National Defence / Défense nationale

# Modelling and Simulating Canadian Armed Forces Career Progression

## 17th NATO OR&A Conference

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Chief of Military Personnel (CMP)

October 31st, 2023

DGMPRA Director General Military Personnel Research and Analysis

DGRAPM Directeur général recherche et analyse sur le personnel militaire

Canada

# Introduction

- Department of National Defence and Canadian Armed Forces (DND/CAF) consists of[1]:
  - Regular Force: 63,288
  - Primary Reserve: 28,941
  - Cadet Organizations Administration and Training Service: 6,033
  - Canadian Rangers: 5,025
  - Civilian employees: ~25,000

- Director General Military Personnel Research and Analysis (DGMPRA)
  - Research and analysis arm within Chief of Military Personnel
  - Works closely with clients to provide evidence for policy/program development and to inform decision-making

[1] As of 31 August 2023

# Introduction

## Director Research Personnel Generation

Research and analysis in areas of attraction, recruiting, training & education, career management, human resources planning, retention and attrition.

## Director Research Personnel and Family Support

Research and analysis in the areas of conditions of service and quality of life of CAF members and their families, employment equity and diversity, and the physical and psychological health.

## Director Research Operational & Organizational Dynamics

Research and analysis in the areas of leadership and culture, operational and organizational dynamics, workplace well-being and performance measurement.

## Director Research Workforce Analytics

Develops workforce analysis tools, simulation models and forecasting tools, and reports various personnel metrics to inform policy, strategy and decision-making at various levels.

## Director Personnel Science-Policy Integration

Enables science-policy integration through research synthesis, knowledge translation, network liaison, strategic outlook, and capability development.

# Goal of the Presentation

To introduce you to a new military workforce simulation model, describing the hurdles encountered during its development and the methods used to overcome them.

Although some workforce simulation results will be shown, they will not be the focus of the presentation.

# Workforce Modelling: Why is it Important?

- Salary and personnel-related costs amount to approximately half of the Canadian Department of National Defence's yearly budget. Accurate workforce projections are essential to maintain an effective Canadian Armed Forces.
- Contrary to the private sector, staffing upper-rank positions cannot be done through hiring. Military members must be trained and gain the experience required to occupy some positions. This requires decades of planning to ensure an appropriate experience profile.

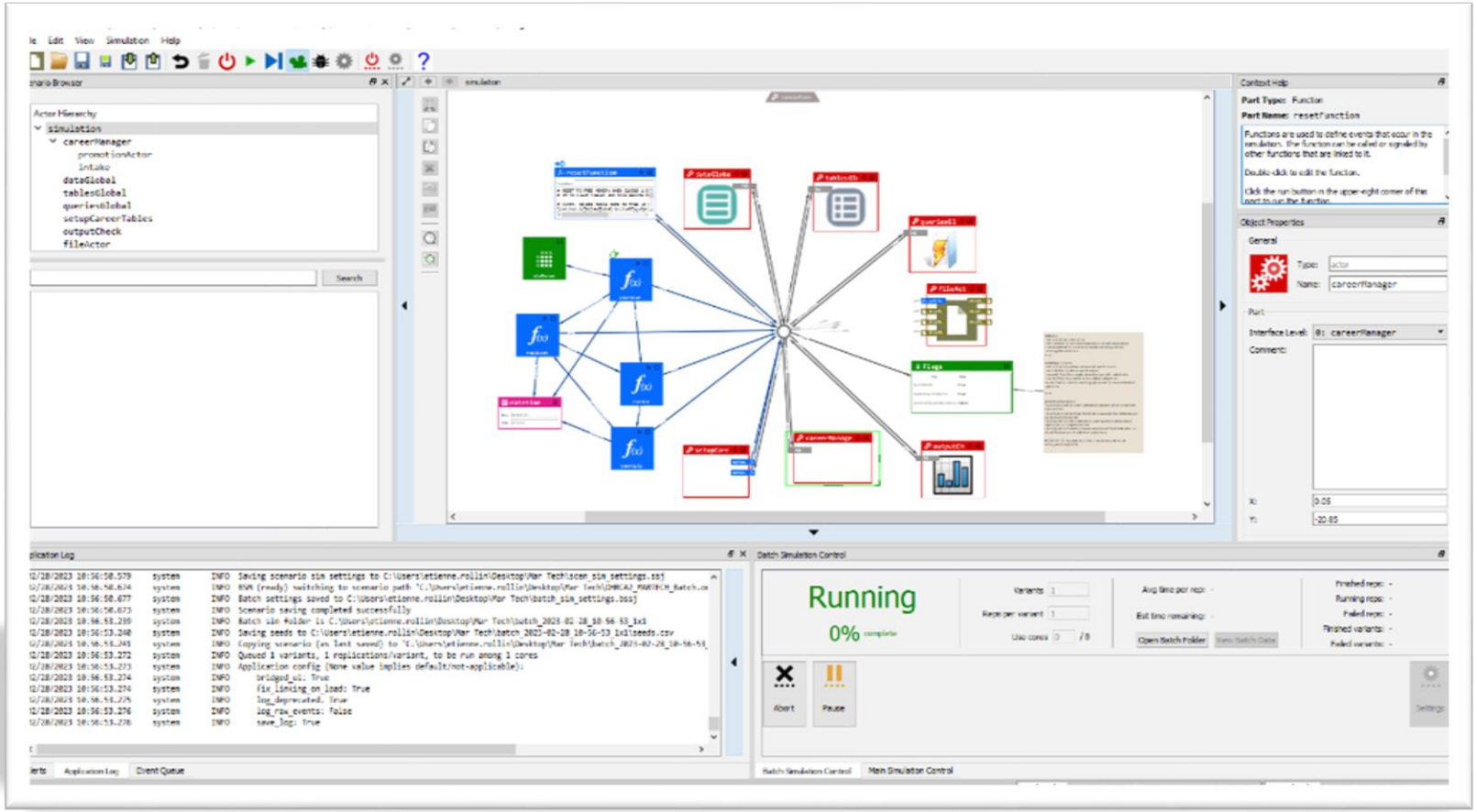
# Workforce Modelling:  DGMPRA Models

- Long Range Planning Model (LRPM): Excel-based, fast, reliable and does not require a special software used to set the Strategic Intake Plan (SIP).
- Occupational Structure Sustainability Model (OSSM). Excel-based, used to evaluate occupation structures to ensure that they will be sustainable in the long term (steady state).
- (new) OHRCA2: ORIGAME-based, using the Python programming language. Discrete event Monte Carlo simulation, highly customizable but more complex and can readily handle scenarios that are not in a steady state.

# ORIGAME

Python-based discrete event programming environment created by Canada's Department of National Defence a few years ago.

Open source as of September 2023.
Accessible on Github.

