DEPARTMENT OF NATIONAL DEFENCE
CANADA

OPERATIONAL RESEARCH DIVISION

DIRECTORATE OF OPERATIONAL RESEARCH
(CORPORATE)
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DOR(Corp) RESEARCH NOTE RN 2003/03

STRATEGIC INTAKE PLAN FOR PILOTS – A SPREADSHEET MODEL

by

L. STEMATE

JULY 2003

OTTAWA, CANADA

National Defence Défense nationale

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Recommended by: _____ Approved by: _____
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OTTAWA, ONTARIO JULY 2003

ABSTRACT

This research note documents a spreadsheet model that was requested by the Directorate of Air Personnel Production and Development (D Air PPD) to assist them in preparing the Annual Military Occupation Review (AMOR) for the pilot occupation. More precisely, the model uses the desired yearly production levels for the next few years as an input and produces an intake plan that details the recruitment needs by fiscal year and entry plan, so that the desired production levels are met.

RÉSUMÉ

Cette note de recherche documente un modèle qui a été sollicité par le Directeur de la Production et du Développement du Personnel – Air (DPDP Air) dans le but d'aider dans la préparation de Révisions Annuelles des Occupations Militaires (RAOM), pour les pilots. Plus précisément, le modèle utilise comme données d'entrée les niveaux désirés de production annuelle de pilots et produit un plan de recrutement organisé par années fiscales et par plans d'entrée, correspondant aux niveaux de production désirés.

TABLE OF CONTENTS

LIST OF ABBREVIATIONS

AFT	Advanced Flying Training
AMOR	Annual Military Occupation Review
AMT	Aeromedical Training
BFT	Basic Flying Training
BOTC	Basic Officer Training Course
D Air PPD	Directorate Air Personnel Production and Development
DEO	Direct Entry Officer
FLIT	Fighter Lead-In Training
GeM	Generic Modelling
MA	Managing Authority
ME	Multi Engine
OT	Occupational Transfer
PARSIM	Production/Absorption/Retention Simulation
PAT	Personnel Awaiting Training
Phase I	PFT
Phase II-a	BFT
Phase II-b	AFT- Jet Aircraft
Phase III	AFT – Jet Aircraft
Phase IV	FLIT
PFT	Primary Flying Training
PORT	Personnel Operational Research Team
RMC	Royal Military College
ROTP	Regular Officer Training Plan
RW	Rotary Wing
SLT	Second Language Training
UPTD	Undergraduate Pilot Training Database
UTPNCM	University Training Plan for Non-Commissioned Members

STRATEGIC INTAKE PLAN FOR PILOTS – A SPREADSHEET MODEL

I. INTRODUCTION

1. Since the devolution of Human Resources functions, the Chief of the Air Staff became Managing Authority (MA)[1] and, as such, has responsibility for conducting Annual Military Occupation Reviews (AMORs). Two of the important items on an AMOR agenda are:

a) To forecast production requirements for the following five years (which is basically done by determining the difference between the Trained Effective Strength and the Preferred Manning Level for a given occupation).
b) To decide on the Terms of Service offers.

2. The model described in this paper was produced at the request of the Directorate of Air Personnel Production and Development (D Air PPD) to assist in the preparations for the pilot AMOR. It ties in with item a) above and is meant to be an **end-user tool** addressing recruiting, given a certain production requirement. Basically, the model answers the following question:

Given the number of pilots that one needs to produce in the following years, ***how many*** *candidates should one recruit and* ***when****, in order to meet the production requirements, taking into account attrition and different commissioning plans (entry plans), each with its own training needs.*

3. The issues of pilot training and pilot production are not new. The most recent studies (Ref. 1, 2) favour the simulation approach to address these issues by providing an

[1] The roles of an MA are the following: (1) Forecast Individual Training & Education (IT&E) needs; (2) Establish IT & E qualitative requirements; (3) Deliver IT&E for assigned MOCs and specialties; (4) Evaluate equivalencies for assigned MOCs and qualifications; and (5) Conduct AMORs.

analysis capability to be used by decision makers to determine the best strategies to manage the pilot MOC. However, the analysis capability can only be provided at a cost, and this cost is the complexity of the model.

4. The possibility of addressing the current problem by building upon one of the simulation models already developed was considered, but the idea was finally abandoned for two main reasons. First, the analysis capability was not required in this case and therefore the added complexity associated with providing this capability was not justified. Second, it was important for the tool produced to be simple to understand and use by the staff preparing the AMORs, whom may change often and may have various academic backgrounds.

5. As such, it was decided to build this tool in a well known environment such as Excel 2000. To enhance the accuracy of the model, @Risk, an add-on to Excel was used in the development phase. However, the end-user of this tool is not required to have special knowledge of either Excel or @Risk. There is however a requirement to have both of them installed on the computer.

6. This paper documents the model to facilitate its future use. The document is organized in six main sections, corresponding to the six worksheets of the Excel 2000 model. The first worksheet is named *'Read Me'* and provides a brief description of the model. The second worksheet, named *'Controls'* deals with the input data. This is the only worksheet where the user is expected to input data. No calculations are performed here, the worksheet being dedicated to the inputs. The third worksheet contains historical attrition values corresponding to the various training phases in each of the entry plans. The next two worksheets are the *raisons d'être* of the model. Specifically, the fourth worksheet deals with the question "**How many** candidates should one recruit?", while the fifth one answers the question "**When** should they be recruited?". Finally, the last worksheet is provided primarily for the users' convenience. There is no new information in this worksheet, it only takes data from the previous worksheet and re-organizes it to facilitate the user's task.

