increasing rank N. A more detailed description of the promotion mechanism has been provided in Figures 9 and 10.

- **WORKFORCE PLANNING BALANCING LOOP (B2):**
  This is the main way through which the organization tries to attain the desired personnel strength levels. This is, in fact, a goal-seeking feedback loop whose objective is to obtain a zero value for the variable *WORKFORCE GAP*, which is the difference between actual and desired personnel strength. Recruitment needs (that is the number of cadets that needs to be enrolled in the Academy) is decided based upon the *WORKFORCE GAP*, the forecasted number of retiring officers and the expected "attrition" rate (early dismissal for loss of military status, mostly) especially during the initial phase of officers' training. Not all the cadets that enter the Academy, in fact, complete the officers' training phase and this, if not preemptively compensated, could create a new gap. As we will discuss later, this could be one of those high leverage points where some actions or inputs might have a long lasting impact on the whole systems in terms of inverting a trend, thus reversing a vicious cycle (Maani & Cavana, 2000).

At this point it is possible to build a detailed causal map of the workforce process, describing the individual sectors and defining the main parameters and control variables.

SYSTEM INPUT (RESOURCES INFLOW)

As mentioned earlier, the number of cadets that will be recruited is determined every year based upon a "TARGET CADETS" value (based on the forecasted retirements) increased by a quantity that takes into account the expected attrition rate of the initial training phase of the Academy ("NORMALIZING VALUE"). An open hiring phase (started by a public call) is then entered and, through many tests of different nature (psychological, physical and general knowledge), candidates are selected down to the defined number.

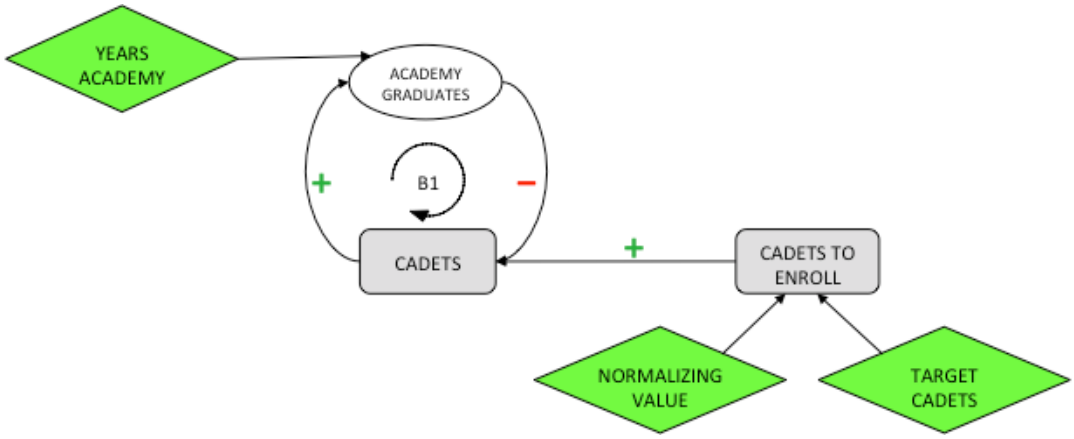


Figure 5: Italian Air Force "hiring" process (resources inflow to the system)

More in detail, we can see the **three variables** that control this portion of the process, two of which contribute to determine the required number of cadets and one that takes into account the officers' training time held at the Academy:

- **TARGET CADETS**: it is a fixed value, based on time series. It can be described as the number of enrollments that would keep the total personnel strength at the desired level if there weren't any unforeseen dismissals (early dismissals, deaths, etc.).
- **NORMALIZING VALUE**: it is a quantity that increases or decreases the number of enrolled cadets, so to counter any attrition rate of the early training phase, thus keeping the workforce gap at the desired level (zero). This is very similar to the "bullwhip effect" of the "beer game".
- **YEARS ACADEMY**: this is simply the number of years that elapse from cadets' enrollment and completion of officers' training.

RESOURCES OUTFLOW

The main system's outflow is determined through the dismissal mechanism, which is made out of three modalities:

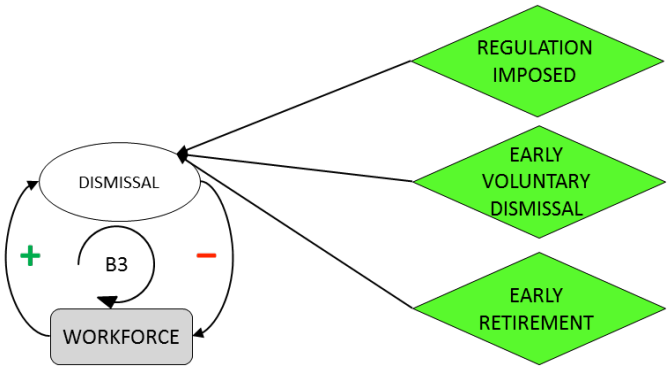


Figure 6: Italian Air Force dismissal process (outflow)

- **REGULATION-IMPOSED** dismissal, for age limit or loss of military status (physical/medical aptitude or disciplinary reasons);
- **EARLY VOLUNTARY** dismissal, requested by the individual and accepted by the Air Force, provided that the minimum bound-to-serve time has been observed;
- **EARLY RETIREMENT** dismissal (Early Retirement Package Availability / Eligibility): package for those officers with more than 40 years of service and/or within 5 years from retirement age (provided that enough financial resources are in place).[2]

[2] The difference between this measure and the "normal" retirement mechanism lays in the fact that, for the early retirement, the onus of the financial coverage rests with the Air Force, whereas, in the case of normal retirement, the cost of the pension is the responsibility of the Ministry of Welfare and is budgeted separately from the Defence budget. Once the individual who benefitted from the package reaches the age for normal retirement, the cost of his pension migrates from the Defence to the Welfare Ministry.

CAREER ADVANCEMENTS

Progression through the ranks of the military pyramid is an internal mechanism where the total numbers (which can be generally thought as the carrying capacity of the system) do not change. If we consider each rank pool as a stock variable whose desired level is the one required (and prescribed) by the law, then promotions can be seen as in-flows and outflows of several stocks (each representing a different rank).[3]

Having detailed the individual sub-systems, we can thus show the whole causal loop diagram.

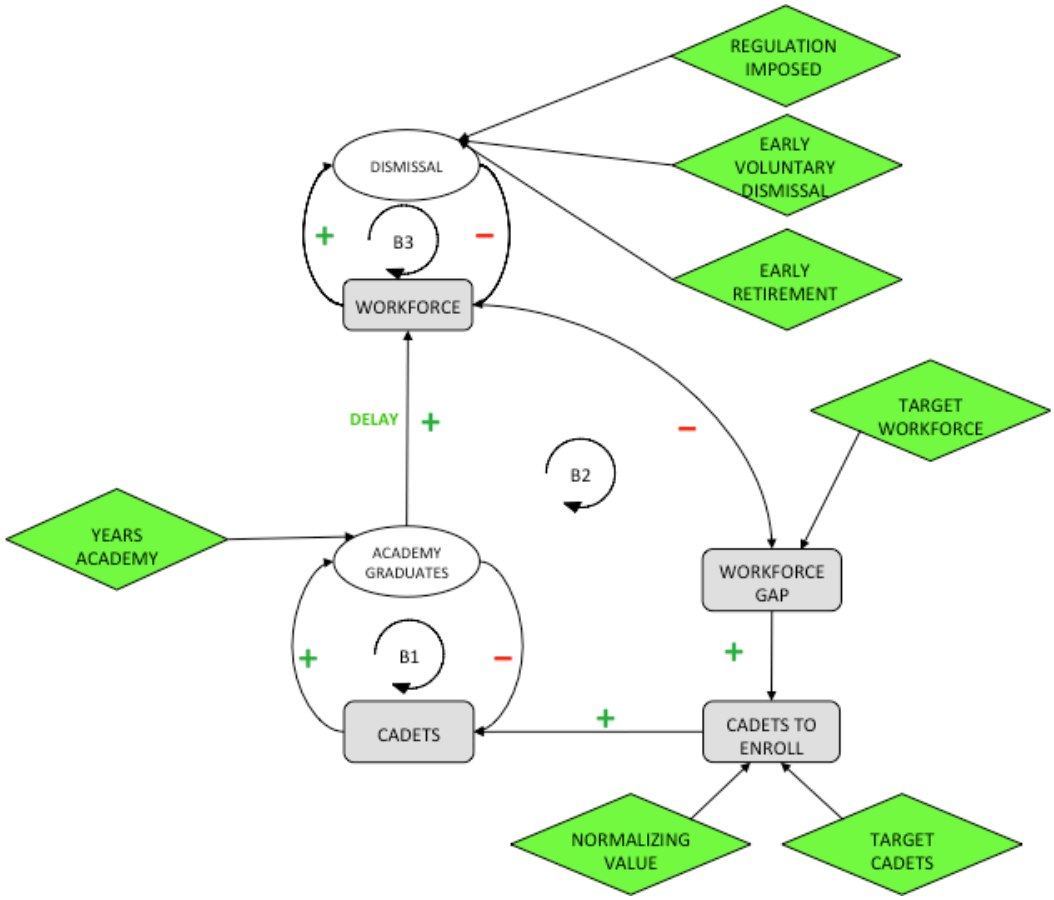


Figure 7: General Causal Loop Diagram

The only variable still to introduce is the TARGET WORKFORCE, which will be dictated by the Law.