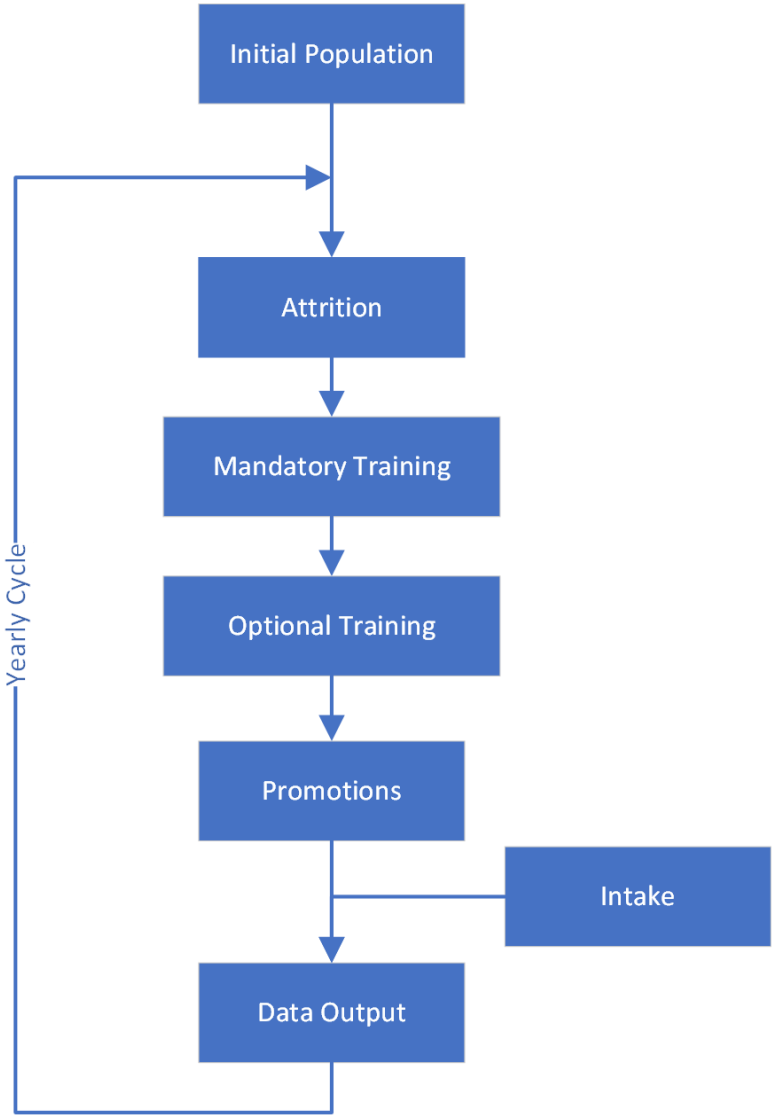



https://github.com/DND-DRDC-RDDC/OS_ORIGAME

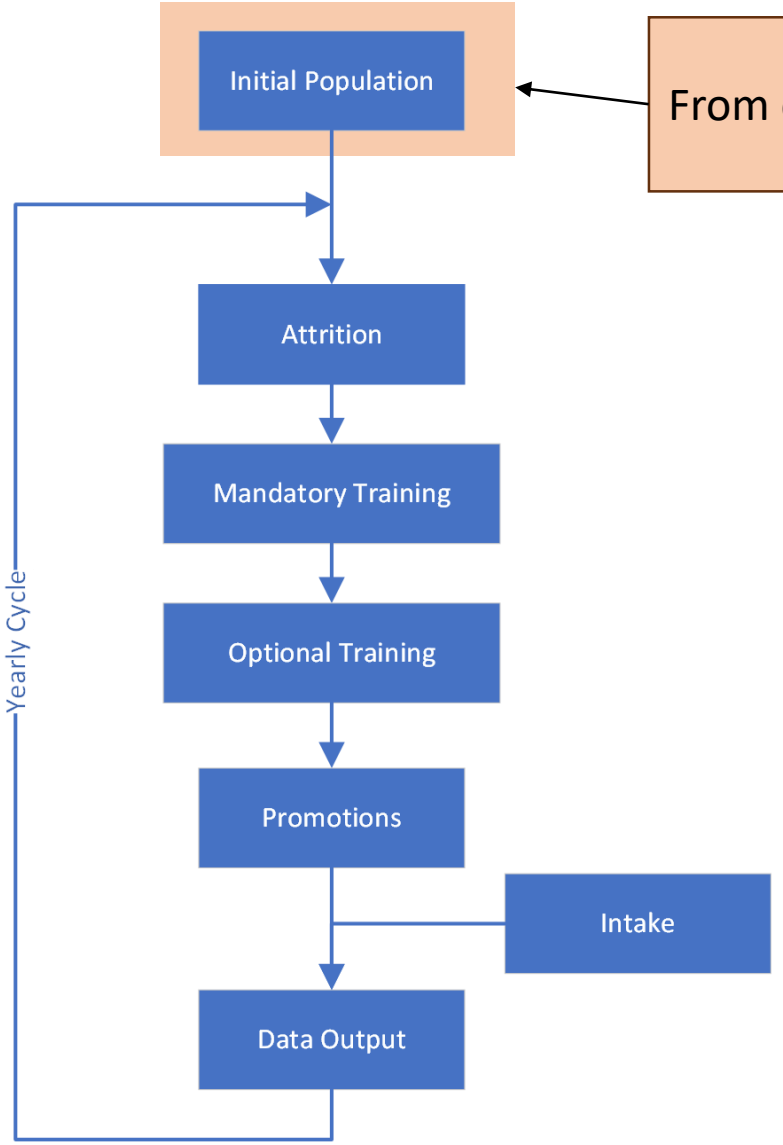
# OHRCA2 – Features

- OHRCA2 is a discrete event Monte Carlo simulation. Each individual takes part in different events (training, promotion, attrition, etc...) and random numbers associated to an algorithm specify the outcome of each event.
- It is possible to simulate a scenario with a different random number seeds to explore alternate outcomes and explore the range of likely results, allowing for a risk analysis.
- It can manage one or a few occupations (sub-occupations, specializations, etc...).
- Allows users to modify parameters and algorithms to investigate what-if scenarios.
- Can be fully customized (attrition/intake conditions, promotion rate, sub-occupation features, training).

# OHRCA2 Flow Diagram



# OHRCA2 Flow Diagram



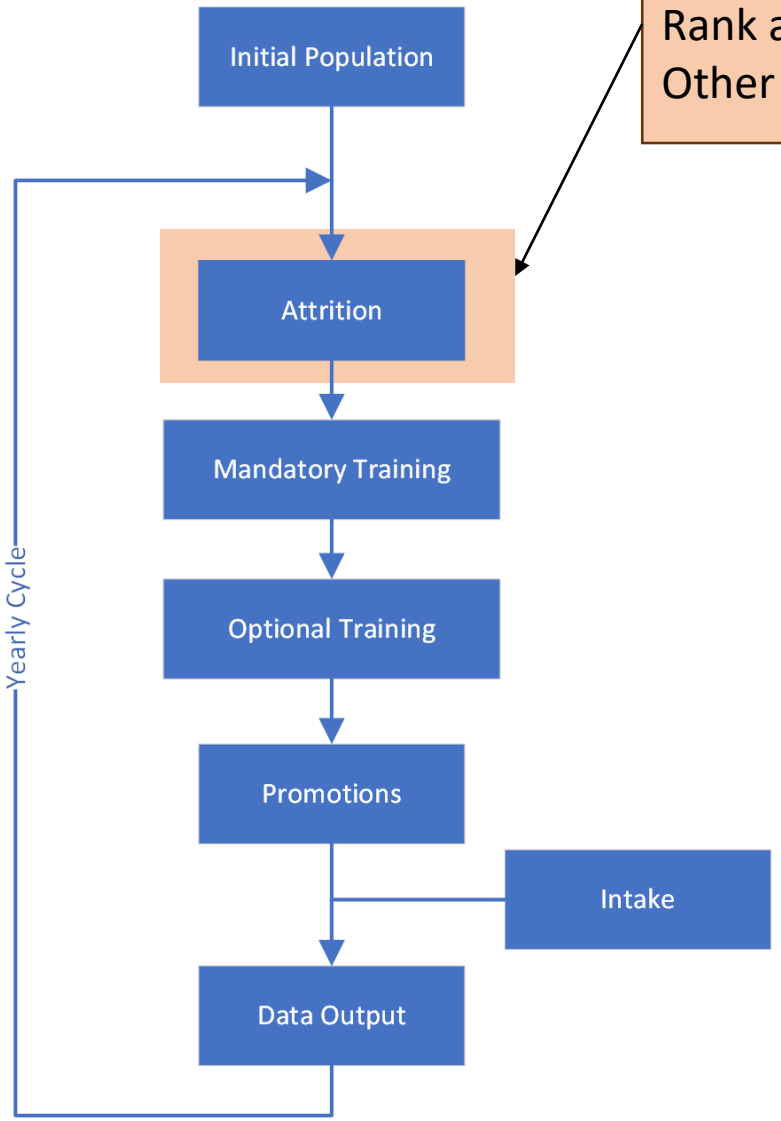

From our Human Resources (HR) System database extracts.

```
PersID: 1
YOS: 21
AGE: 53
MOSID: 153
Rank: WO
StreamID: 2
Quals: ...
```

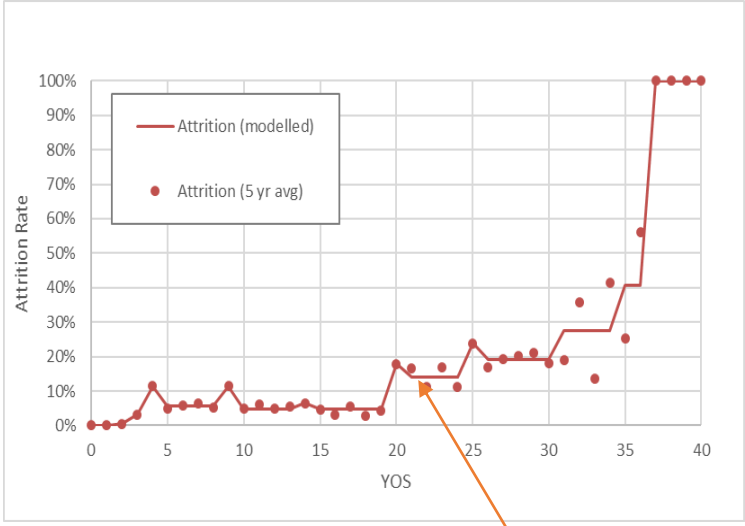
```
PersID: 2
YOS: 1
AGE: 23
MOSID: 223
Rank: Avr(T)
StreamID: 1
Quals: ...
```

...

# OHRCA2 Flow Diagram




Calculated from the HR data.
Rank and/or Years of Service (YOS)-based.
Other conditions can be added.