II. THE 'READ ME' WORKSHEET

7. The first worksheet in the model named *'Read Me'* is intended to provide a short description of the model. It represents a very short version of this document, and for this reason, it will only be described here very briefly.

8. This worksheet provides information regarding the purpose of the model, some of the assumptions utilized, and short descriptions of each of the worksheets of the model. It explains that the model is organized in six worksheets (including this one), each of them dealing with one particular area.

III. THE 'CONTROLS' WORKSHEET

9. The worksheet named *'Controls'* is intended solely for data entry and is the only place where the user is expected to intervene in the model. Figure 1 presents a snapshot of this worksheet. Demarcated by the orange lines are the four sections where data is expected. Generally the user is expected to enter data in all cells that are coloured in blue. Green-shaded cells could be edited in case the parameters defined in these cells change. However, since these parameters are not expected to change frequently, these cells were given a different colour to point out the fact that normally, these cells should not be edited.

10. The first section (Section 1) should be used to specify the desired number of pilots to be produced yearly over the next ten years. The pilot production levels depend on many factors, such as training capacity, absorption capacity and, of course, demand (as it can be determined from known Air Force commitments). Determination of the pilot production requirements is beyond the scope of this model. These production figures must be calculated through other means. Currently, D Air PPD uses the Generic Modelling (GeM) (Ref. 3) to generate this information.

SECTION 1

Total # of pilots desired	Date by which the pilots are desired		
	Year	Month	Day
93	2013	4	1
93	2012	4	1
93	2011	4	1
93	2010	4	1
93	2009	4	1
93	2008	4	1
93	2007	4	1
93	2006	4	1
82	2005	4	1
82	2004	4	1

SECTION 2

Minimum Training Duration [weeks]	JET	Multi-Engine	Rotary Wing
ROTP (RMC)	309	278	279
ROTP (Civ. Univ.)	309	278	279
UTPNCM	184	153	154
DEO	141	110	111
DEO Bypasses	133	102	103
OT	108	77	78

SECTION 3

Entry Plan	Recommended split between the various entry plans [%]									
	2012/2013	2011/2012	2010/2011	2009/2010	2008/2009	2007/2008	2006/2007	2005/2006	2004/2005	2003/2004
ROTP (RMC)	39	39	39	39	39	39	39	39	39	39
ROTP (Civ. Univ.)	0	0	0	0	0	0	0	0	0	0
UTPNCM	3	3	3	3	3	3	3	3	3	3
DEO	45	45	45	45	45	45	45	45	45	45
DEO Bypasses	0	0	0	0	0	0	0	0	0	0
OT	13	13	13	13	13	13	13	13	13	13
Total =	100	100	100	100	100	100	100	100	100	100

SECTION 4

Desired Split between Jet, Multi-Engine and Rotary Wing [%]										
	2012/2013	2011/2012	2010/2011	2009/2010	2008/2009	2007/2008	2006/2007	2005/2006	2004/2005	2003/2004
JET	13	13	13	13	13	13	13	13	13	13
Multi-Engine	34	34	34	34	34	34	34	34	34	34
Rotary Wing	53	53	53	53	53	53	53	53	53	53
Total =	100	100	100	100	100	100	100	100	100	100

Figure 1: *'Controls'* Worksheet

The Production/Absorption/Retention Simulation (PARSIM) model (Ref. 1) could also be used for the same purpose. It should be noted that by default the model assumes that the production requirements are to be met by the end of the fiscal year. For instance, in the case of the last row in Figure 1, 82 pilots are required to be fully trained by the end of the fiscal year 03/04 (i.e., 1 April 2004).

8. The second section (Section 2) contains information regarding the minimum training duration in weeks for each entry plan:

a) Regular Officer Training Plan (ROTP) - Royal Military College (RMC);
b) ROTP – Civilian University (Civ U);
c) University Training Plan Non Commissioned Members (UTPNCM);
d) Direct Entry Officer (DEO);
e) DEO Bypass; and
f) Occupational Transfer (OT),

and each training stream:

a) Jet;
b) Multi-Engine (ME); and
c) Rotary-Wing (RW).

The same colour convention is used: green, to signify that these cells should not be changed unless the current training process is changed. The current values, provided by D Air PPD, are expressed in weeks. "Minimum training duration" is defined as the total length of all courses involved in any particular training stream, as if they were back to back, without accounting for any waiting time that students might experience in between courses.

9. The third section (Section 3) of this worksheet captures the desired split between the various entry plans, expressed in percentages, for each of the ten years of the model's horizon. This information will be used to derive the number of recruits needed in each

entry plan. Note that the user is only expected to input data in the blue cells. The labels at the top are modified automatically by the model, once the years of interest have been specified in Section 1. The model also calculates a total of the percentages in each column as an aid to the user to ensure that the column adds up to 100%. On a final editing note, the percentage sign (%) should not be included. For example, "40%" should be input as "40".