To complete the model, after having defined most of the key elements and their control leverages, we need to delve into the details of the workforce "box", so to show in detail the variables relevant to each individual rank within the organization. The following picture (Figure 8) details, the whole life-cycle of officers through the career advancement progress within the Italian Air Force.

For sake of simplicity all ranks have been aggregated in three main groups:

- Junior ranks (from 2nd Lieutenant to Captain),
- Senior ranks (from Major to Colonel)
- General ranks (Brigadier, Major and Lieutenant General)

[3] A simplified graphic description of this mechanism is represented in Figure 7 on the next page.

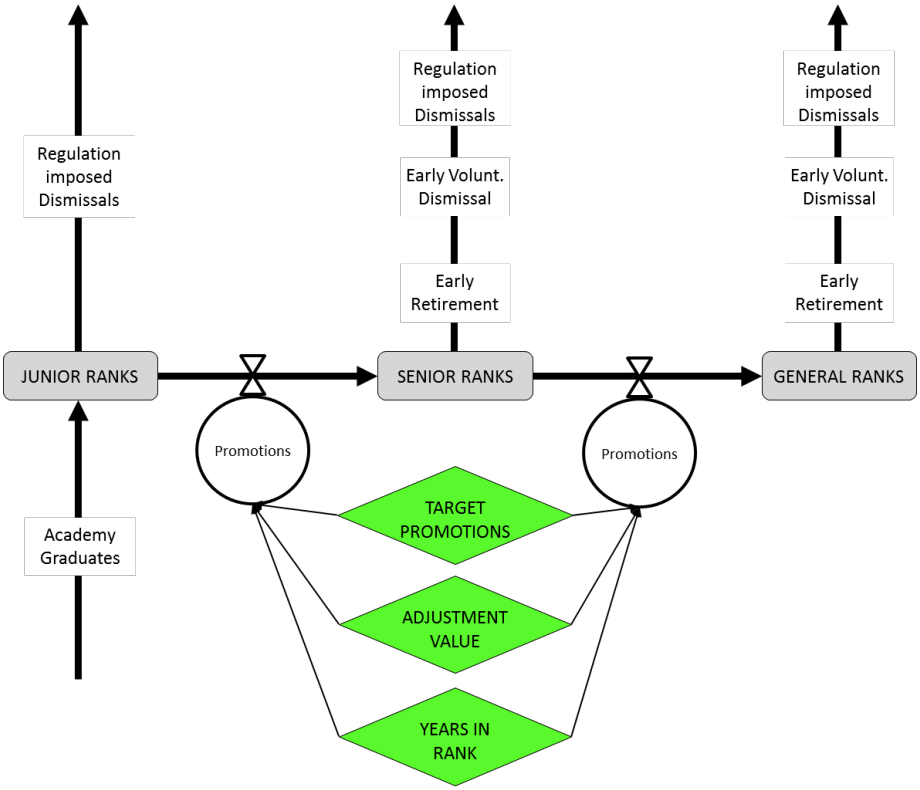


Figure 8: Flows of promotions within the total workforce

Promotions from one aggregate rank (N-1) to the next (N) fall under the "**Promotion by selection**" criteria (see Figure 9): in addition to a minimum numbers of years to serve in the preceding rank, candidates for promotions are evaluated by a commission and, after being included in a graded list, only a portion of them (the highest ranking ones) is promoted in accordance with the available positions in the next rank (**pull-flow**).

Conversely, within each aggregate rank pool (see Figure 10, **push-flow**), there are some instances of "**Promotion by seniority**", where the only pre-requisite to be promoted to the next rank is to have served a pre-determined number of years in the preceding one (applicable to 1st Lieutenant, 2nd Lieutenant and Majors).

The control variables of this process are:

- YEARS IN RANK**,** the number of that need to be served in each rank;
- TARGET PROMOTIONS, the number of promotable officers set by the law;
- ADJUSTMENT VALUE, aimed at matching the number of promotions to the surplus/deficit condition of the next rank strength.

Human resources stay in one single level for a given number of years and, after fulfilling certain requirements (years in rank, selection criteria) they are promoted according to the two possible methods (push flow, pull flow), determining in-flows and out-flows between the rank stocks. In order to initialize the model, a "year zero" value has been introduced for each stock initialization (corresponding to the personnel strength data on 1997, for validation purposes, and on year 2009, for simulation purposes).

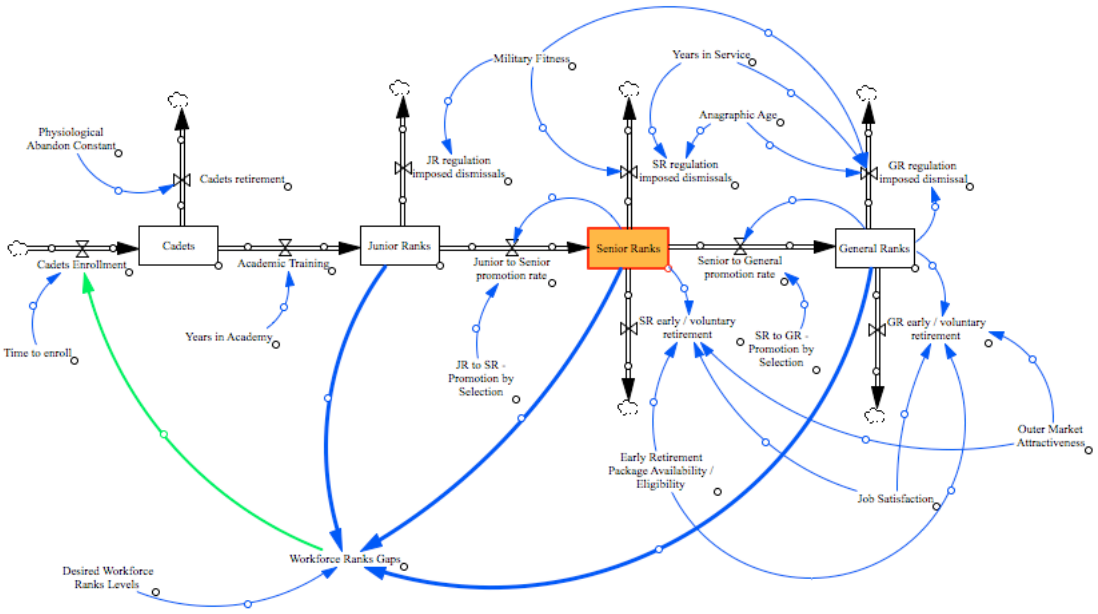


Figure 9: General SFD – flows between generic ranks are represented (Senior Ranks Box, without details on the outflow – already showed here -, is reported in Figure 10)

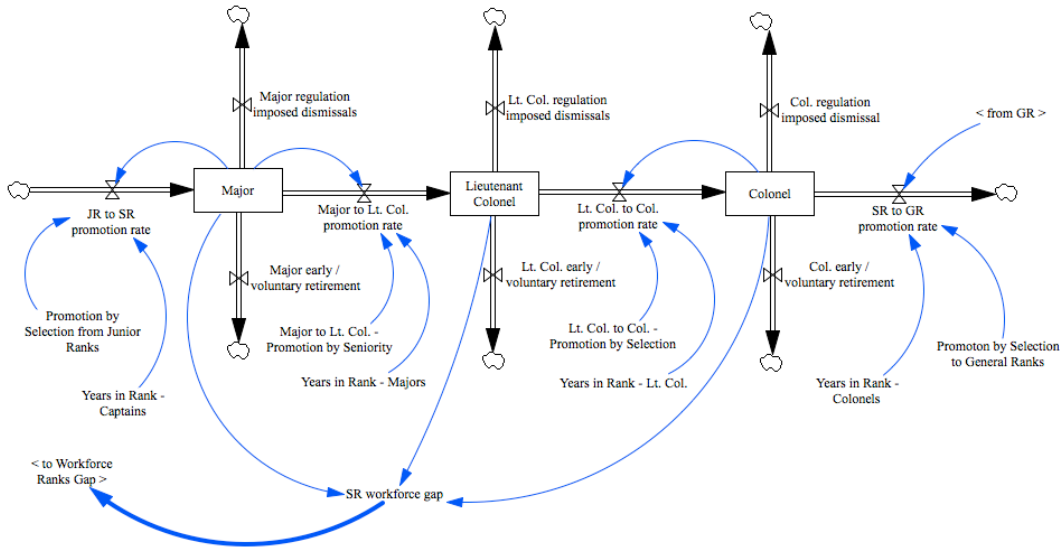


Figure 10: Senior Ranks detailed SFD

Flows may fall into one of three types:

- **Recruitment**. This is the only flow of people that, by increasing the "entry" stock of Cadets, will be capable of augmenting the total personnel strength of the whole system. This characteristic makes the process very similar to a typical "aging chain", where fixed-number packages of personnel are spiraled up through the organizational pyramid.
- **Promotion**. As already said, this constitutes the flow between the various ranks. Promotion rates of some ranks are constant (with provision for adjustment), by law requirements. Such is the case with all the promotions by selection, where the number of promotable officers is pre-determined (**pull flow**). On the other hand, in the case of promotion by seniority (**push flow**), the promotion rate corresponds to

the number of officers in the previous rank, who will be promoted, irrespectively of the surpluses/vacancies in the next rank. In this specific case, the rate value has been set accordingly to an array of data extrapolated from time series.