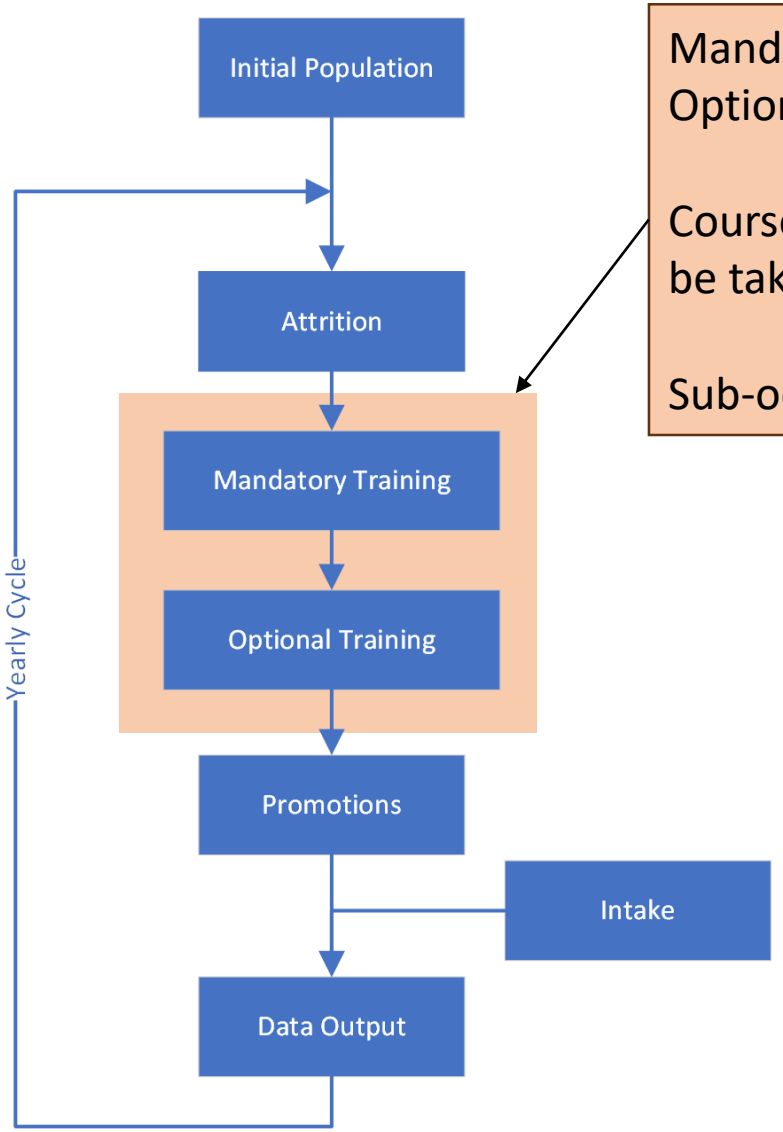



```
PersID: 1
YOS: 21
AGE: 53
MOSID: 153
Rank: WO
StreamID: 2
Quals: ...
```

84%

16%

# OHRCA2 Flow Diagram

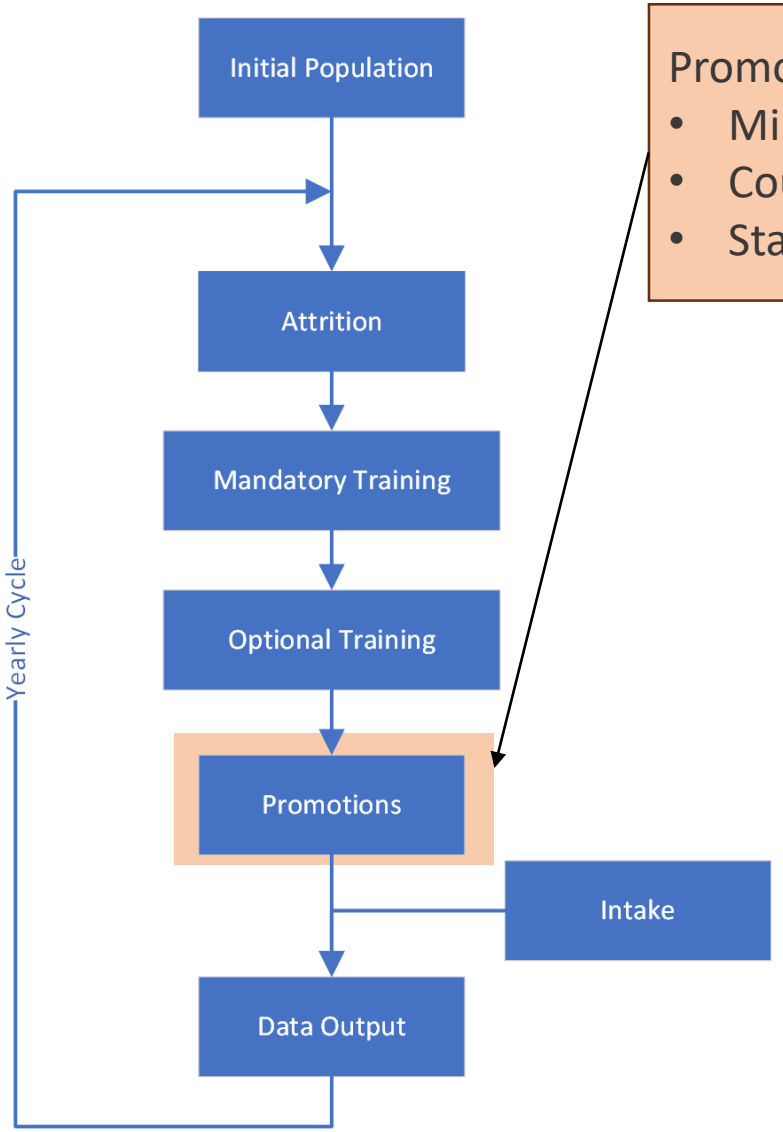



Mandatory training is required for promotions while Optional courses do not play a role in promotions.

Course length, capacity/frequency and pre-requisites can be taken into account.

Sub-occupations can have different training schemes.

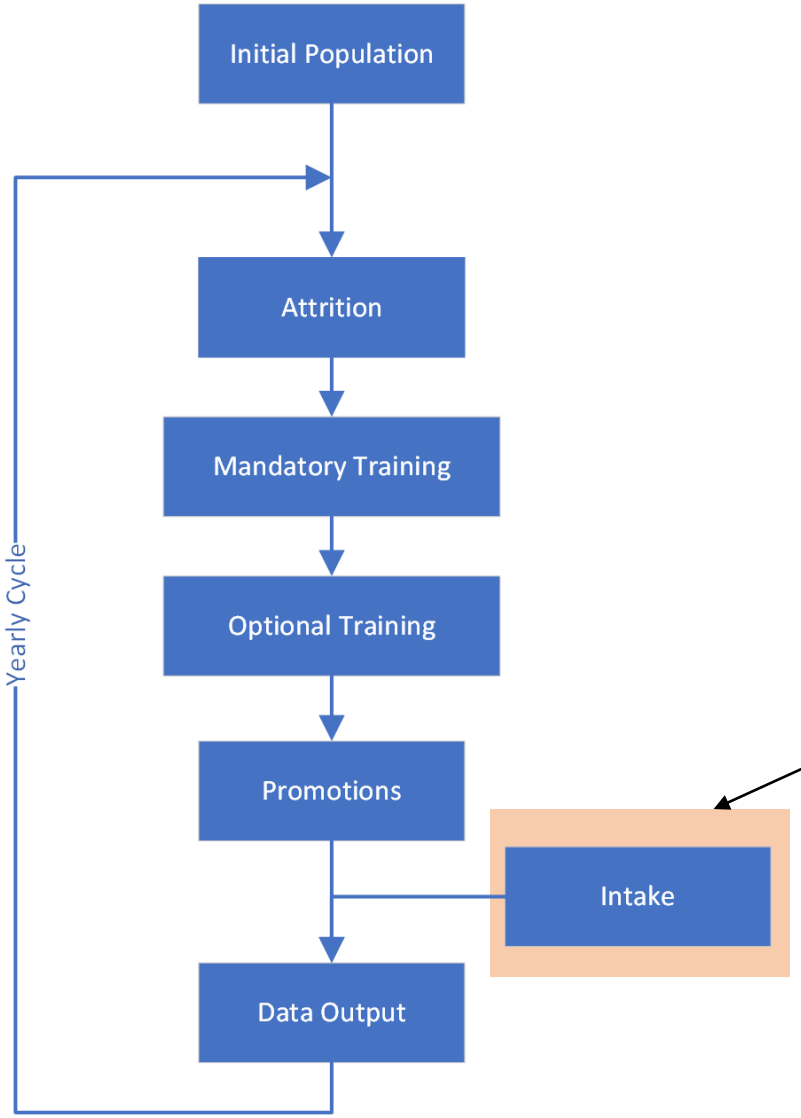
# OHRCA2 Flow diagram




Promotions can take into account:

- Minimum TIR.
- Course requirements.
- Staffing levels.