10. Finally, the fourth section (Section 4) should be used to enter data regarding the desired split between the various types of pilots, in terms of the type of aircraft for which they are trained: Jet, ME and RW. Once again, these values are expressed in percentages (without including the percent sign), for each of the ten years considered in the model. This information will be used to estimate *when* the recruits should be brought into the training process, given that each stream's training program has a different duration. In other words, this information is used to capture the reality that a future Jet pilot spends more time in the training system than a future multi-engine or rotary-wing pilot. More details regarding this aspect are provided in the description of the worksheet *'When'*.

11. As before, the user is expected to enter values only in the blue cells. The model adjusts the labels at the top of each column automatically, once the years of interest have been entered in Section 1. Totals for each column are also calculated and serve as an additional verification to the user that the sum of all percentages in one column adds up to 100%.

IV. THE 'ATTRITION' WORKSHEET

12. The third worksheet of the model is called *'Attrition'*. It contains historical attrition data associated with each training phase in each of the entry plans considered in the model. For the purpose of this model, several sources of data were used. The first one is a database called Undergraduate Pilot Training Database (UPTD), originally developed by the Operational Research Division at Air Command Headquarters (Ref. 4) and presently maintained by D Air PPD. This database contains data from course reports regarding the three phases of training: Primary Flying Training (PFT), Basic Flying Training (BFT) and Advanced Flying Training (AFT). The second source of data was the historical database maintained by the Personnel Operational Research Team (PORT), within the Directorate of Strategic Human Resources (D Strat HR). This second database was only used in order to attach an entry plan to each of the students recorded in the UPTD database. This information is critical for the present model and was not available from the UPTD database. Additionally, paper course reports, available from the schools, through D Air PPD, were also used to complement the UPTD database with more recent data.

13. In all, about ten years worth of data were used, from 1992 to 2001 inclusive. The numbers were quite small, due to many causes. To begin with, the number of students trained each year is often limited, since the period covered by the UPTD database includes the years of the Forces Reduction Program. Furthermore, due to incomplete data (ex: missing course reports) or conflicting information in some reports, some other entries could not be considered[2] in this study, reducing the numbers even further. In addition, there was a requirement for this study to differentiate (if possible) between the attrition levels experienced by the various entry plans. Therefore, the numbers were smaller yet when they had to be split between the various entry plans. Statistical analysis and expert judgement were used to produce average attrition rates by entry plan and training phase.

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[2] It was considered better, for the purpose of this study, to completely eliminate entries that contained conflicting information or not enough information, rather than risk the accuracy of our estimates. The conservative principle "when in doubt, throw it out" was used throughout the analysis. Note that only entries that were incomplete with regards to information that is essential for this study were eliminated.

14. The average attrition values for the three training phases, by entry plan, over all the years considered, are summarized in Table I.

TABLE I
AVERAGE ATTRITION VALUES

		PFT	BFT	AFT
ROTP	**Total**	103	225	251
	Failures	14	30	12
	Attrition	**13.6**	**13.3**	**4.8**
DEO	**Total**	129	96	94
	Failures	21	24	12
	Attrition	**16.3**	**25**	**12.8**

15. These data were validated by comparing the model results for recruiting with those generated for the 2003 Pilot AMOR. The analysis conducted by D Air PPD 2 yielded a final number of 138 recruits, vs. 140 recruits obtained through the model. The closeness in the results obtained through the two different methods increased the level of confidence. After a subsequent fine tuning of the model, the result obtained through the model was identical to the one obtained by D Air PPD 2.

16. More detailed attrition rates compiled from the various data sources mentioned are provided in Annex A. Rather than using the average historical attrition rates from Table I, the model simulates attrition using @Risk, an add-on to Excel. See Annex B for a discussion on the @Risk simulation component of the model.

17. Figure 2 shows a portion of the worksheet *'Attrition'* (the worksheet being too big to fit in one page). This worksheet shows the various training phases corresponding to each entry plan, in chronological order. In addition, estimates based on historical attrition rates experienced in each training phase are also shown here. The values appearing in Figure 2 represent the mean values of the probability distributions used to model the attrition. For example, the figure *13.67* seen in the cell corresponding to Phase I (PFT) in the ROTP stream should not be looked at as a constant value, but rather as the mean

ATTRITION									
Entry Plan									
	BOTC 1	BOTC 2	Univ - YR 1	Phase 1 (PFT)	Univ - YR 2	SLT	Univ - YR 3	AMT / LST/ SST	Univ - YR 4
ROTP (RMC)	0	0	0	13.67	0	0	0	0	0
ROTP (Civ. Univ.)	BOTC 1	BOTC 2	Univ - YR 1	First half Univ -YR 2	Phase 1 (PFT)	Second half Univ YR 2	SLT	Univ - YR 3	AMT / LST/ SST
	0	0	0	13.67	0	0	0	0	0
UTPNCM	BOTC 1	Univ - YR 1	BOTC 2	Univ - YR 2	SLT	Phase 1 (PFT)	AMT/ LST / SST	Phase II-a (BFT)	AFT
	0	0	0	0.00	0	0	0	18.33	8.67
DEO	BOTC 1	BOTC 2	SLT	Phase 1(PFT)	AMT/LST/SST	Phase II-a (BFT)	AFT		
	0	0	0	14.67	0	18.33	8.67		
DEO Bypasses	BOTC 1	BOTC 2	SLT	AMT/LST/SST	Phase II-a (BFT)	AFT			
	0	0	0	0	18.33	8.67			
OT	Phase 1(PFT)	SLT	AMT/LST/SST	Phase II-a (BFT)	AFT				
	14.67	0	0	18.33	8.67				
CFR	NO								
OCTP	NO								
CCEP	NO								