- **Dismissal**. This is the "exit" mechanism that will generally contribute to decrease (all things being equal) the total personnel strength numbers. As previously described, it can be the result of various conditions (age limit retirement, early dismissal, early retirement package). For each potential case of dismissal, a default dismissal rate has been determined based on the average on the observed period (1997-2009). These rates have been applied across all ranks of the systems, with reference to observed rates in each one of them. So, for example, the EARLY DISMISSAL RATE due to loss of military status for 2nd Lieutenant has been set at 4%, whilst VOLUNTARY EARLY DISMISSAL for Majors has been set at 2% and so on. Note that, even if in Figure 10 some variables acting upon the relevant outflow have been reference (e.g.: *Other Market Attractiveness* or *Job Satisfaction*), this has been done just for clarity's sake, since such variables would be the link to completely new parts/aspects of the system which however we have not explicitly taken into account into this first exploration of the Italian Air-Force workforce problems.

The TIMESTEP for the process has been set at 1 YEAR, which reflects, by large, the way that each flow variable changes over time. Along the same line, we have opted for a ZERO ORDER integration type, which means that each flow rate value is determined on the 31st of December of every year, whilst the corresponding stocks are changed accordingly on the following year, providing information about the number of promotions one year in advance.

Validation of the model has been attained through two simple steps.

- **First** the model has been adapted in order to reflect the current situation at the beginning of the observation period (year 1997 AS-IS model).
- **Secondly**, the AS-IS model has been used to run simulations that returned values equal to the time series available. The overall process required the introduction of initializing values, correction values and algorithms capable of replicating the historical conditions that took place in the 13 years of observed data (see Table 2).

Table 2: historical time series representing stock level in each rank.

Time	Cad	2nd Lt	1st Lt	Cap	Maj	Lt Col	Col	B Gen	M Gen	Lt Gen
1997	109	199	133	245	93	245	237	37	14	13
1998	109	183	154	244	99	245	243	38	14	13
1999	103	181	175	236	105	245	249	39	14	13
2000	121	181	159	256	105	251	255	40	14	13
2001	106	175	157	269	105	256	260	40	14	13
2002	87	193	157	273	105	261	265	40	14	13
2003	104	180	151	284	105	266	270	40	14	13
2004	98	161	169	288	105	271	275	40	14	13
2005	104	178	157	293	105	276	279	40	14	13
2006	94	172	138	315	105	280	283	40	14	13
2007	62	178	155	308	105	284	287	40	14	13
2008	72	171	149	311	105	288	291	40	14	13
2009	96	139	155	321	105	292	295	40	14	13
2010	106	148	150	318	105	296	299	40	14	13

The results of the simulations largely confirm the reliability of the model, since the output of each stock variable in the system matches exactly the values of the time series.

After building and validating our model, we will now describe how we have explored and experimented with certain policies (by describing "incremental" scenarios), thus assessing the way and the possibility to achieve the desired target values within the norm-imposed timeframe and what lines of actions might be recommendable, based on the insights derived from our experimentations with the model.

6. SIMULATION

In this paragraph, we present several simulation results by experimenting with different scenarios. It is worth to evidence again that the input used for the validation and the ones used for the simulations are slightly different. For the validation, in fact, the model had to use historical time series as input data and therefore the latter has been provided as an array. The input data used for the various simulations is instead the result of a calculation (all scenarios are a result of subsequent incremental adaptations in the input data for the model).

Simulation Period

As explained at the beginning of our paper, January 1st 2015 is the deadline fixed by the new law to reach the new workforce target values. Due to this, the observation period has been set between 01 January 2009 (the most recent year with available time data) and 01 January 2020, which should allow for enough "over-run" time to assess the real effectiveness of the analyzed policies.

Stocks' Initial Values

To initialize the model, we have set all the stock variables in the system at the value that they had reached, in the AS-IS model runs, at the end of the year 2009 (see Table 3).

Table 3: stocks initialization in the "aging chain"

T_0	Cad	2nd Lt	1st Lt	Cap	Maj	LtCol	Col	B Gen	M Gen	Lt Gen
2009	96	139	155	321	105	292	295	40	14	13

Flows Discretization:

Given the fact that the default setting for the stocks initial values is as described above, the initial settings of the related outflows must be adjusted, too. Therefore the default values of the outflows have been set so to empty the related stock levels before (it means at the beginning of the time interval) the stocks will be populated by the simulation itself (stocks assume their new value, due to the inflows, at the end of the simulation interval – zero-order integration), which constitutes our implemented discretization mechanism.

Example:

- *CADETS = 96 <<ppl>>* (initial value of the CADETS stock)
- *ACADEMY TRAINING YEARS = 2 <<year>>*

- *NO. OF NEW TRAINEES* (on a 2-years basis) = *{48, 48} <<ppl>>*

So the first year of simulation the initial historical population of 96 cadets will decrease of 48 people (and will increase of a number of people as a result of the simulation at the start of T_1); it will decrease of other 48 people the second year of simulation (and again will increase of a number of people as a result of the simulation at T_2).

Reference behavior

To compare the simulation trends with the real world, we will use the numbers of needed (by 2015) officers in each rank, as a target given by the Law (Table 4):

Table 4: number of needed officers per rank (TARGET, as per NLAU)

RANK	VALUE
CADETS & 2nd LIEUTENANT	Not defined
1st LIEUTENANT	200
CAPTAIN	277
MAJOR	145
LT. COLONEL	228
COLONEL	221
BRIGADIER GENERAL	35
MAJOR GENERAL	15
LIEUTENANT GENERAL	11

Note that there is no number given by law for the rank of Second Lieutenant as this will be dictated by the number of 1st Lieutenant of 200.

Career Advancement Rates (Promotions)

These are a direct indication of the new Law (NLAU – L.490/90).

In particular, since the law allows for some ranks, during the "transition phase" (up to 01 January 2015), to vary their career advancement rates within a pre-determined interval[4], for each fixed value an "adjustment index" has been provided, in accordance with the following scheme (as an example, we use the CAPTAIN promotion rate):

CAPTAINS SELECTIVE PROMOTION = FIXED VALUE + ADJUSTMENT INDEX

where: *FIXED VALUE = 33*

and: *0 <= ADJUSTMENT INDEX >= 7*

[4] During the transition phase, to allow for a smooth evolution, the number of yearly promotion can be varied, according to specific needs, within the interval created by the lower and higher target value contained in the new and old regulation. So, for example, the number of Captain to be promoted can vary between 33 and 40.

For the ranks that do not have such a flexibility (Colonel and above), a different algorithm has been used which return a promotion rate equal to the vacancy of the higher rank, following the example of the Colonel promotion to Brig. General.

```
COLONEL SELECTIVE PROMOTION = MAX (0<<Ppl>>; IF('Organico
  GenBA'-('Generale BA'-'CA Gen BA'-'CV Gen BA'-'PS Gen
BA')>=0<<Ppl>>; 'Organico GenBA'-('Generale BA'-'CAGen BA'-'CV
  Gen BA'-'PS Gen BA'); 0<<Ppl>>))
```

Years in Rank

These are the minimum years that have to be spent in each rank to be eligible for promotion (both by seniority and by selection) to the next rank (see Table 5). During the transition phase (up to 01 January 2015), the new Law (NLAU) allows to increase this period as necessary. In this perspective, it becomes an effective "leverage point".

Table 5: number of needed years per rank

	Cad	2ndLt	1stLt	Cap	Maj	LtCol	Col	B Gen	M Gen
YEARS IN RANK	-	2	5	7/10	4	3/6/13	5	2	3

Dismissal figures

- **Dismissal imposed by the regulation (Regulation Imposed Dismissals)**

  This is the case when officers of any rank are dismissed before retirement age, for reasons related to physical fitness, disciplinary action and, as is often the case for pilots, for not meeting standards during the early stages of pilot training. An average value, based on the historical dismissal rate observed over the period 1997 - 2009, has been set for each rank as follows (Table 6):

Table 6: Historical Early Dismissal Rate

	Cad	2nd Lt	1st Lt	Cap	Maj	LtCol	Col	B Gen	M Gen	Lt Gen
Historical Early Dismissal Rate	0,03	0,04	0	0	0,055	0,03	0,05	0,05	0,08	0,16

- **Early Voluntary Retirement**

  Comparing the L.490 (NLAU, most recent) to the Angelini Law, it is evident that the obligation to serve has increased in years and, as previously noted, pilots are required to undersign on obligation to serve for 16 years upon promotion to 2nd Lieutenant. Given the minimum number of years to serve in each rank (see Table 7), this term usually expires during the years as Majors. Since the retention bonus system has been adopted, the average yearly rate of officers that, once free of obligation, leave the Air Force has stabilized at around 4% for Majors and 2% for Lieutenant Colonel.