# OHRCA2 Flow Diagram

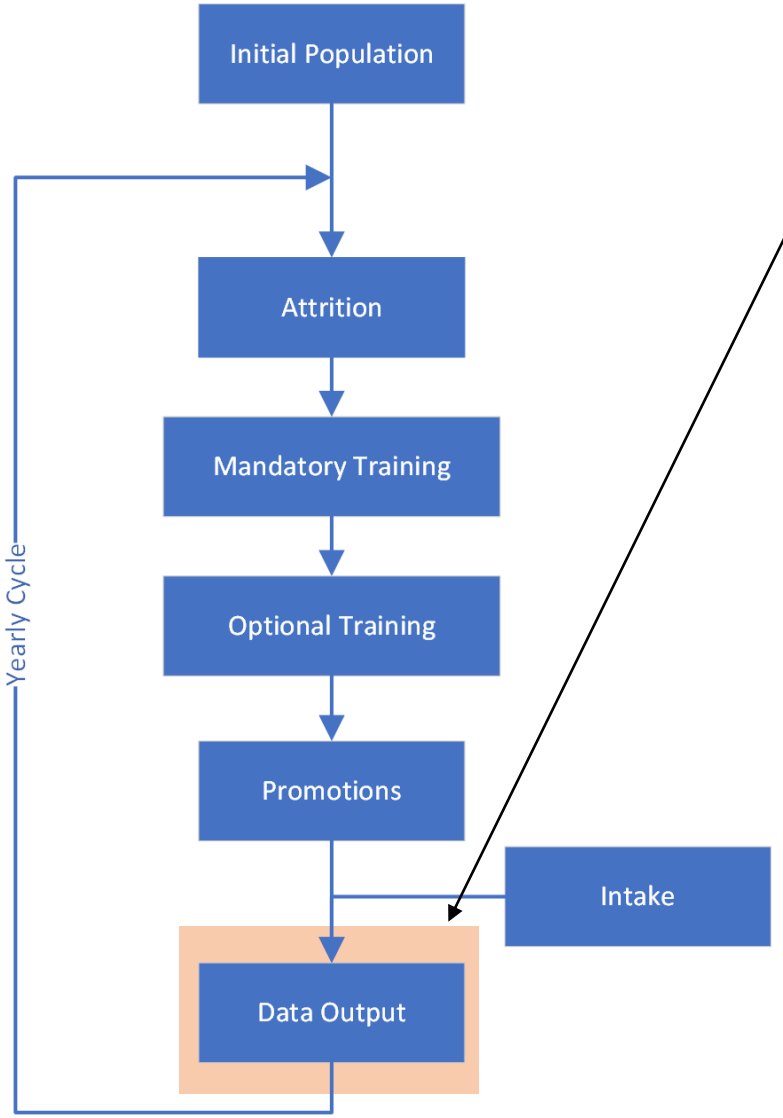



Intake is fully customizable.

Different Entry Plans can be defined leading to a different YOS/TIR/Age distributions and Course attributes.

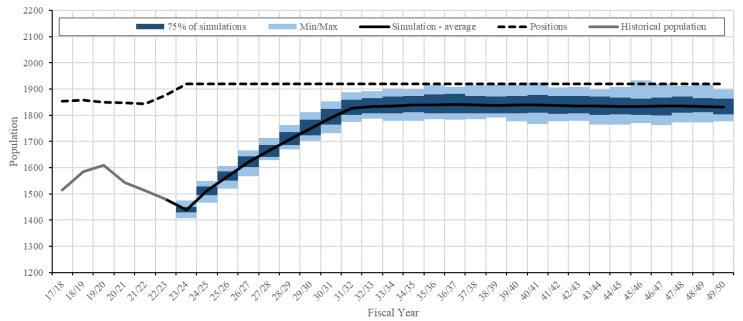
New members are added at the end of the year and their attrition is accounted for.

# OHRCA2 Flow Diagram




Data Output contains both pre-determined graphs and text files for offline analysis (yearly snapshots, intake, attrition, promotion and training tables).

| Replication | RunYear | PersID | RankID | YOS | YCS | TIR | MOC | EntryType | Engagement | AGE | MOSID | DSCR | StreamID | Class |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 1 | 13 | 22.01 | 0 | 5.33 | 8 | 0 | W | 48 | 8 | R | 8 | Halifax |
| 1 | 0 | 2 | 13 | 32.19 | 0 | 6.81 | 4 | 0 | E | 24 | 4 | R | 4 | Halifax |
| 1 | 0 | 3 | 13 | 18.21 | 0 | 0.33 | 8 | 0 | W | 42 | 8 | R | 8 | Halifax |
| 1 | 0 | 4 | 13 | 11.05 | 0 | 1.22 | 4 | 0 | E | 56 | 4 | R | 4 | 0 |
| 1 | 0 | 5 | 14 | 23.41 | 0 | 5.43 | 8 | 0 | W | 49 | 8 | R | 8 | 0 |
| 1 | 0 | 6 | 14 | 23.54 | 0 | 1.05 | 8 | 0 | W | 58 | 8 | R | 8 | Halifax |



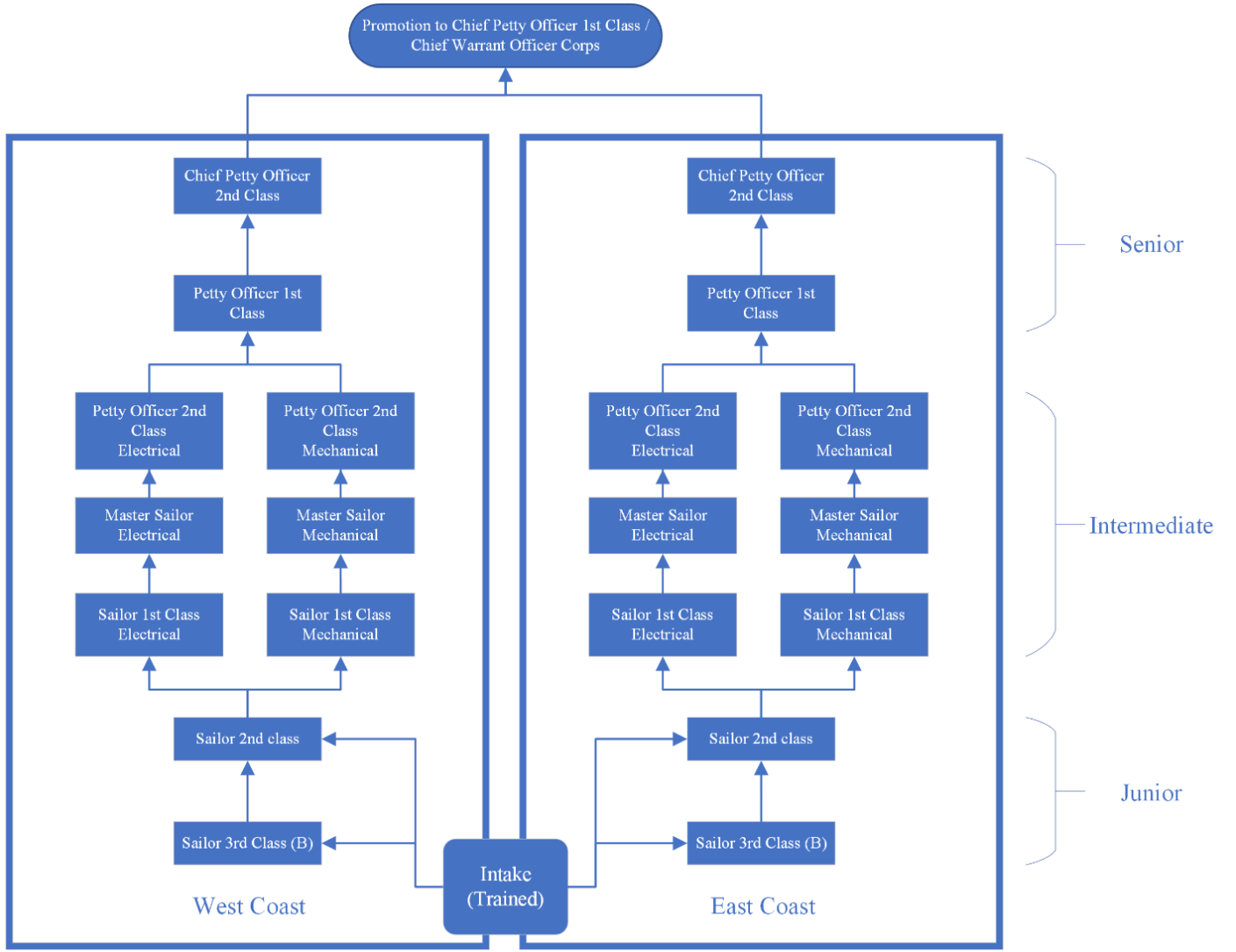
# Case Study: Marine Technicians Rank Structure

- Two coasts.
- Two specializations for intermediate ranks.
- Three rank levels.