Figure 2: Excerpt from the ***'Attrition'*** worksheet

value of the probability distribution associated to this training phase, which is in this case *RiskTriang(3,13,25)* (as it appears in the formula portion of the Excel screen when clicking on the corresponding cell). This formula is an @Risk function that specifies that we will be drawing from a triangular distribution with a minimum attrition value of 3%, a maximum attrition value of 25% and a most likely value of 13%.

V. THE 'HOW MANY' WORKSHEET

18. As its name (*'How Many'*) suggests, the fourth worksheet in the model is used to calculate how many recruits are needed in order for the training system to produce the desired number of pilots by the time they are required. A portion of this worksheet is presented in Figure 3.

19. The results of the model calculations are presented to the user in the top part of the worksheet and have a coloured background, to distinguish the final results from the rest of the worksheet containing details of the calculations. The results provide the answer to the question: "How many recruits are required so that the desired yearly production levels can be reached?"

20. The number of recruits is computed backwards, starting with the desired number of pilots produced, to which we add the attrition experienced in the last phase of training, and so on, until the first phase of training. More precisely, the calculations are done as follows. For each of the years of interest, the model will take the value designating the desired production level for that year from the *'Controls'* worksheet and use the recommended values for the split between entry plans corresponding to that year, from the same worksheet, to compute the desired production level by entry plan. For example, according to the numbers shown in Section 1 of Figure 1, the desired pilot production during the fiscal year 2012/2013 is 93 pilots. From section 3 it is determined that 39% of them should come through ROTP, 45% of them through DEO, 13% through OT, with the remaining 3% through UTPNCM. Based on this information, the model will first calculate the desired production level by entry plan. In the case of the ROTP plan, this calculation will lead to 36.27 pilots[3] (see Figure 3). The number of recruits lost during the last phase of training (calculated according to the attrition rates in the *'Attrition'* worksheet) will be added to this number. The result represents the number of recruits that

[3] Note that no rounding will be done until the last stage in the calculations, to limit the propagation of errors.

RESULTS	Fiscal Year in which successful recruits will receive their wings								
	2012/2013	2011/2012	2010/2011	2009/2010	2008/2009	2007/2008	2006/2007	2005/2006	2004/2005
# recruits required in ROTP (RMC) stream =	49	49	49	49	49	49	49	49	44
# recruits required in ROTP (Civ.Univ.) stream =	0	0	0	0	0	0	0	0	0
# recruits required in UTPNCM stream =	4	4	4	4	4	4	4	4	3
# recruits required in DEO stream =	66	66	66	66	66	66	66	66	58
# recruits required in DEO_Bypasses stream =	0	0	0	0	0	0	0	0	0
# recruits required in OT stream =	19	19	19	19	19	19	19	19	17
Total Recruits =	138	138	138	138	138	138	138	138	122

				Number of pilots in ROTP (RMC) be					
		FY READY		AFT	BFT	Univ 4	AMT/LST/SST	Univ 3	SLT
Total # pilots from ROTP (RMC) stream =	36.27	2012/2013		38.59	42.71	42.71	42.71	42.71	42.71
	36.27	2011/2012		38.59	42.71	42.71	42.71	42.71	42.71
	36.27	2010/2011		38.59	42.71	42.71	42.71	42.71	42.71
	36.27	2009/2010		38.59	42.71	42.71	42.71	42.71	42.71
	36.27	2008/2009		38.59	42.71	42.71	42.71	42.71	42.71
	36.27	2007/2008		38.59	42.71	42.71	42.71	42.71	42.71
	36.27	2006/2007		38.59	42.71	42.71	42.71	42.71	42.71
	36.27	2005/2006		38.59	42.71	42.71	42.71	42.71	42.71
	31.98	2004/2005		34.02	37.66	37.66	37.66	37.66	37.66
	31.98	2003/2004		34.02	37.66	37.66	37.66	37.66	37.66

Figure 3: Excerpt from the *'How Many'* worksheet

started the last phase of training (AFT), which is the same as the number of recruits that finished the previous training phase (BFT). The number of recruits that finished BFT is in turn equal to the number of recruits starting BFT plus the attrition corresponding to this phase. By continuing like this until the first phase of training, one ends up with the number of candidates that need to be recruited so that the required number of pilots is produced at the end of the training pipeline. In the case of our example (ROTP), this number is 49.48 pilots. This number is then copied, after being rounded, to the 'results' portion of the worksheet.

21. A 'total' for each fiscal year is also provided to the user. This number should be read as "the total number of recruits needed so that the required number of pilots are produced for that particular fiscal year". The reader should note though, that this number includes candidates that are recruited over several years. Because the various entry plans have various training durations, candidates in each plan should be recruited at different times, so that they all finish in the same year.

VI. THE 'WHEN' WORKSHEET

22. The fifth worksheet of the model provides the answer to the second part of the problem. Specifically, *when* should the recruits be brought into the training system, so that they will be graduating with wings by the time they are required?