Table 7: Early Voluntary Retirement figures

YEARS IN RANK	CAD	STEN	TEN	CAP	MAGG	TCOL	COL	G. BA	G. DA
L.490	-	2	5	7/10	4	3/6/13	5	2	3
L. ANGELINI	-	-	2	2	-	2	1	-	1

- **Early Retirement Package**

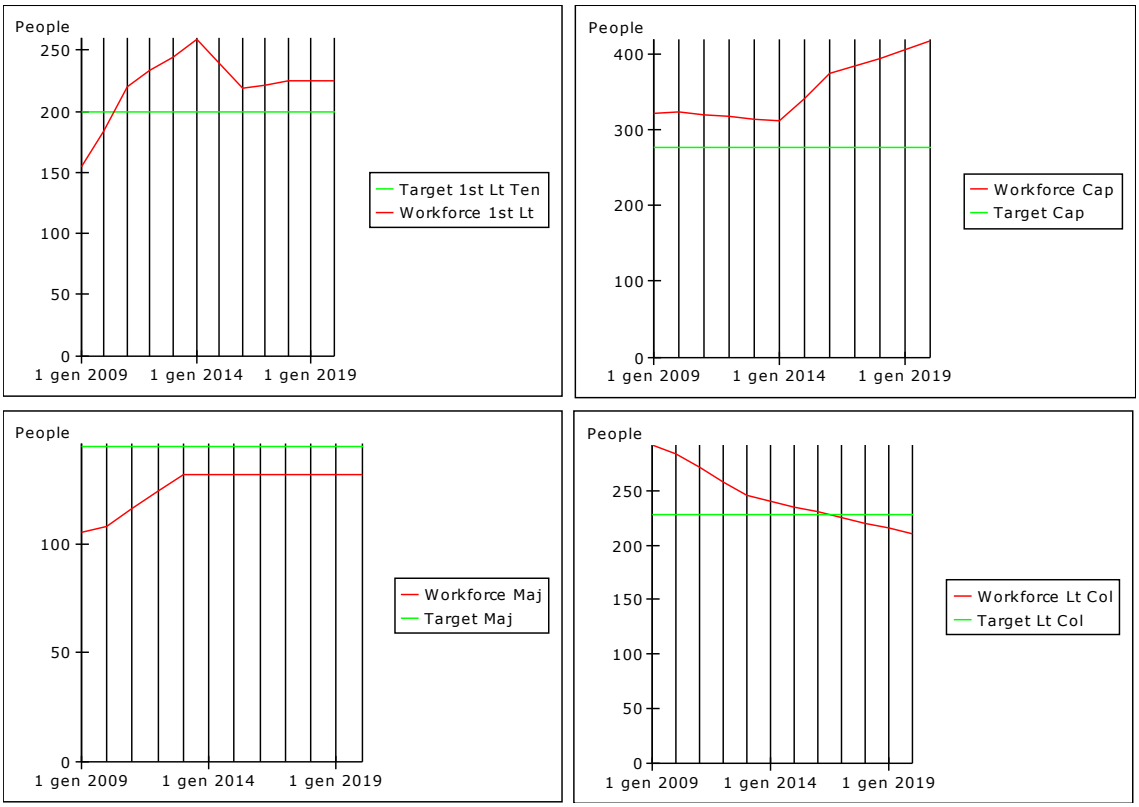
  This kind of dismissal is a sort of package being offered to those officers with more than 40 years of service and/or within 5 years from retirement age (provided that enough financial resources in the AirForce are in place)

After detailing the main key elements of the model, we will now show the scenario simulation results of 4 different workforce management policies (what-if analysis) that will be presented in order to gradually show how to reach a sustainable outcome for all rank stocks.

6.1 SCENARIO #1

This scenario has been designed simply by maintaining throughout the simulation window (2009-2020) the average recruitment rate set at the value that is found for the "observation period" (1997-2009).

The objective of this first scenario is to "assess the performance" of the default values as per the NLAU law: in particular, the scenario goal is to identify to which leverage points any potential corrective actions would need to be applied. The recruitment rate has been set at a constant value of 52 cadets per year. Figure 11 shows the resulting behaviors related to each rank.



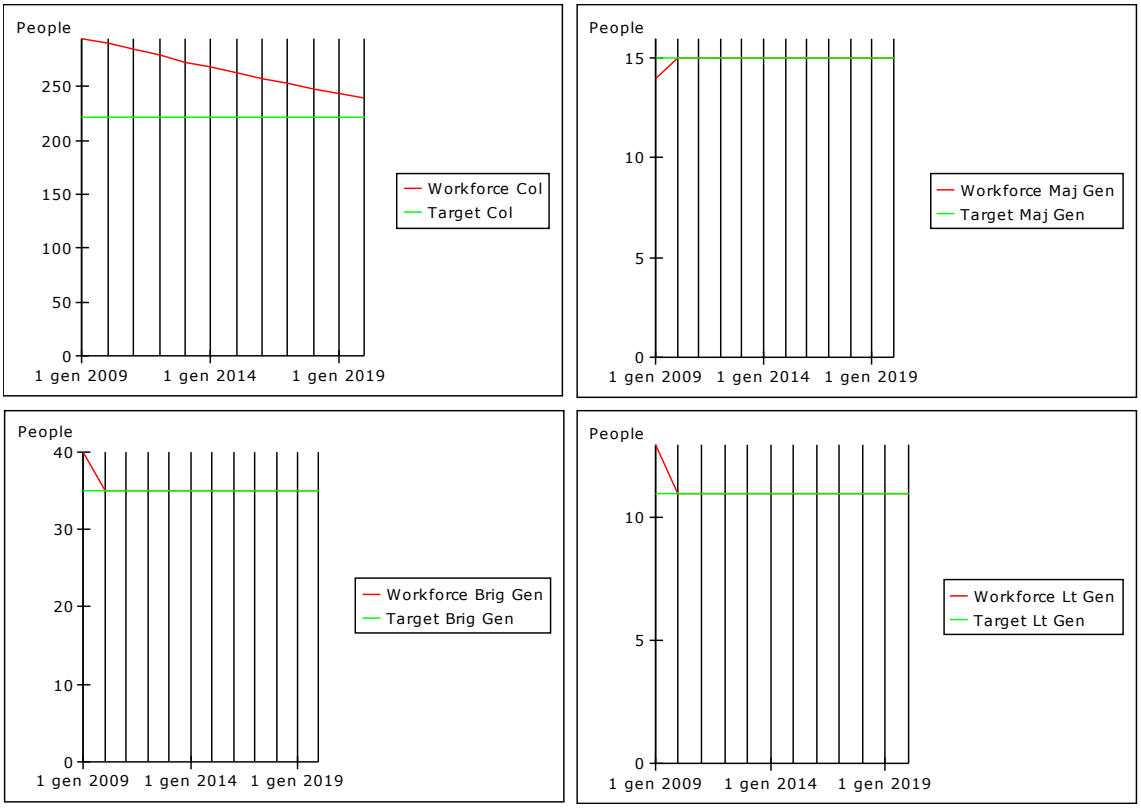


Figure 11: Scenario #1 simulation outcomes

Note that, with the exception of the three General ranks, all the others present a trend clearly not compatible with the target values imposed by the new Law. Worth noticing:

- the massive surplus of 1st Lieutenants and Captains;
- the constant decline of Lt. Colonels and Colonels;
- the stable deficit of Majors.

The immediate conclusion of this scenario is that a constant recruitment rate of 52 cadets, as well as the new regulation (NLAU) imposed values for the promotions rates and the needed years in rank cannot grant the achievement of the new target values.

Particularly interesting is the *inversion* dynamic of ranks' strength between Colonels and Lt. Colonels, where a greater number of "leaders" (Colonels) is accompanied by a smaller number of people to lead (Lt. Colonels). As a matter of fact, the Law itself creates a very narrow difference in the personnel strength values of the two ranks, thus introducing an element of concern within the system. In this light, any major discrepancy in the ratio between higher ranking officers and cadre personnel can pose a real threat to the sustainability of the organization, undermining the very principle of hierarchy at the base of the military social system.

It is therefore necessary to act on leverage points that will soften the situation and reduce such unacceptable gaps, with the aim to invert the situation that the setup of this first scenario creates.

6.2 SCENARIO #2

Starting from the results of scenario #1, we now attempt to manage the situation in order to reduce the gap between the previously obtained values (in scenario #1) and the ones required by the Law (desired target). In this scenario, we will try to balance the

ratio amongst the junior ranks (up to Captains) and, in particular, to stabilize the value for the 1st Lieutenant rank, in accordance with target imposed by the Law (200 officers), bearing in mind that, by year 2015, any change in the strength values of the junior ranks will inevitably affect those of Majors as well.

Considering the behaviors analyzed in Scenario #1 with reference to the ranks of 1st Lieutenants and Captains, way over the desired workforce level, the initial recruitment rate is now set to a lower value than the one in Scenario #1, an in particular it has been set to 45 cadets.