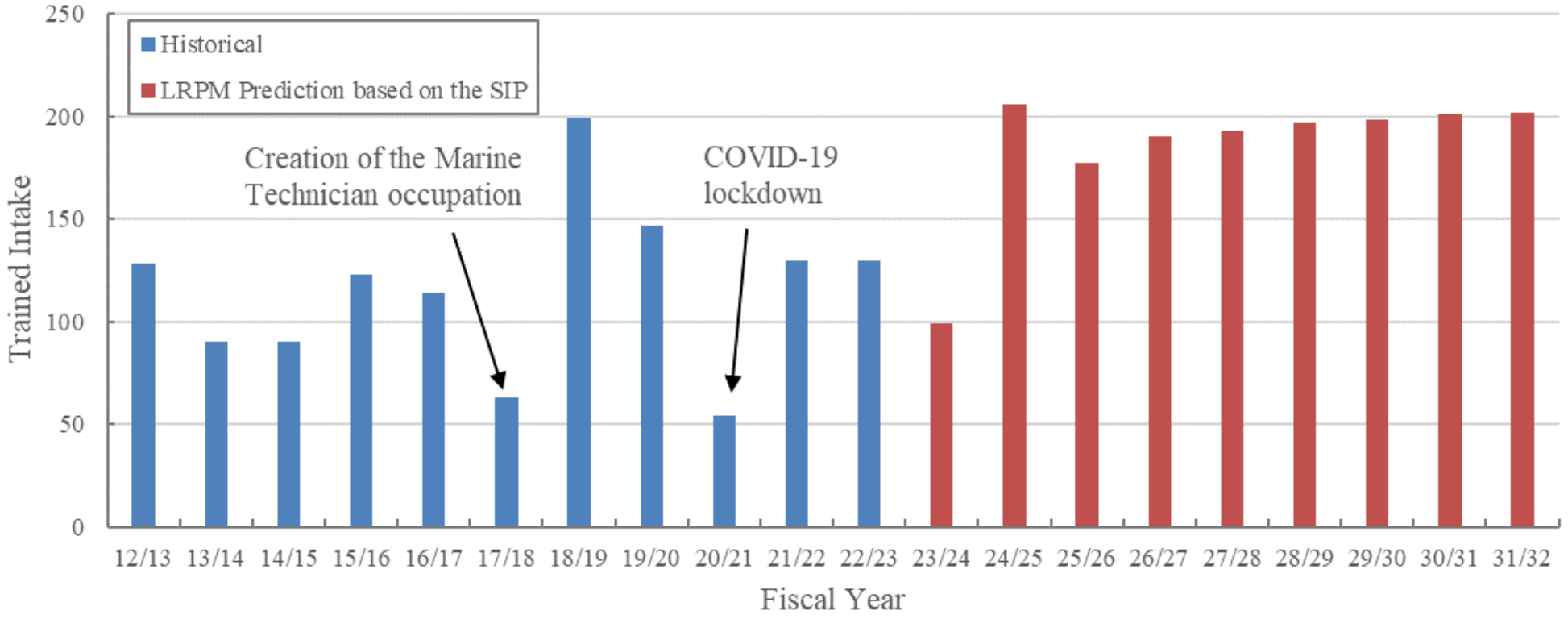
Promotion is based on minimum Time in Rank (TIR) and tries to balance the staffing levels of ranks. Training is not yet considered for promotions.

Intake is done at the Trained level and includes Component Transfers (CT) and Occupation Transfers (OT).

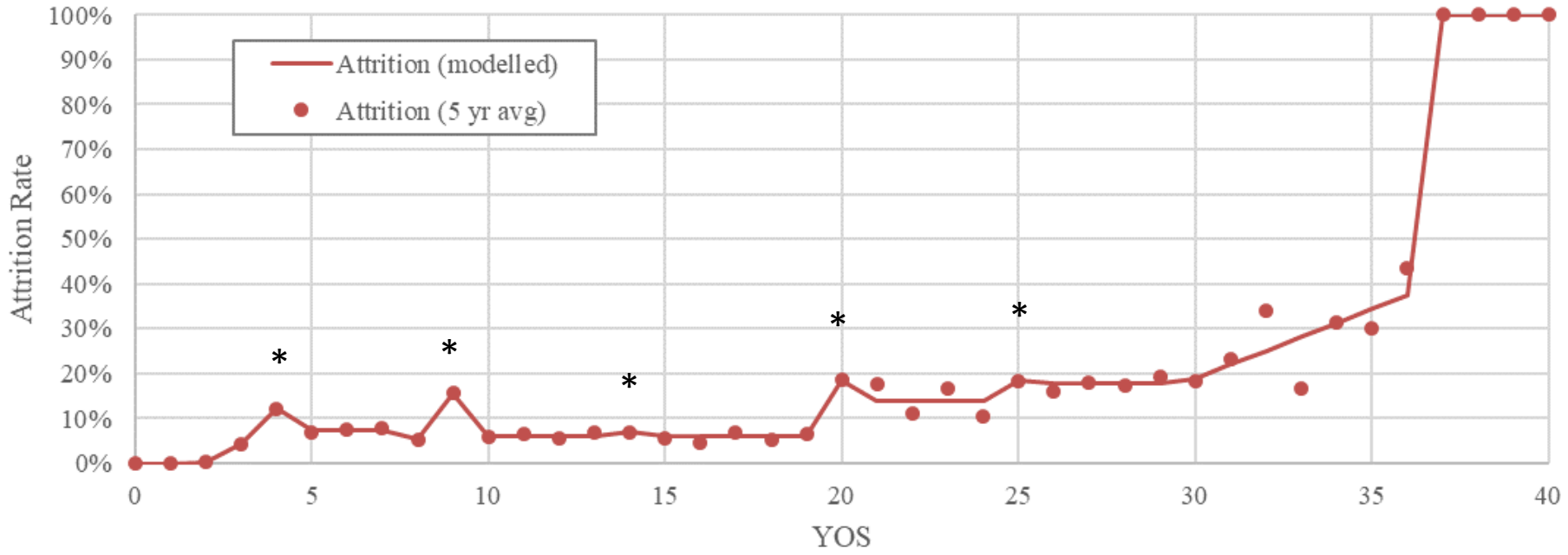
Trainee attrition is modelled separately.



# Input Data - Intake (OFP)



# Input Data - Attrition Rate

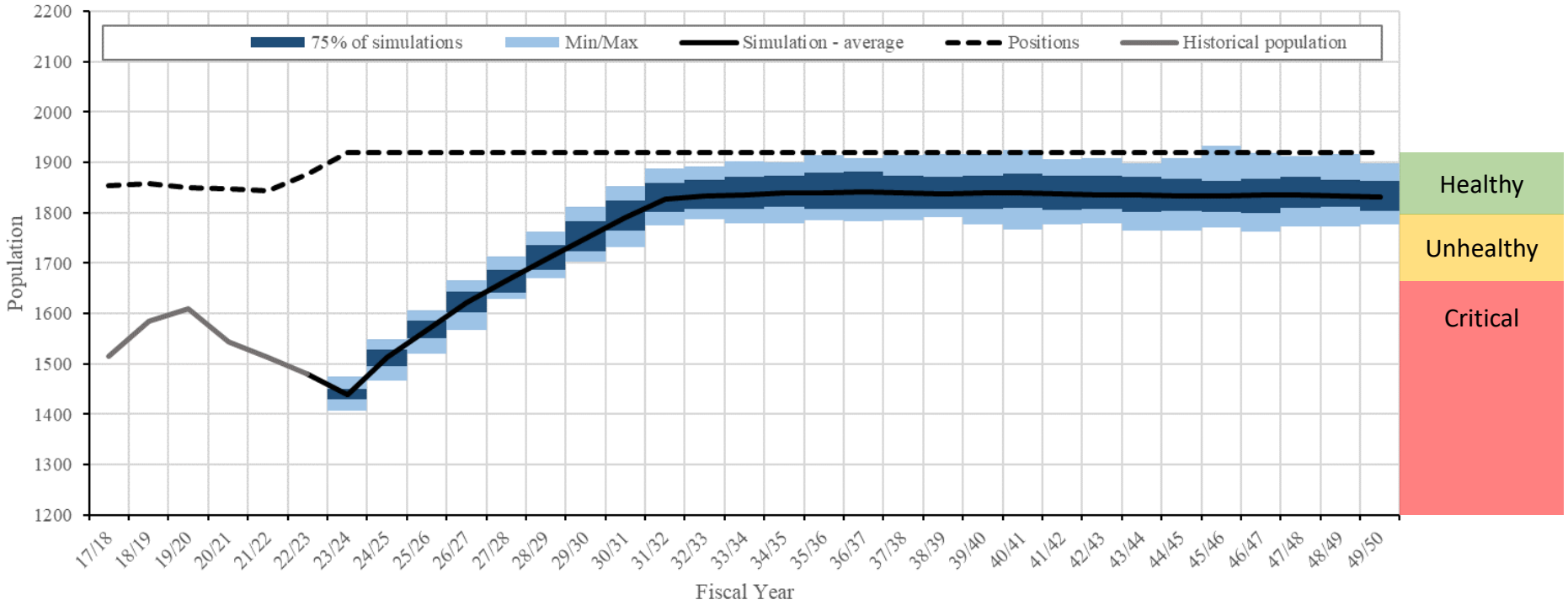



In this case, Occupation Transfers (OT) and Component Transfers (CT) are included in the attrition rate.