23. The time between when a student starts his/her pilot training and when it finishes depends on several factors. The most important one is the entry plan for the student, because the training duration can vary significantly from one plan to the other. The type of aircraft for which they train also has an impact, since Jet training is significantly longer than ME or RW training. Another factor can be the waiting time that may occur between training phases. However, data regarding the Personnel Awaiting Training (PAT) Pools was scarce, and therefore this factor was not included in the model. As such, the results provided by the model account for the training duration characterizing each entry plan and do not account for the PAT pools, nor does it account for time between courses. The model assumes that as personnel complete one course they carry on to the next one the following week.

24. Figure 4 shows a portion of the *'When'* worksheet. The top part of the worksheet contains the results, while the bottom part contains the calculation details. The results are presented by fiscal year in which students are graduating with wings. For each fiscal year, the number of recruits in each entry plan is copied from the previous worksheet (*'How Many'*) and the dates by which they should be brought into the training system are provided as a range of dates, for each of the entry plans. It is considered that students that start their training within this range, stand a very good chance of finishing their training by the time required.

NOTE: The results on this page do not take into account the waiting time in the PAT pools.

RESULTS

ENTRY PLAN	FISCAL YEAR IN WHICH SUCCESSFUL RECRUITS WILL BE GRADUATING WITH WINGS						
	2012/2013			2011/2012			
	# Recruits	Date In - first group	Date In - last group	# Recruits	Date In - first group	Date In - last group	# Recruits
ROTP (RMC)	49	30-Apr-07	1-Nov-07	49	30-Apr-06	1-Nov-06	49
ROTP (Civ. Univ.)	0	30-Apr-07	1-Nov-07	0	30-Apr-06	1-Nov-06	0
UTPNCM	4	21-Sep-09	25-Mar-10	4	21-Sep-08	25-Mar-09	4
DEO	66	19-Jul-10	20-Jan-11	66	19-Jul-09	20-Jan-10	66
DEO Bypasses	0	13-Sep-10	17-Mar-11	0	13-Sep-09	17-Mar-10	0
OT	19	7-Mar-11	8-Sep-11	19	7-Mar-10	8-Sep-10	19

Details of calculation

	Min Duration Jet Trg.	Date Ready	Start Date - first grp	Start date - last grp	Date Ready	Start Date - first grp	Start date - last grp	Date Ready
ROTP (RMC)	[days]							
	2163	1-Apr-13	30-Apr-07	1-Nov-07	1-Apr-12	30-Apr-06	1-Nov-06	1-Apr-11
	Average Trg. Duration	Avg. Trg. Dur.			Avg. Trg. Dur.			Avg. Trg. Dur.
		1978			1978			1978
ROTP (Civ. Univ.)	Min Duration Jet Trg.							
	2163		30-Apr-07	1-Nov-07		30-Apr-06	1-Nov-06	
		1978			1978			1978
UTPNCM	Min Duration Jet Trg.							
	1288		21-Sep-09	25-Mar-10		21-Sep-08	25-Mar-09	
		1103			1103			1103
DEO	Min Duration Jet Trg.							
	987		19-Jul-10	20-Jan-11		19-Jul-09	20-Jan-10	
		802			802			802
DEO Bypasses	Min Duration Jet Trg.							
	931		13-Sep-10	17-Mar-11		13-Sep-09	17-Mar-10	
		746			746			746
OT	Min Duration Jet Trg.							
	756		7-Mar-11	8-Sep-11		7-Mar-10	8-Sep-10	
		571			571			571

Figure 4: Excerpt from the ***'When'*** worksheet

25. From Section 2 of the *'Controls'* worksheet (Figure 1) it can be seen that ME and RW training durations are similar, while Jet training is about 30 weeks longer. However, since it is not known from the very beginning which stream students will take (since this split occurs much later in their training), it was decided to provide the start dates as a range of dates, rather than a single date, to allow for these variations between the training duration for the various students.

26. The first date in the range (labelled "Date In – First Group" in the model) is calculated so as to allow recruits to finish the longest training possible (i.e., Jet training). As such, it is calculated as the difference between the desired graduation date (labelled "Date Ready" in the model) and the duration of Jet training expressed in weeks (which is provided in the *'Controls'* worksheet).

27. The second date in the range (labelled "Date In – Last Group" in the model) is determined so as to make the model sensitive to the variations in the split between Jet, ME and RW pilots. More precisely, if mostly Jet pilots are needed, the difference between the first and second date in the range should become smaller. At the limit, if only Jet pilots are needed this difference should be zero. In order to make the model respond in this manner, a "weighted average training time" is used to calculate the second date in the range.

28. The "weighted average training time" is computed as the ratio between the total training time required by all recruits, calculated according to the split between Jet, ME and RW, and the total number of recruits. The second date in the range ("Date In –Last Group") will therefore be calculated as the difference between the graduation date and the "weighted average training time", expressed in days.

VII. THE 'RECRUITMENT BY YEAR' WORKSHEET

29. The last worksheet of the model exists solely for the user's convenience. This worksheet provides no new information, it only re-organizes data from the previous worksheet in a more convenient way for the user. More precisely, it provides the user with a yearly recruitment plan corresponding to the demand (in terms of pilots to be produced), as formulated by the user in the 'Controls' worksheet. As such, the user is informed about the recruitment requirements, by fiscal year, for the next seven fiscal years.