Figure 12 shows the SFD developed in Powersim®, including the initial RECRUITMENT RATE setting and how this affects the inflow of people within the system:

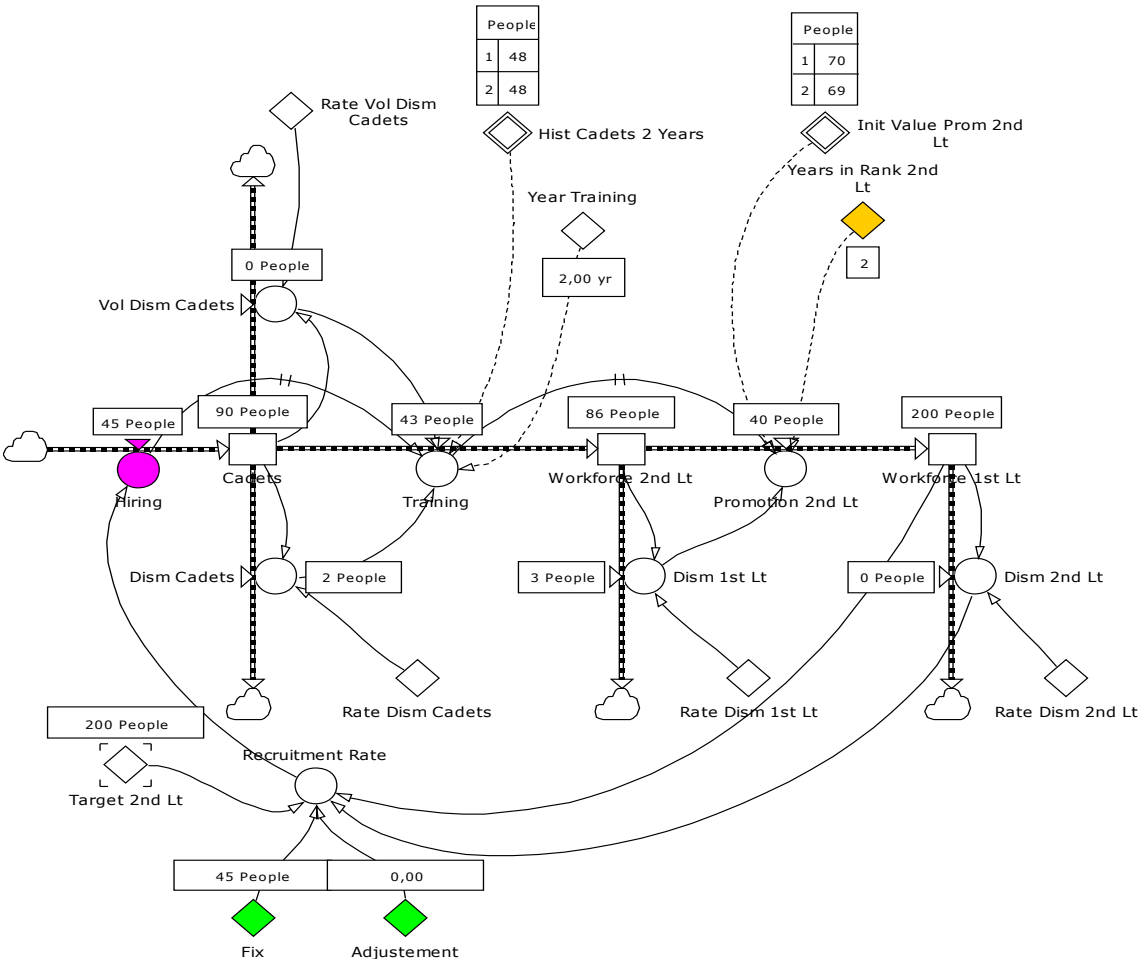


Figure 12: SFD related to Scenario #2 stabilization (diagram implemented with Powersim®)

In the following Figure 13, the behaviors generated by the simulation are reported.

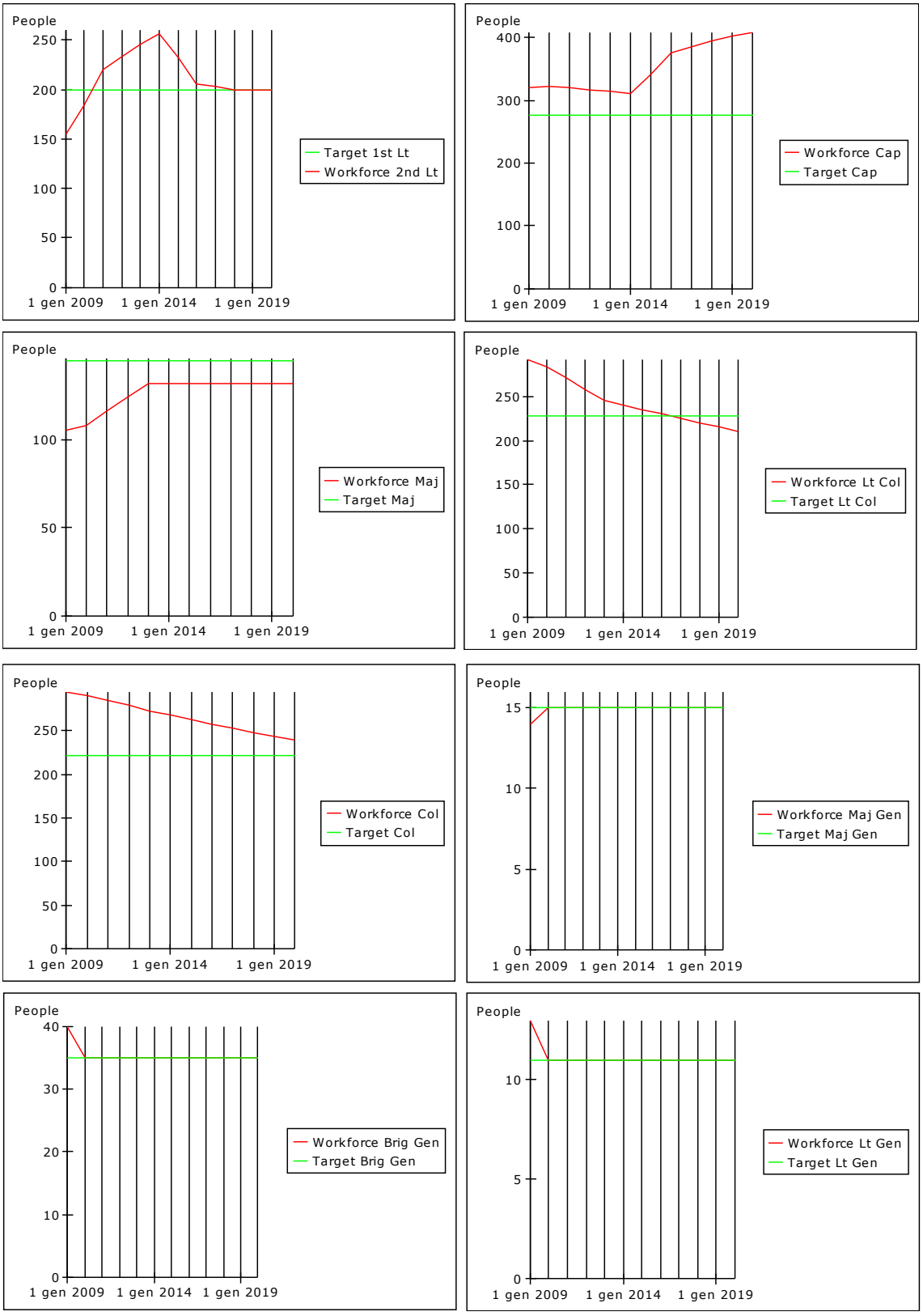


Figure 13: Scenario #2 simulation outcomes

As said, with reference to the ranks 1st Lieutenant and Captains, as opposed to the actual Air Force policy of recruiting a variable number of cadets every year, in pursuit of an ever-changing workforce gap, a **constant recruitment value of 45 cadets**, although 3 year later than required, seems to generate a long lasting effect, which matches the value imposed by the regulation. It's worth noticing how the result of a constant recruitment

value is very much in line with one of the takeaways from the "beer game" (Senge, 1990), where the constant input and the reduction in the "bullwhip effect" are demonstrated to be strictly correlated (Sterman, 2000). The surpluses of 1st Lieutenants in the years 2015, 2016 and 2017 are 32, 6 and 3, respectively (and then matches the numbers of the law), which seems a good result..

Further simulations, with different constant recruitment values, apart from generating a departure from this stable condition in the 1st Lieutenant rank, have not been capable to produce any positive effects on the remainder of the organizational chain, leading to the conclusions that the recruitment value does not need to be modified anymore in the next scenarios and that a different leverages have to be identified with reference to the following ranks in the aging chain.

We will see how matters change drastically in the next simulations, where the actions needed in order to reach and maintain the target values require policy actions that are not supported by the existing regulation.

6.3 SCENARIO #3

Having stabilized the stock of 1st Lieutenant we proceed now to stabilize the stock of Captains first, and then the one of Majors.

The objective of this scenario is to reach and maintain the target values in the following ranks:

CAPTAINS = 277<<ppl>> (starting from 2015)

MAJORS = 145<<ppl>> (starting from 2015)

Considering the previous trends related to the ranks of Captains (over-populated) and Major (under-populated) by inverting the behaviors in the Captains rank, thus allowing for a faster decreasing of the relative stock (which is achieved, in turns, by a higher promotion rate), we obtain an increase of the stock of Majors basically achieving both results at the same time.