Only includes Trained members.

* Represent the end of an Engagement Contract for a typical Marine Technician Career

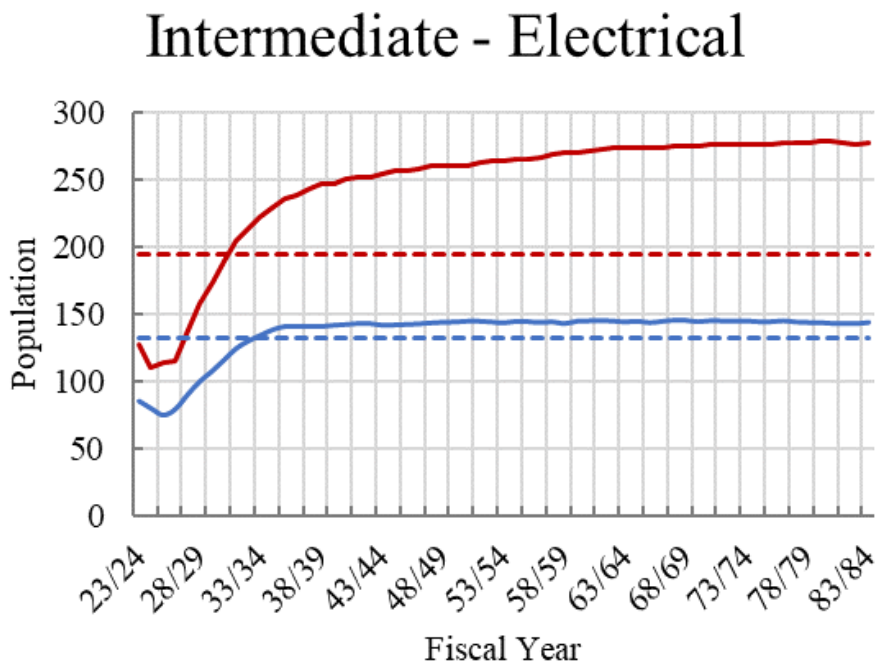
# Example of Results (100 simulations)*

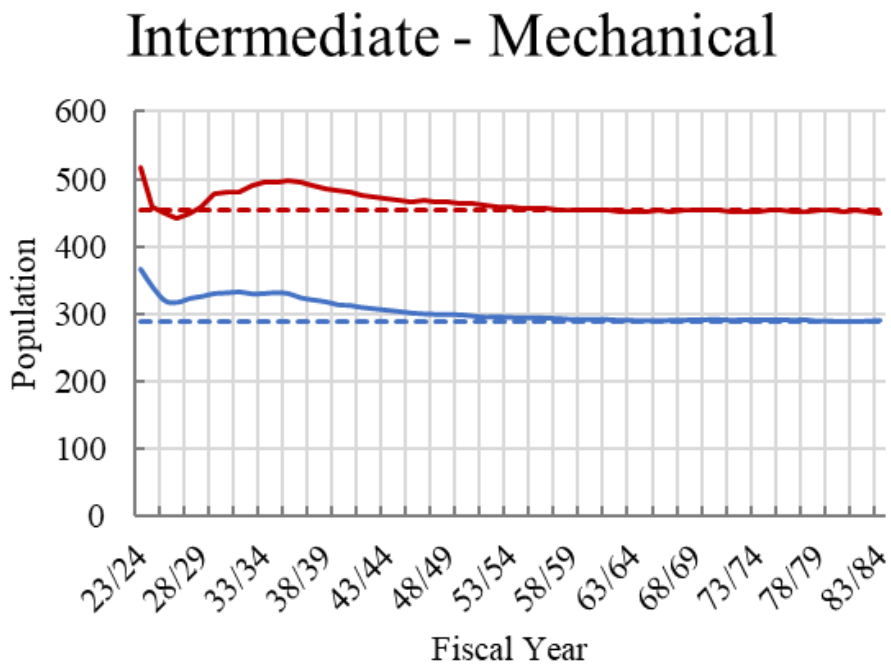



*Assuming SIP is achieved every year

# Example of Results - Details

Looking at the results for specific levels can reveal imbalances in certain rank bands or specializations.



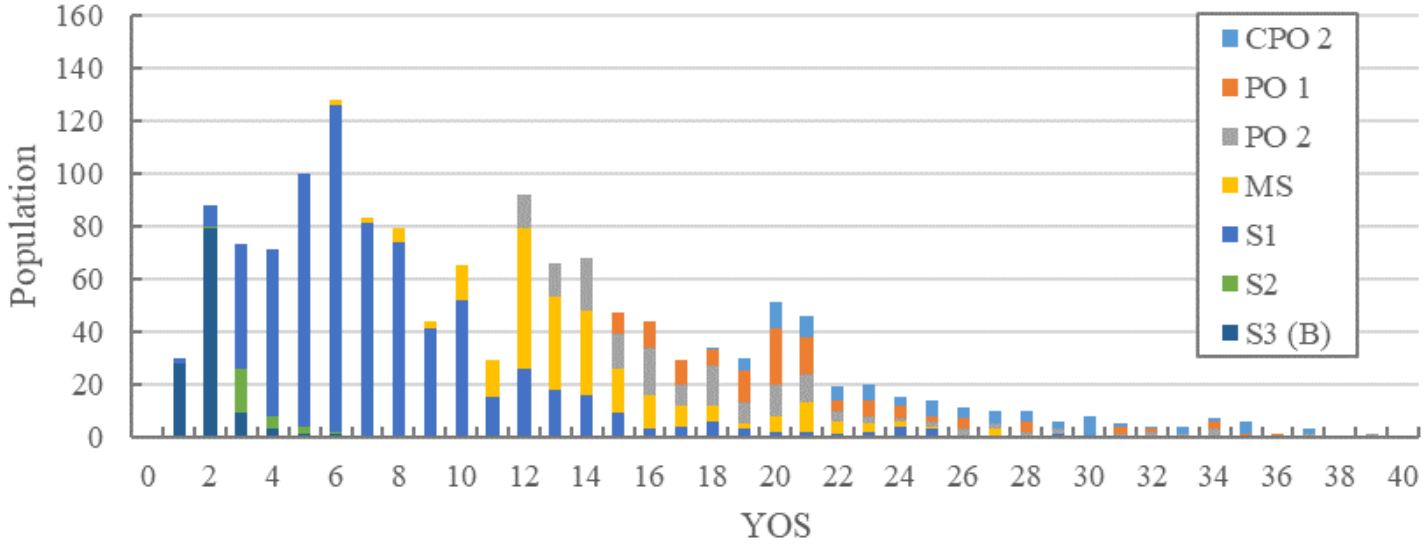





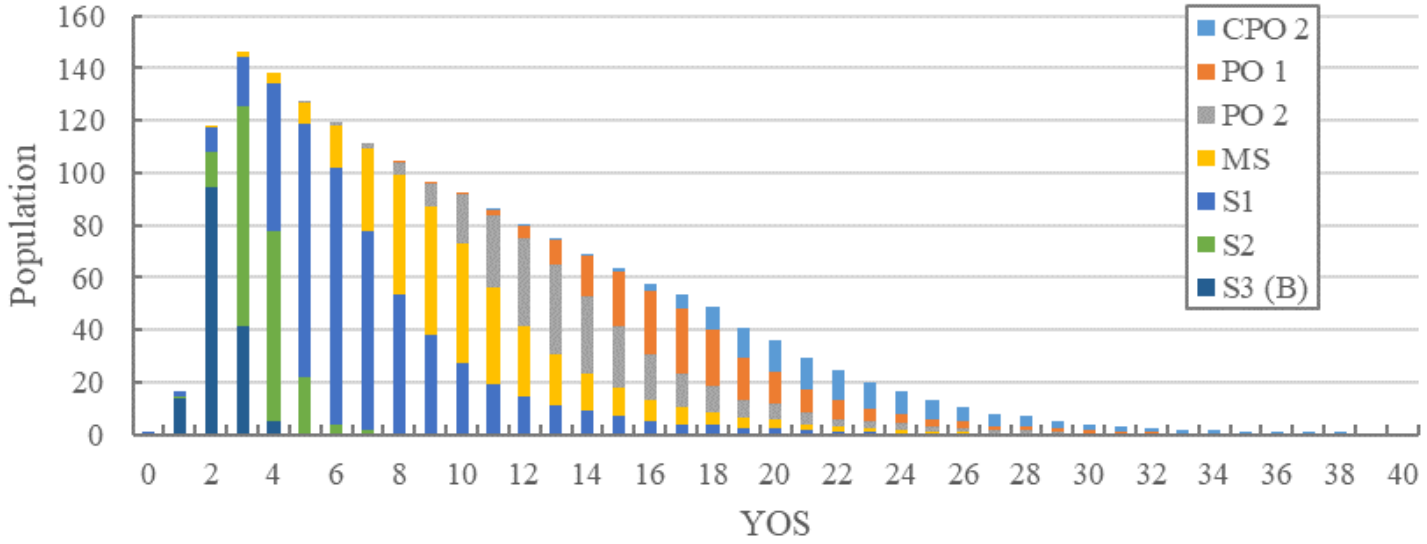
*PML = Preferred Manning Level
(Number of positions available)