30. There are essentially three output variables of interest for this model: how many people should be recruited, when should they be recruited and when will they be graduating with wings. The *'When'* worksheet groups data by fiscal year of graduation (on columns) and provides answers regarding the number of recruits and when they should start training (on rows), for each of the entry plans. The *'Recruitment by Year'* worksheet uses the same information from the *'When'* worksheet and groups it by fiscal year of recruitment (on columns) and provides answers regarding the number of candidates that should be recruited in each fiscal year.

31. For example, from the *'When'* worksheet (see Figure 4), one learns that there will be 49 recruits needed in the ROTP(RMC) entry plan, and that they should be recruited between 30 April 2007 and 1 November 2007. The model will compare the first date in the range to 1 April of the same year (2007 in this case), in order to determine the fiscal year in which these people should be recruited. In this case, the result is 2007/2008 and therefore these 49 recruits will appear in the *'Recruitment by Year'* worksheet under the column labelled "2007/2008", on the row labelled ROTP(RMC) (see Figure 5).

32. The reader should be aware that this process of re-organizing data by fiscal year of recruitment might introduce a certain amount of inaccuracy. For example, in the case of the 19 OTs required to satisfy the estimated pilot demand in 2012/2013, the *'When'*

RECRUITMENT BY FISCAL YEAR

Entry Plan	2003/2004	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010
ROTP (RMC)	49	49	49	49	49	0	0
ROTP (Civ. Univ.)	0	0	0	0	0	0	0
UTPNCM	4	4	4	4	4	4	4
DEO	66	66	66	66	66	66	66
DEO Bypasses	0	0	0	0	0	0	0
OT	19	19	19	19	19	19	19
TOTAL:	**138**	**138**	**138**	**138**	**138**	**89**	**89**

Details of Calculation

	# Recruits	IN - FY starting			# Recruits	IN - FY starting
ROTP(RMC)	49	1-Apr-07		ROTP(Civ. Univ.)	0	1-Apr-07
	49	1-Apr-06			0	1-Apr-06
	49	1-Apr-05			0	1-Apr-05
	49	1-Apr-04			0	1-Apr-04
	49	1-Apr-03			0	1-Apr-03
	49	1-Apr-02			0	1-Apr-02
	49	1-Apr-01			0	1-Apr-01
	49	1-Apr-00			0	1-Apr-00
	44	1-Apr-99			0	1-Apr-99
	44	1-Apr-98			0	1-Apr-98

Figure 5: An excerpt from the *'Recruitment by Year'* worksheet

worksheet informs the user that they should be recruited in the interval between 7 March 2011 and 8 September 2011. By the same process of comparing the first date in this range to 1 April of the same year, the model will conclude that these 19 people should be recruited in the fiscal year 2010/2011 (since 7 March 2011 is prior to 1 April 2011, hence it belongs to the previous fiscal year), whereas the bulk of them could very well be recruited in the fiscal year 2011/2012.

33. Therefore, although the *'Recruitment by Year'* worksheet offers the convenience of yearly recruitment planning at a glance, it is strongly recommended that the user always check the previous worksheet as well, for two reasons: first, to make sure that no such inaccuracies were introduced and second, to get a more precise idea of the suggested interval of recruitment (provided as a six month interval in the worksheet *'When'*, rather than as one year intervals, as is the case in the *'Recruitment by Year'* worksheet).

VIII. SUMMARY

34. This research note documents a spreadsheet model that can be used in preparation for the Annual Military Occupation Review (AMOR) for the pilot occupation. More precisely, the model answers the following questions:

Given the number of pilots that one needs to produce in the following years, ***how many*** *candidates should one recruit and* ***when****, in order to meet the production requirements, taking into account attrition and the fact that pilots are recruited through different commissioning plans (entry plans), each with its own training needs.*

35. The model was developed in Excel 2000 using @Risk, and therefore, in order to run the model, one needs to have both Excel and @Risk installed on the computer.

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ANNEX A

DOR(Corp) RESEARCH NOTE RN 2003/03

JULY 2003

ATTRITION RATES

1. For the purpose of this study, attrition corresponding to a given training phase is defined as the ratio between the number of phase training failures and the number of students initially enrolled in that training phase. A distinction is not made between students who failed because of medical problems, poor academic results, poor flying or even voluntary release, because all that is important for this study is the fact that these students did not graduate with wings.

2. The Undergraduate Pilot Training Database (UPTD) (Ref.4) utilizes the following codes for the students' results: *8* signifies that the student has passed; *7, 6, 5, 4* and *3* signify that the student has failed (for various reasons, depending on the code); *2* and *1* indicate that the student was re-coursed; *0* indicates that there is no rating (although a course report exists, at least in a partial form); finally, *Z* is used in the cases where no course report exists. For this model, all students marked by one of the "fail" or "pass" codes were considered (counted). The students marked with *Z* were eliminated from the study. Students for which a course report exists but the rating was *0* were considered failures. In most cases, *0* was used for the voluntary releases, which clearly represents a loss (failure) in the context of this study. Finally, students that were re-coursed, were eliminated from the count in the case of the course they did not finish and were counted later on, when they took that course again and finished it with a clear result: either "pass" or "fail".