SIMULATION #3.1

The quickest and most effective way to decrease the stock of Captains is to increase the number of yearly promotions to the following rank (Majors). This is achieved by introducing an adjustment value to the number of promotions, which is set by the Law at the value of 33 ppl/year. After running some simulations, we found that the value that creates the best result is 3, which gives us an overall yearly promotion rate of 36:

CAPTAINS PROMOTION ADJUSTMENT FACTOR = 3 <<ppl>>

PROMOTIONS BY SELECTION CAPTAINS = 36<<ppl/year>>

Limiting our observation to the ranks from 1st Lieutenant to Lieutenant Colonel, we have the following trends:

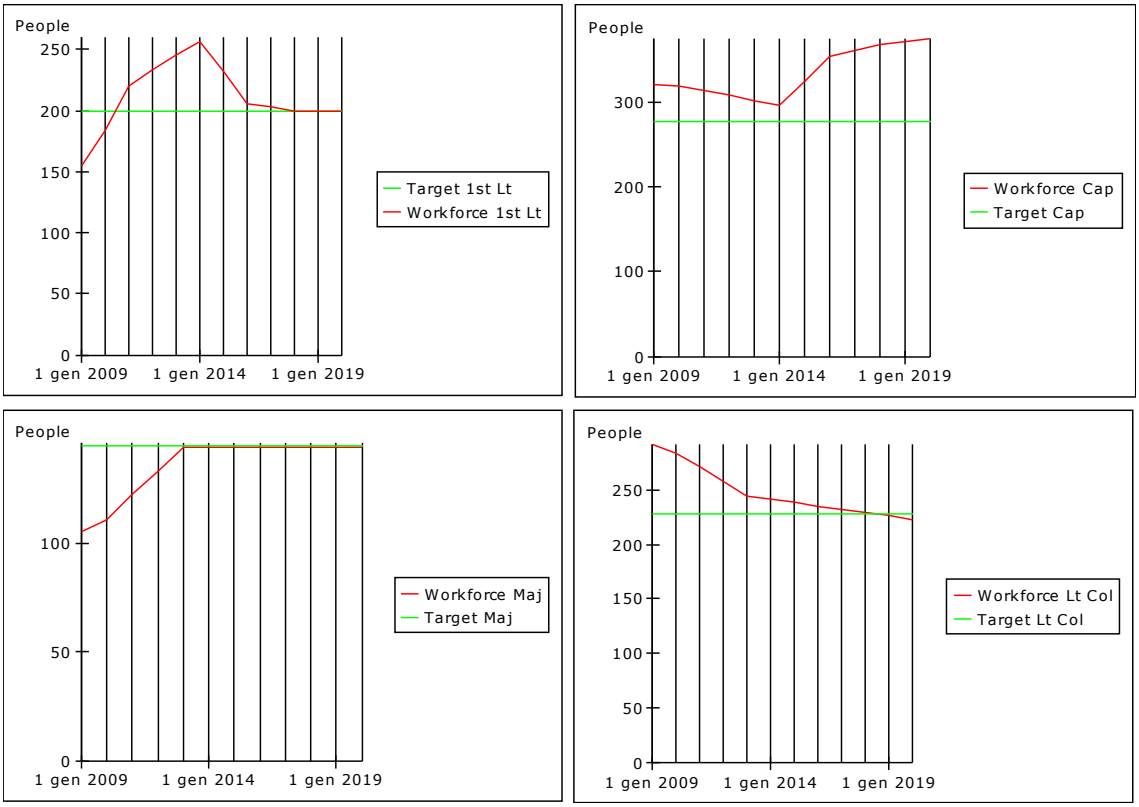


Figure 14: Scenario #3.1 outcome results

The most noticeable result does not impact the Captain rank (which only receives a modest decrease of the gap from the target value), rather it mainly affects the Majors whose level value, for the chosen Captain promotion rate of 36 ppl/year, reaches and maintains the target value (Figure 14). Other simulations performed with different promotion rates within the allowed interval[5], have very little impact on the surplus of Captains, while drastically affecting the level of Majors. We therefore proceeded by leaving the promotion rate from Captains to Majors at 36 ppl/year and exploiting a different leverage point, by acting on the dismissal rate.

SIMULATION #3.2

With the aim to reduce the number of Captains through a sort of "dismissal" policy, we have found that the best dismissal rate to allow stabilizing the level of Captains at (around) the target value is as follows: 5% until 2014 and 1.5% from 2014 to 2019

[5] As earlier mentioned, during the transition phase, the promotion rates may vary between the interval that has lower bound the lowest promotion rates of the two regulations (old and new) and for upper bound the highest promotion rate of the two regulations. In the case of Captains this interval is 33 – 40.

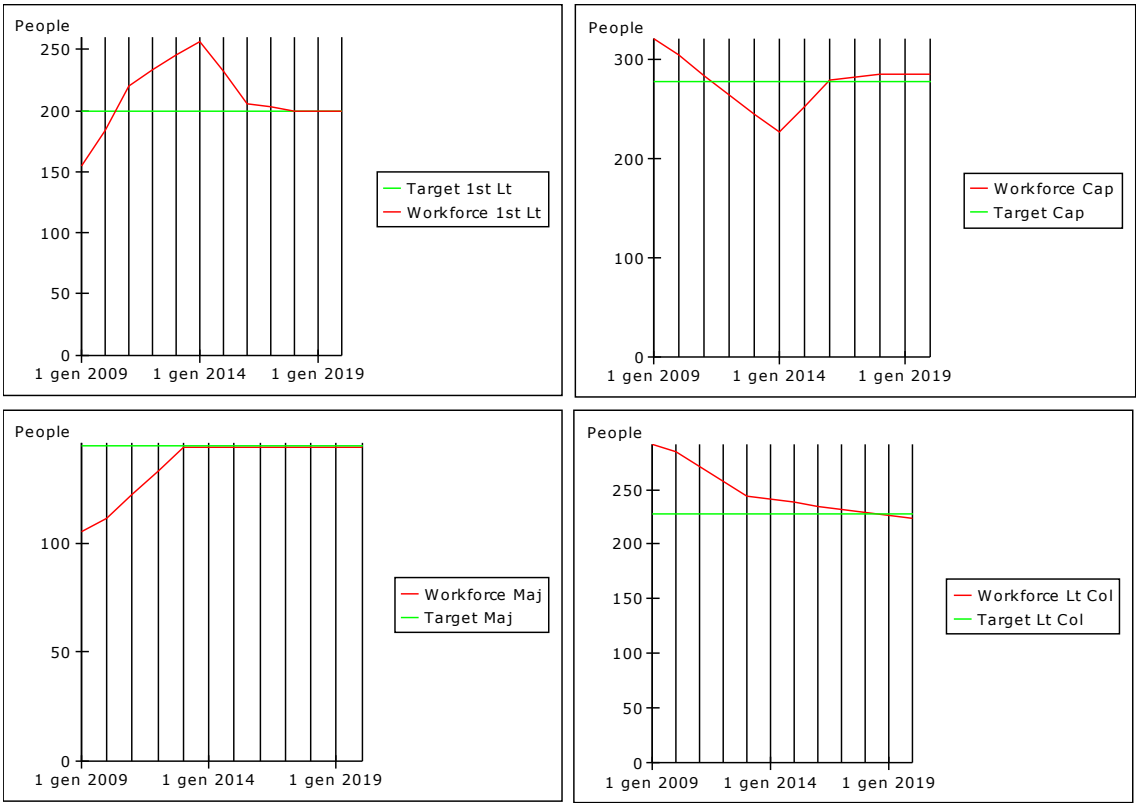


Figure 15: Scenario #3.2 outcome results

As we saw from the simulation results of scenario #3.1, varying the promotion rate for the Captains allows stabilizing the stock level of Majors at the desired level (Figure 15). Such a policy, though, is only available during the transition phase, which, as already noted, is going to end by year 2015. Additional simulations, not reported here for the sake of brevity, have shown that, if we remove the ability to act on this particular leverage point, the resulting trends would again depart from the target values in the years to follow. It is therefore safe to say, as a foretaste of our conclusions, that if we want to attain and maintain a new *status quo,* the possibility to vary the promotion rate (at least at the values that, as we have seen, would be able to stabilize certain stocks) should be maintained well beyond 2015.

We also observed that the level of Captains naturally tend to inflate due to the differences between inflow (promotions from 1st Lieutenant) and outflow (promotions to Major). We noticed that, if a *minor* surplus of 7 Captains can be accepted as a "small price to pay", then a hypothetical rate of dismissal of 5% until 2014 and 1.5% thereafter, could be a viable solution to control the stock level of Captains. As we will argue later, such a leverage point is not supported by the existing regulation and the historical rate of early dismissal for Captains, is almost naught[6], so in the concluding part of this paper we will explore possible ways to achieve such a goal.

SCENARIO #4

We will now focus on the relationships between those remaining ranks that are still out of balance: Lieutenant Colonels and Colonels.

[6] It is worth mentioning that Captains are serving under a miminum serving time of 16 years, which expires during the years as Majors. So the only motives for early dismissal in this case are for loss of military fitness or disciplinary reasons which, historically, are not very recurrent.

The goal of this scenario is to reach and maintain the target values of 228 for the rank of Lieutenant Colonel and 221 for the rank of Colonels:

TARGET LIEUTENANT COLONELS = 228<<people>>

TARGET COLONELS = 221<<people>>

These are the resulting trends from the previous simulation, with respect to the ranks of Lieutenant Colonel and Colonel.

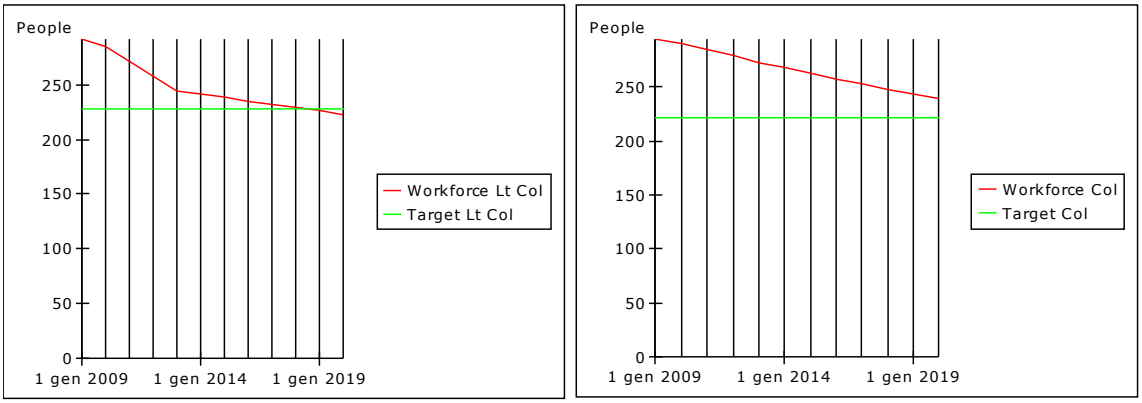


Figure 16: Scenario #4 outcome results

We can see that the trends are not in line with the desired worforce; moreover, two elements of concern would also need to be considered:

- in a first instance, the trend of Lt. Colonels is not stable, rather it decreases, and this would bring to level values below the target over the subsequent years;
- second, note that the level of Colonels, although decreasing, is constantly above the target level as well as constantly above the value of the level of Lt. Colonels (Figure 16), replicating the *inversion phenomenon* that we addressed earlier in the document (more leaders, fewer people to lead!).