# Example of Results

Current



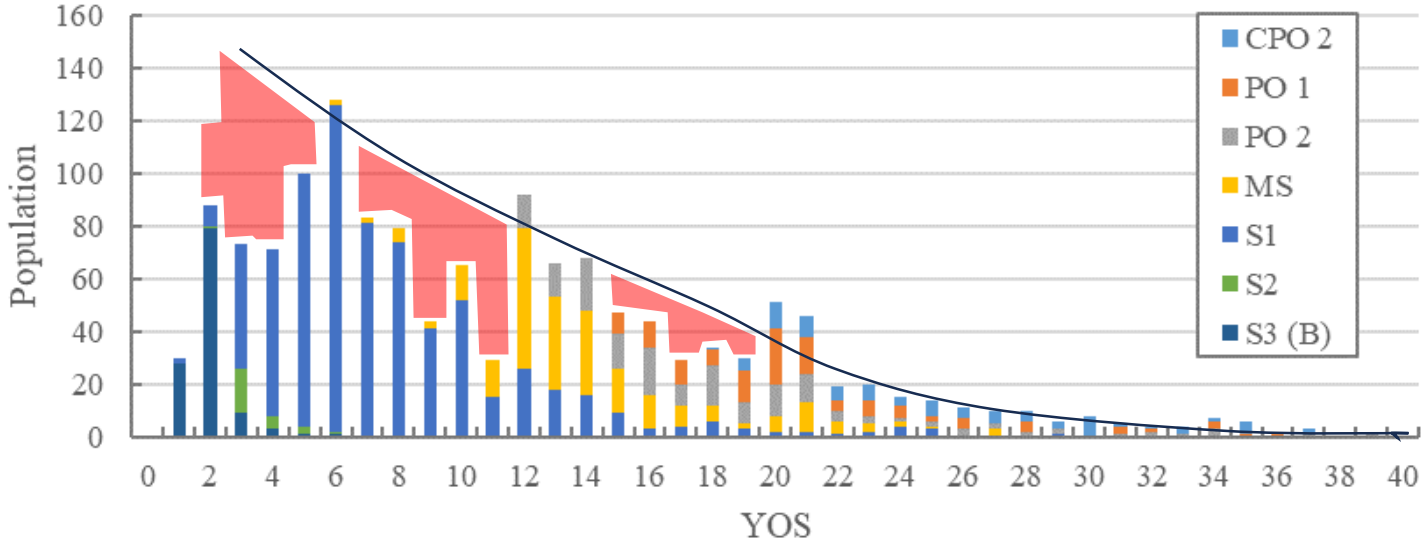

Steady State
(>40 years)




| CAF Navy Rank | CAF Navy Rank | NATO code |
|---|---|---|
| Chief Petty Officer 1st Class | CPO 1 | OR-9 |
| Chief Petty Officer 2nd Class | CPO 2 | OR-8 |
| Petty Officer 1st Class | PO 1 | OR-7 |
| Petty Officer 2nd Class | PO 2 | OR-6 |
| Master Sailor | MS | OR-5 |
| Sailor 1st Class | S1 | OR-4 |
| Sailor 2nd Class | S2 | OR-3 |
| Sailor 3rd Class (Basic) | S3 (B) | OR-2 |
| Sailor 3rd Class (Recruit) | S3 (R) | OR-1 |

# Example of Results

Current

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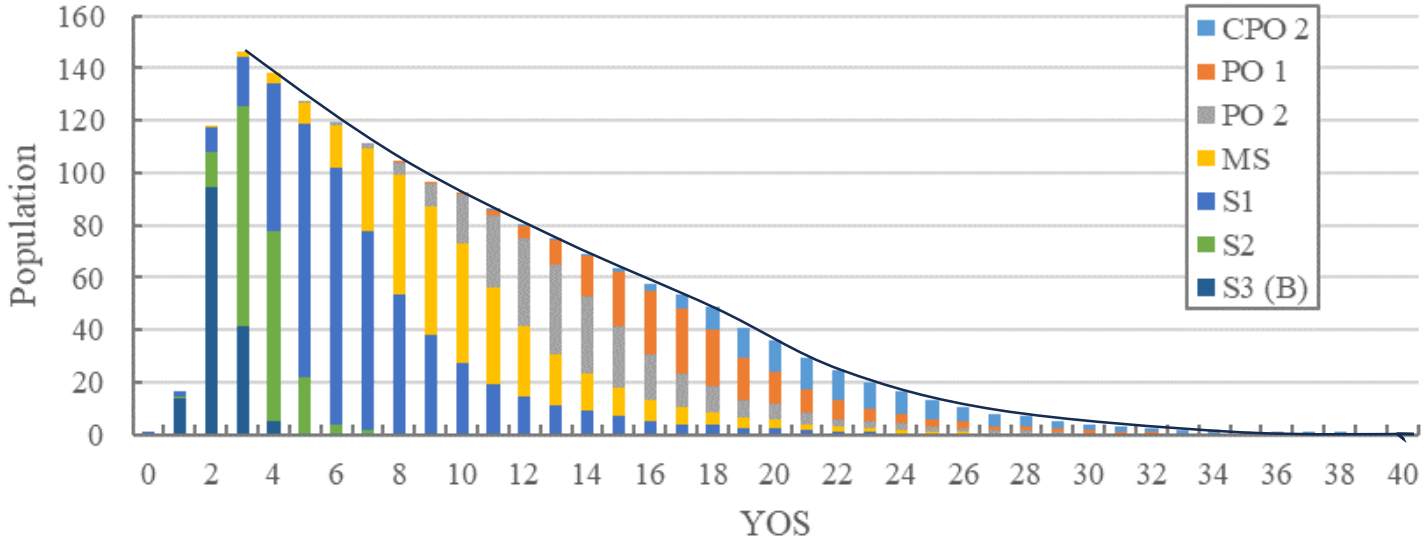


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| Sailor 3rd Class (Basic) | S3 (B) | OR-2 |
| Sailor 3rd Class (Recruit) | S3 (R) | OR-1 |

# Examples of Possible Analysis Using OHRCA2

- Determine the intake required to reach adequate staffing levels.
- Estimate the average TIR at promotion.
- Anticipate training attendance and backlogs.
- Explore the effect of changing a hiring plan.
- Project the experience profile of members after a sudden perturbation in recruitment.
- Observe the evolution of a newly created occupation.
- Quantitively measure the risk of an occupation becoming unhealthy, given some assumptions.
- Follow the flows of feeder-receptor occupations based on current populations and historical trends.

# Conclusion

- OHRCA2 is a discrete event Monte Carlo simulation model used to project Military Workforce by taking into account individuals' attributes to determine their career path.
- Useful for more complex occupations or for systems that are not in a steady state. It can take weeks if not months to model run and analyze the model depending on its complexity.
- Although OHRCA2 is not available to share for now, its programming environment (ORIGAME) is now open source, free and available to everyone.