3. A summary of the results gathered from the afore-mentioned information sources and taking into account the definitions and assumptions discussed above, is provided in

Table A-1 (Primary Flying Training), Table A-2 (Basic Flying Training) and Table A-3 (Advanced Flying Training).

TABLE A-1
ATTRITION EXPERIENCED IN PRIMARY FLYING TRAINING
(ROTP AND DEO ENTRY PLANS)

PRIMARY FLYING TRAINING										
	Year	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
ROTP	**Total**	N/A	N/A	44	13	8	4	13	12	9
	Failures	N/A	N/A	1	1	1	1	4	5	1
	Attrition [%]	N/A	N/A	2.3	7.7	12.5	25	30.8	41.7	11.1
DEO	**Total**	2	38	5	5	4	6	15	31	23
	Failures	0	4	2	0	0	2	4	5	4
	Attrition [%]	0	10.5	40.0	0	0	33.3	26.7	16.1	17.4

TABLE A-2
ATTRITION EXPERIENCED IN BASIC FLYING TRAINING
(ROTP AND DEO ENTRY PLANS)

BASIC FLYING TRAINING											
	Year	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
ROTP	**Total**	28	37	51	6	5	7	3	1	39	48
	Failures	3	3	7	0	0	0	1	0	6	10
	Attrition [%]	10.7	8.1	13.7	0	0	0	33.3	0	15.4	20.8
DEO	**Total**	10	26	12	19	10	3	4	5	5	2
	Failures	3	5	4	4	5	1	0	0	1	1
	Attrition [%]	30.0	19.2	33.3	21.1	50.0	33.3	0	0	20.0	50.0

TABLE A-3
ATTRITION EXPERIENCED IN ADVANCED FLYING TRAINING
(ROTP AND DEO ENTRY PLANS; AMALGAMATION OF JET, ME AND RW)

ADVANCED FLYING TRAINING											
	Year	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
ROTP	**Total**	1	33	30	30	31	42	31	7	6	40
	Failures	0	2	3	1	0	2	4	0	0	0
	Attrition [%]	0	6.1	10	3.3	0	4.8	12.9	0	0	0
DEO	**Total**	7	20	22	14	6	5	8	5	2	5
	Failures	0	0	3	0	0	2	5	0	0	2
	Attrition [%]	0	0	13.6	0	0	40.0	62.5	0	0	40

ANNEX B

DOR(Corp) RESEARCH NOTE RN 2003/03

JULY 2003

USING @Risk TO MODEL ATTRITION

1. Rather than using the average historical attrition values, the model simulates attrition using @Risk, an add-on to Excel. Triangular distributions were used to model attrition. This type of distribution is completely defined by three values: the lowest value, the most likely value and the highest value (Figure B-1). Triangular distributions are commonly used in simulation studies when the amount of data available is limited.

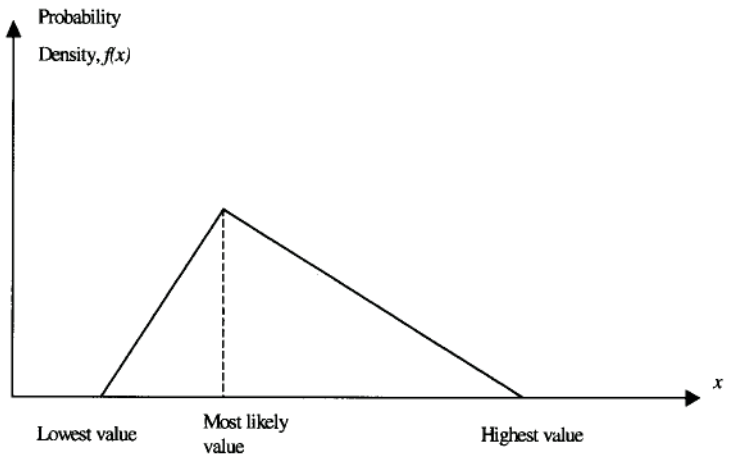

Figure B-1: Example of a triangular distribution

2. Using a Monte-Carlo simulation enables one to determine the most probable outcome, in terms of recruitment requirements, given that some of the model's parameters are uncertain (i.e., it is assumed that the attrition corresponding to each of the various training stages can take any values within a certain range).

3. More precisely, at each iteration, the model draws samples from the probability distributions used to describe the uncertain parameters. As such, at each iteration a new "scenario" is built and the recruitment requirements are computed for that particular

scenario. The model is set to run to convergence. @Risk provides all kinds of statistics that could be used to determine the probability distributions of the recruitment requirements, to perform risk analysis, etc. It also calculates the mean value corresponding to all of the scenarios computed and returns this value in the Excel spreadsheet.

4. Considering the nature of this problem, risk is not a big issue. The risk of failing to produce the exact number of pilots required could be reduced by increasing the number of recruits, and therefore the costs associated with training all these recruits. However, considering that the system is a dynamic system and, even assuming that the pilot production levels are set with the greatest accuracy at the moment of the analysis, there is still a good chance of changes occurring in the Air Force future commitments that will drive a change in the number of pilots needed. Furthermore, the cost increase associated with reducing this risk will be dramatic, so there is really no need to make such efforts to reduce this type of risk.