Due to this, acting similarly to the previous stabilization policies, we try to adjust the level of promotions of the lower rank (default value 26), in order to influence both ranks. After several runs, we determined that a value of 22, (which is the lower end of the interval of promotable officers that the transition phase of the Law allows), gives the following situation:

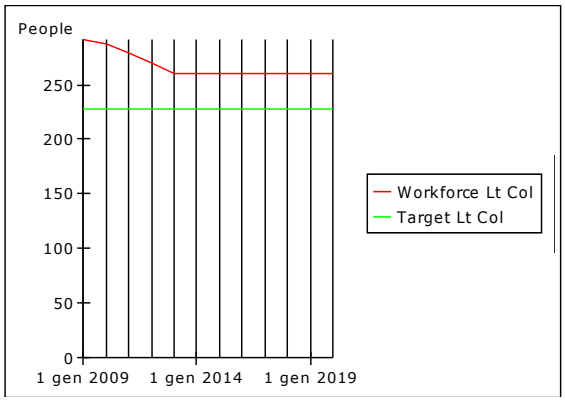


Figure 17: Lt. Colonels stabilization policy (no dismissal case)

Although this rate leaves a constant surplus of Lieutenant Colonels (see Figure 17), it has the great advantage of stabilizing the level of the stock. Different rates of

promotions, as several runs have shown, will only be able to produce trends that intercept the target value, but then depart from it, restoring the gap in either direction. As done in the previous scenario, also in this case a provision for early dismissal will be hypothesized. Introducing a dismissal rate for Lt. Colonels of 5% until 2013 and of 2.5% from 2014 until 2019, the related stock (Figure 18) reaches and maintains the target value of 228.

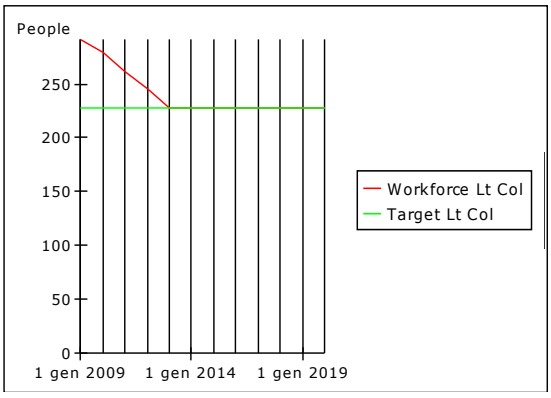


Figure 18: Lt. Colonels stabilization policy (w/ dismissals)

It is just the case to remind again that the current regulation doesn't support any early dismissal other than those already examined and based on: (1) "voluntary early dismissal" (provided that the "minimum obligation service time" has passed), (2) loss of physical fitness and (3) disciplinary reasons.

Similarly, for the rank of Colonel, the trend (Figure 19) needs to be fixed and the dismissal rate acts, in this respect, as a leverage point.

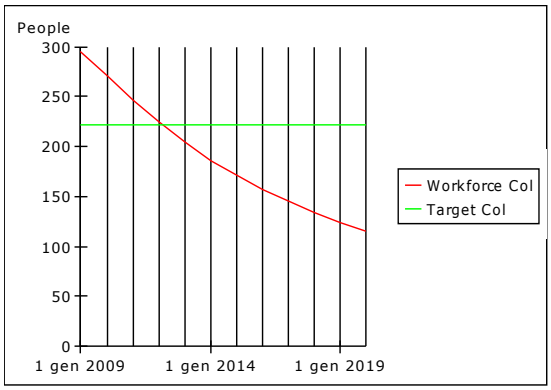


Figure 19: Colonels stabilization policy (no dismissal case)

Our simulations highlighted that, by setting the "early retirement" rate at 9.5% until 2012 and at 0.9% thereafter, the stock level of Colonel stabilizes at the target value of 221, as shown in Figure 20.

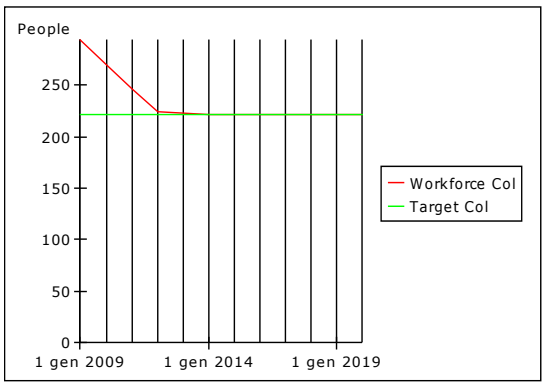


Figure 20: Colonel stabilization policy (w/ dismissals)

The results of this batch of simulations highlighted that the possibility to adjust the number of promoted Lieutenant Colonels is a necessary, but not sufficient condition to reach and maintain the desired level of Lt. Colonels and Colonels: the leverage points that influence the overall dismissal rate of the two rank pools must also be acted upon. So, while the impact of early retirement of "older" officers must be somewhat reduced, a way to "encourage", at least initially, a voluntary early dismissal of Lieutenant Colonels should be introduced. Such a policy-leverage will be further discussed and explored in the last chapter on future developments of our model.

This latter aspect, as we will argue in the conclusive part of our paper, seems to be in contrast with the retention policy adopted by the Air Force to stop the pilots from abandoning the service in favor of the civilian airlines.

As already mentioned the three General ranks present, since the first scenario (figure 12), a trend clearly compatible with the target values imposed by the Law and therefore there is no need for any adjustment.

7. CONCLUSIONS & SUGGESTED GUIDELINES

The opening statement of this paper referred to a "massive task" that is being undertaken by the Armed Forces in their attempt to reach a leaner, more balanced and sustainable workforce structure. Review of existing literature in the field of workforce planning has induced us to consider that a systemic approach might probably be the only one capable of generating conditions that are both plausible and sustainable. It is in particular the power of systems modeling and simulation, typical of the System Dynamics methodology, that allows managers to understand, and properly introduce, measures by acting on those leverage points in their organizational structure that are capable of generating such durable conditions.

The results of our modeling and simulation performed throughout this work have only just "scratched" the surface of the complexity of the required endeavor. The challenge that the Armed Forces are facing is made even harder by the apparent incompatibility between the desired end states and the means that the current regulation makes available (or unavailable…). So while some results are indeed attainable using management leverages that the Law itself introduces (some of which are, though, only limited to the transition phase), there doesn't seem to be enough freedom of action for the Armed Forces in general, and for the Air Force in particular, to reach a sustainable set of acceptable conditions.

The four scenarios that we have produced helped us measuring the magnitude of the required effort and showed us both the span of the achievable results under the current regulation and just some of the possible directions to take in order to complement the picture towards the desired final situation.

In particular:

- **Scenario #1** highlighted that the existing compensation mechanism between deficits and surpluses in the various ranks only works for the General ranks. In the three highest ranks, the simulated results are, in fact, already at the target values from the first years of the simulation.
- **Scenario #2** has shown that a fixed recruitment rate of 45 Cadets per year allows achieving and maintaining the target value of the Lieutenant rank, thus producing a considerable stabilizing effect on the rest of the structure. This variable has then been "frozen" for the rest of the simulations.
- **Scenario #3** showed the limitations in which we incur when trying to reach sustainable conditions with the management/policy leverages actually made available by the Law. Promotion rates can be adjusted, but only during the transition phase and with very limited impact towards desired stock values in the rank pools of Captains and Majors. It is only by introducing adequate measures to allow some kind of early dismissal, that we get close enough to the values required by the Law. But such policies are not supported by the current set of rules.
- **Scenario #4**, similarly to scenario #3, required the introduction of measures that are not supported by the current regulation. In particular, after determining a value for the promotion rate that stabilizes the level of Lt. Colonels, an "artificial" rate of dismissals (towards a reduction in the stock of Lieutenant Colonels and an increase in the stock of Colonels) had to be provided.

The four scenarios helped us explore and assess possible lines to take in order to remove those limitations that, *de facto*, will prevent the achievement, let alone the sustainability, of the required workforce structure.

By drawing conclusions from the analysis performed during this work, we are now in a condition to introduce some suggestions for a possible strategy, articulated along three lines of action:

1. **RECRUITMENT**
   Given the fact that our aim was not to explore how the workforce system reacts to phenomena from the "outer world" and therefore aiming at taking the workforce to a desired level a constant recruitment rate policy would need to be introduced. From our analysis, we have evidence that this is the only condition that may allow for further policy actions to be effective and their outcomes predictable. In fact, trying to correct internal balance with a variable inflow rate of officers exposes the Air Force to the risk of unmanageable oscillations in due course, induced by the inherent feedbacks and delays that characterize the workforce structure. The value, of course, can be adjusted to caper for changing external circumstances (like a requirement for personnel reduction due to budgetary spending cuts…), but not every year and, definitely, not in pursue of a new internal balance.

2. **RETIREMENT**
   This line deals with a very "edgy" issue. The whole Italian pension system is currently under a profound revision. For the purpose of this analysis, we will only consider the impact on the minimum serving years that the new pension system will introduce. This will "simply" translate in a higher "normal" retirement age. Having said this, the early retirement policy of the Air Force should be revised to achieve the retirement rates that will keep the level of Colonels at the target value. This measure is still within the array of available means of the existing regulation and should, unless things change in the next years, be implemented without problems.

3. **PROMOTION**

As we noticed from the different scenarios, the flexibility to adjust the number of yearly promotions in certain ranks, granted by the Law during the transition phase, is critical in order to stabilize the stock values in the whole structure. During the simulations, we highlighted the need to extend this faculty indefinitely, so that enough flexibility is allowed in those leverage points that hold the shortest yield time. Corrections in the number of promoted officers have, in fact, an immediate impact on the adjacent ranks, thus allowing re-balancing of situations that have not been foreseen (such as an unexpected spike in the rate of voluntary early dismissal).

4. **DISMISSAL/RETENTION**

We come now to the last and, potentially, the most controversial point of the proposed strategy: the dismissal/retention policy. Currently the Air Force does not have any dismissal policy for the ranks up to Lieutenant Colonel. Conversely there is a retention policy which encourages pilots to stay in the Air Force by means of a monetary bonus. This policy has been designed and introduced in a time of massive "exodus" of pilots, when the "centrifugal force" exerted by the civilian airlines was not balanced by the "gravitational pull" of the Air Force salaries. Filling the gap between the attractive salaries offered by the civilian world and the ones provided for by the Air Force, was (and probably still is) the highest leverage point, and thus the most effective way, to achieve the desired retention effect. Such was the effectiveness, that since it was first introduced, the economic retention bonus has been capable of stabilizing the rate of voluntary early dismissal of Majors and Lieutenant Colonels to a level that is now safe to consider "physiological".

It seems that the need, drawn by the simulation, for a dismissal of officers in the ranks of Captain and Lieutenant Colonel contrasts with the retention policy in place leading to the conclusion that such an incentive policy should come to an end.

However we consider this assumption just a starting point for future studies. In fact we strongly believe that additional areas, such as, the job satisfaction and the offer by the outer market must be considered in order to provide a more valuable assessment on the matter. In the following chapter we try to share a deeper comprehension of the issue.

8. DEVELOPMENT & FUTURE WORKS

Since this work was first conceived, the conditions it was aiming to address have naturally evolved in directions that would require an extension of the model in order to grasp the newly introduced elements that may change the structure of the system itself and, ultimately, its possible behaviors in response to certain policies. The forecasting power of the actual developed model, though, left us reasonably assured that any decision capable of acting on the identified leverage points would elicit those system behaviors that generate the desired sustainable end state conditions.

In addition to the natural evolution of the system that we attempted to describe (and influence), the external environment has also drastically changed, and more dramatic (and scary!) changes are still to come. Under current budget spending review, in fact, it has been decided that a further personnel reduction of 30.000 to 40.000 soldiers (this is a 21% reduction on the actual total strength!) across the whole Armed Forces, must be achieved over the next 10 to 20 years, and a likewise reduction in the strength of Air Force pilots is, of course, to be expected. When we started to work on this project, our aim was to determine how to reach a new set of conditions that were acceptable under a newly imposed regulation. Now that a massive 20% personnel reduction becomes a new task for the Armed Forces, we believe that the approach we have suggested in this paper

is the only plausible and reliable tool to lead the way toward a new Armed Forces structure.

As a first and probably most important step, changes that take into account the current situation must be implemented in the developed model. With a new and adapted model of the workforce structure of the Armed Forces, computer simulation would help developing a plan in which all the decisive conditions toward the desired end state could be identified. In particular, by creating several simulation scenarios, we may be able to gain vital insight, while designing a viable strategy, into three main areas.

- **Timeframe**. As we showed in this paper, when the new regulation was imposed in 1997, a transition phase was also provided in order to allow for a smooth evolution. The first time limit introduced to achieve the desired reduction was the year 2005. Throughout the years of application of the new regulation, the deadline to achieve the new numbers has been rolled forward many times and today is set at 2015. At the end of our analysis, we were in a position to assess that not even the 2015 mark will be respected and that some of the management leverages that should be available only during the transition phase, will necessarily have to be extended indefinitely. Had proper modeling and simulation been carried out before defining such a compelling and tight schedule, we would have probably had a better chance to be where we wanted and at the time we wanted. Today, under the pressure of unavoidable and non-deferrable costs reduction, the temptation to set up an over-optimistic time schedule seems very strong. At our advice, it is only through the advantages that System Dynamics and computer simulation offer, that such a risky trap can be avoided.
- **High leverage**. Given the amount of the required personnel reduction, it could appear that some "linear cut" policy would be the more balanced and "fair" approach to the issue. But long lasting effects in complex systems are hardly ever the result of indistinct and vague measures in non-key points of the structure. Experience shows that System Dynamics modeling and Computer Simulation, are very reliable tools in identifying those high leverage points where "*some actions or inputs might have a long lasting impact on the whole systems in terms of inverting a trend, thus reversing a vicious cycle*" (Maani & Cavana, 2000).
- **Required legislation**. At the end of the previous paragraph, we addressed some corrective measures that are not covered by current regulation. The supporting legislation is not in place simply because nothing has been done in the past to create it. The reason for this gap is that the problems we are dealing with today had not been explored when the restructuring workforce program was set in motion, and therefore the need for new regulation had not been anticipated.
  Today we are in the situation where a further 20% personnel reduction program is about to start, and if the required legislative "freedom of action" is not pre-emptively identified (or, even better, created), that could have disastrous effects during the implementation of the plan. Any bit of regulation which is not in place at the time when specific policy measures are identified, in fact, have the potential to introduce elements of delay that will interfere with the execution phase in ways that are hard to predict.
  Once again it is only through policy modeling and simulation that we can explore the full array of required measures beforehand and, therefore, start any preparatory work to make the necessary legislative framework available, when needed.
  As far as assessing the consequences of the lack of supporting legislation, a major learning point can be drawn from the contrast between the existing pilots' retention policy and the non-existing dismissal policy needed to reach the desired stock levels in the various ranks, which was described in the previous paragraph.

We raised the issue that, in the absence of a proper dismissal policy, removing the retention incentive, based on the output of simulation, might not be as obvious as it looks like. We suspect, in fact, that removing the retention incentive could trigger a typical case of negative feedback with delay (a "hot shower-cold shower" effect). We also suspect that if, on one hand, it could work in the short term to re-establish the level of officers in the affected ranks at the desired levels, on the other hand it might reproduce the same starting conditions that made it necessary. In addition we are also aware that an assessment of the attractiveness of civilian airlines salary in comparison with the Air Force pay checks must be considered.

In conclusion we are not able to state that removing the retention incentive is an obvious solution and we feel stuck with the problem of how to "encourage" early voluntary dismissal, without "encouraging" it so much as to make it a problem!

And this is precisely the kind of dilemma that will inevitably be generated if proper tools and instruments are not introduced when a policy decision is made! Hence the importance, once again, of using proper modeling and simulation to foresee those areas requiring some kind of "preparatory legislative work".

For sake of completeness, in the example offered in this section, further exploration of policy modeling, supported by the use of our model, suggested possible alternative ways out of the difficult situation in which we are stuck today.

- Introducing a different kind of incentive aimed at encouraging to leaving the Air Force. After having determined the required number of officers to retain, all the others could be given not only the chance but the incentive to leave. The determination of the required number of officer to retain in service should be accomplished, needless to say, by running simulations based on a model that reflects the reality of the complex organizational structure (that is what we did in this work!).

- Set up specific conventions with potential civilian "employers" to hire Air Force pilots that are willing to leave the Service. Such an experiment would not be a complete novelty. Few years back, the Department of Civil Protection, in coordination with the Ministry of Defense, launched a hiring campaign aimed at Air Force Captains who were willing to transit over, under provision of an equal pay level, with prospects of a quicker advancement in career and a longer active flying duty time: quite an alluring proposal. Similar initiatives could concern civilian airlines, firms of various natures and other Public Administrations.

- Establish a "career revision date", at which point every officer is offered a choice to stay in the service (and enjoy the economic benefits of the retention bonus) or to apply for one of the available external positions. The revision would of course be based on a two-way analysis of personal expectations by the individual and likely career paths that the Air Force can offer, based on the available positions and, of course, on the assessed performance so far displayed by the officer. This practice is common to many Armed Services in the western world (e.g.: USA and UK), where the serving time is pre-determined and, unless officers are selected to continue their career in the military, they are "eased" into the civilian world, by way of sponsoring personal growth courses (both in the academic and the technical world), setting up conventions, writing letters of recommendation and so forth.

In conclusion, we would like to point out that such a drastic reduction and re-distribution of personnel strength cannot be achieved at zero cost. What the systemic approach can guarantee, though, is that the efforts put in place will be rewarded by achievement of possible final states that would be plausible and sustainable.

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