5. Therefore, instead of computing probability distributions for the recruitment requirements, it is strongly suggested that the mean values that are directly computed by @Risk and conveniently provided in the Excel spreadsheet, in the appropriate locations (*'How Many'* and *'Recruitment by Year'* worksheets) are used.

ANNEX C

DOR(Corp) RESEARCH NOTE RN 2003/03

JULY 2003

MODELLING DATA AND CALCULATIONS

1. Table C-1 provides the actual distributions that were used to model attrition. Note that distributions used for ROTP and DEO entry plans are based on historical attrition data. The attrition patterns corresponding to OT and UTPNCM entry plans were assumed to be similar to the ones experienced in the DEO plan. This assumption, endorsed by D Air PPD 2, was necessary because not enough historical data was available for these plans.

TABLE C-1
DISTRIBUTIONS USED TO MODEL ATTRITION

Entry Plan	Training Phase	Distribution
ROTP (RMC) and ROTP (Civ. U.)	Phase I (PFT)	Triang (3, 13, 25)
	Phase II-a (BFT)	Triang (0,13,16)
	AFT	Triang (0,5,13)
DEO, OT and UTPNCM	Phase I (PFT)	Triang (3, 16, 25)
	Phase II-a (BFT)	Triang (0,25,30)
	AFT	Triang (0,12,14)

2. The following paragraphs will provide the reader with a full mathematical description of the model. A code of colours is utilized to make this mathematical formulation easier to read: *blue* is used for all quantities that are introduced by the user (the input data), *green* is used for all quantities that are estimated based on historical data, and *red* is used for the quantities calculated by the model (the output data).

3. Note that all calculations in the model are repeated for each year of the model's horizon. Therefore, only the calculations associated to any one particular year will be provided here, keeping in mind that the same process is repeated for all years. In addition, to simplify things further, the year will be omitted from the notation.

5. The following definitions are used:

a) N = Desired number of pilots in a given year (i.e., production level required);
b) $N\ (Entry\ Plan)$ = Desired number of pilots in a given entry plan;
c) $N\ (Start\ Training\ Phase)$ = Number of students that *start* a given training phase;
d) $Attrition\ (Entry\ Plan,\ Training\ Phase)$ = Attrition rate associated to a given entry plan and a given training phase;
    - *Entry Plan* can be any of ROTP(RMC), ROTP(Civ.U.), DEO, UTPNCM or OT
    - *Training Phase* can be any of the phases of training specific to each entry plan. Note however that the attrition rate is assumed to be zero for all of them except for Phase I (PFT), Phase II-a (BFT) or AFT
e) $Percentage\_Pilots\ (Entry\ Plan)$ = Desired percentage of pilots that are to be brought into the system through a specific entry plan;
f) $Percentage\ (Aircraft\ Type)$ = Desired percentage of pilots that are to be trained for a specific type of aircraft;
    - *Aircraft Type* can be any of Jet, Multi-Engine and Rotary Wing
g) R = Total number of recruits that need to be enrolled so that the required pilot production level is met;
h) $R\ (Entry\ Plan)$ = Number of recruits that need to be enrolled in a particular entry plan so that the required production level for that entry plan is met.

6. The number of recruits is determined for each entry plan. The calculations are done backwards, starting with the desired number of pilots produced in that entry plan, to

which is added the attrition during the last phase of training, and then the attrition during the previous training phase and so on until the first phase of training.

7. To calculate the desired number of pilots produced in each of the entry plans, equation (1) is used:

$$N\,(Entry\ Plan) = N * Percentage\_Pilots\,(Entry\ Plan) \quad (1)$$

8. The model then calculates the number of students that started each phase of training in that entry plan, starting with the last one and ending with the first one, given that a certain attrition rate is experienced at each phase. Formula (2) is used:

$$N\,(Start\ Training\ Phase) = N\,(Entry\ Plan) / (1 - Attrition\,(Entry\ Plan, Training\ Phase)/100) \quad (2)$$

8. The number of recruits that need to be enrolled in each entry plan is calculated using formula (3):

$$R\,(Entry\ Plan) = N\,(Start\ Training\ Phase) \quad (3)$$

where *Training Phase* is the first training phase in that particular entry plan.

9. Finally, the total number of recruits will be calculated as the sum for all entry plans of the number of recruits required in each entry plan. Formula (4) is used:

$$R = \sum_{\text{All entry plans}} R\,(Entry\ Plan) \quad (4)$$

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STRATEGIC INTAKE PLAN FOR PILOTS – A SPREADSHEET MODEL

4. AUTHORS (last name, first name, middle initial)

STEMATE, LUMINITA

5. DATE OF PUBLICATION (month Year of Publication of document)	6a. NO OF PAGES (total containing information. Include Annexes, Appendices, etc.)	6b. NO OF REFS (total cited in document)
JULY 2003	35	4

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This research note documents a spreadsheet model that was requested by the Directorate of Air Personnel Production & Development (D Air PPD) to assist them in preparing the Annual Military Occupation Review (AMOR) for the pilot occupation. More precisely, the model uses the desired yearly production levels for the next few years as an input and produces an intake plan that details the recruitment needs by fiscal year and entry plan, so that the desired production levels are met.

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