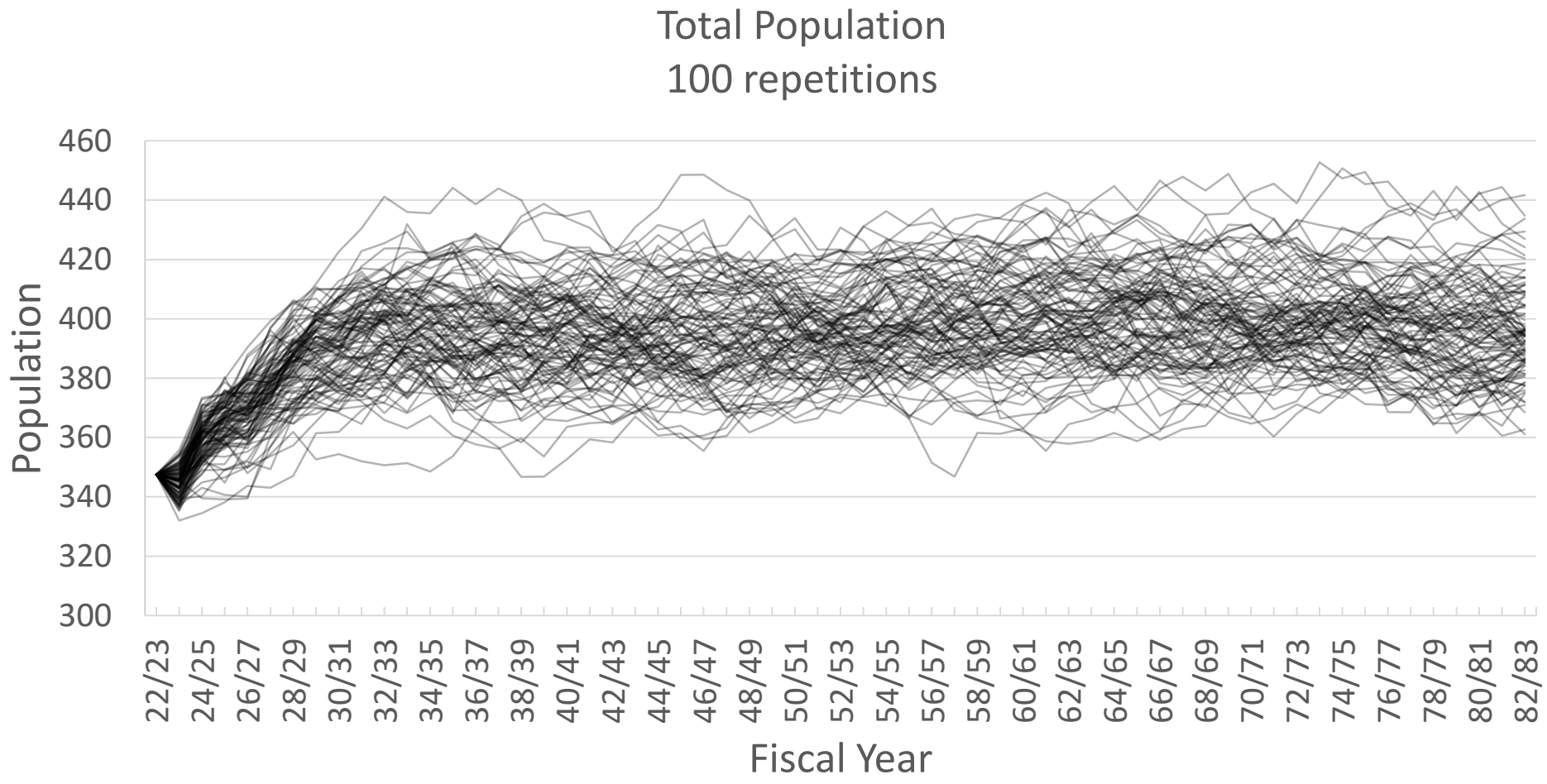
- Questions? Comments?

# Extra slides

# OHRCA2

***O**RIGAME **H**uman **R**esources **C**areer **A**nalysis **2***

***O**perational **R**esearch **I**ntegrated **G**raphical **A**nalysis and **M**odelling **E**nvironment*


Total Population
100 repetitions
Population
460
440
420
400
380
360
340
320
300
22/23
24/25
26/27
28/29
30/31
32/33
34/35
36/37
38/39
40/41
42/43
44/45
46/47
48/49
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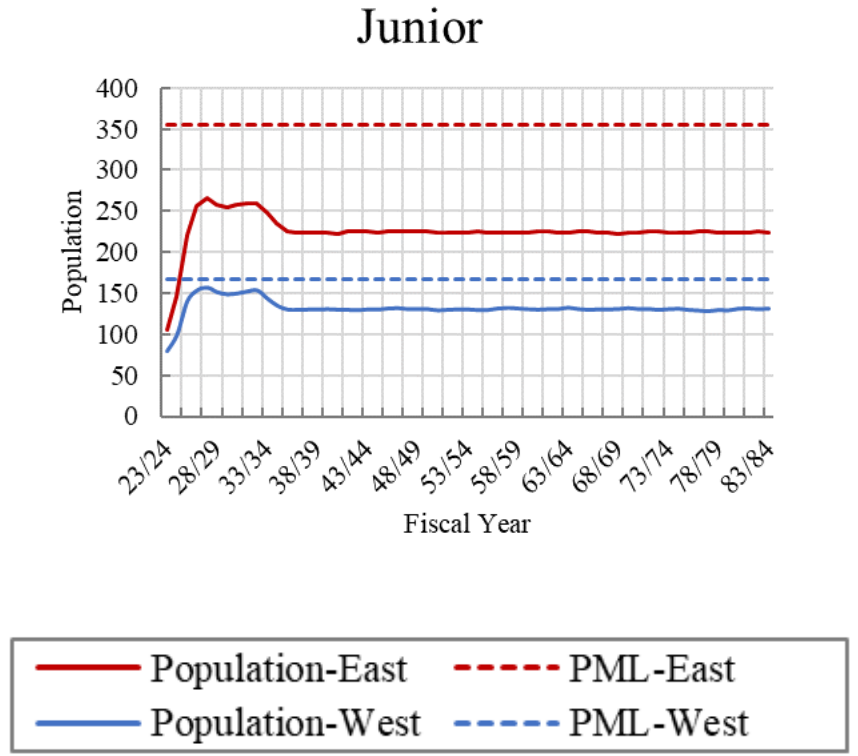
54/55
56/57
58/59
60/61
62/63
64/65
66/67
68/69
70/71
72/73
74/75
76/77
78/79
80/81
82/83
Fiscal Year

# Example of Results – Details

Looking at the results for specific levels can reveal imbalances in certain rank bands or specializations.




For junior ranks, promotions don't require a vacant position in the rank above to happen.

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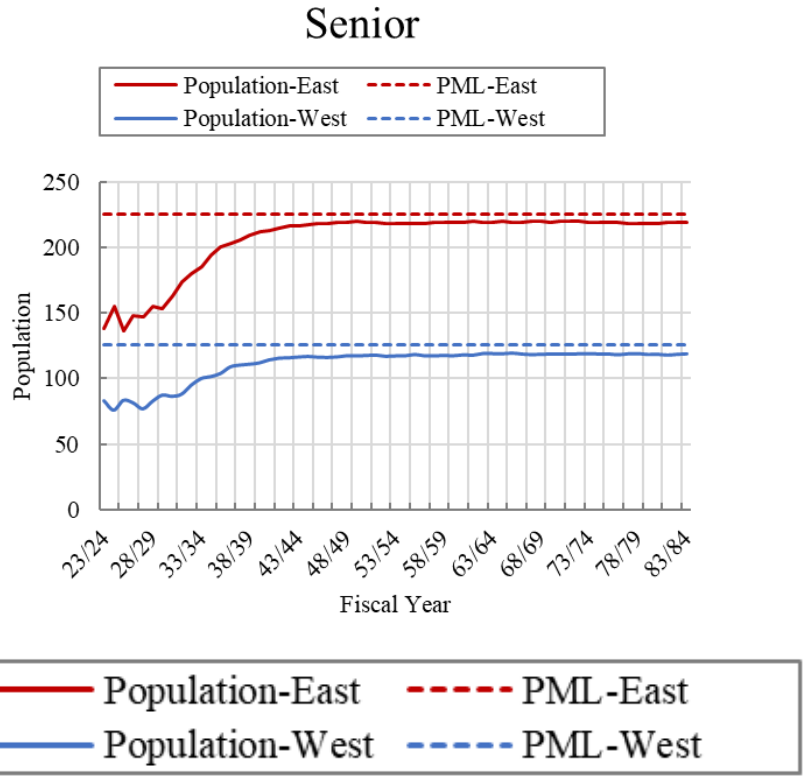


# OHRCA2 – Features (2)

- Uses Python (within the ORIGAME environment) as the underlying programming language and allows importing Python modules.
- Reads input data from Excel, Access or text files.
- Exports information as predefined graphs but logs all the information in text files that can be analyzed offline later on.

# Outline of the Presentation

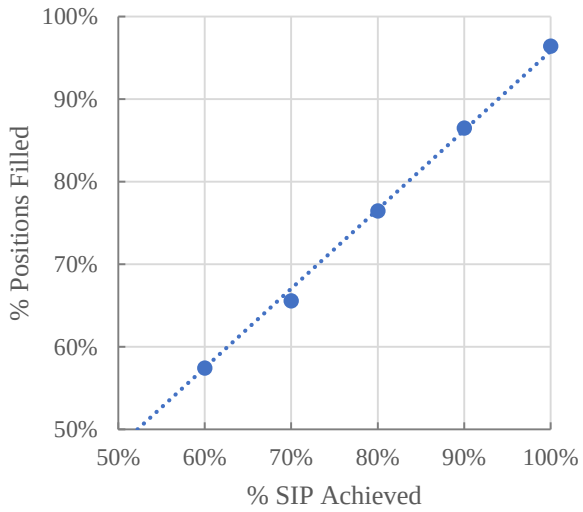
- Why workforce modelling is important.
- Description of the OHRCA2 model.
- Case Study: the Maritime Technician occupation.

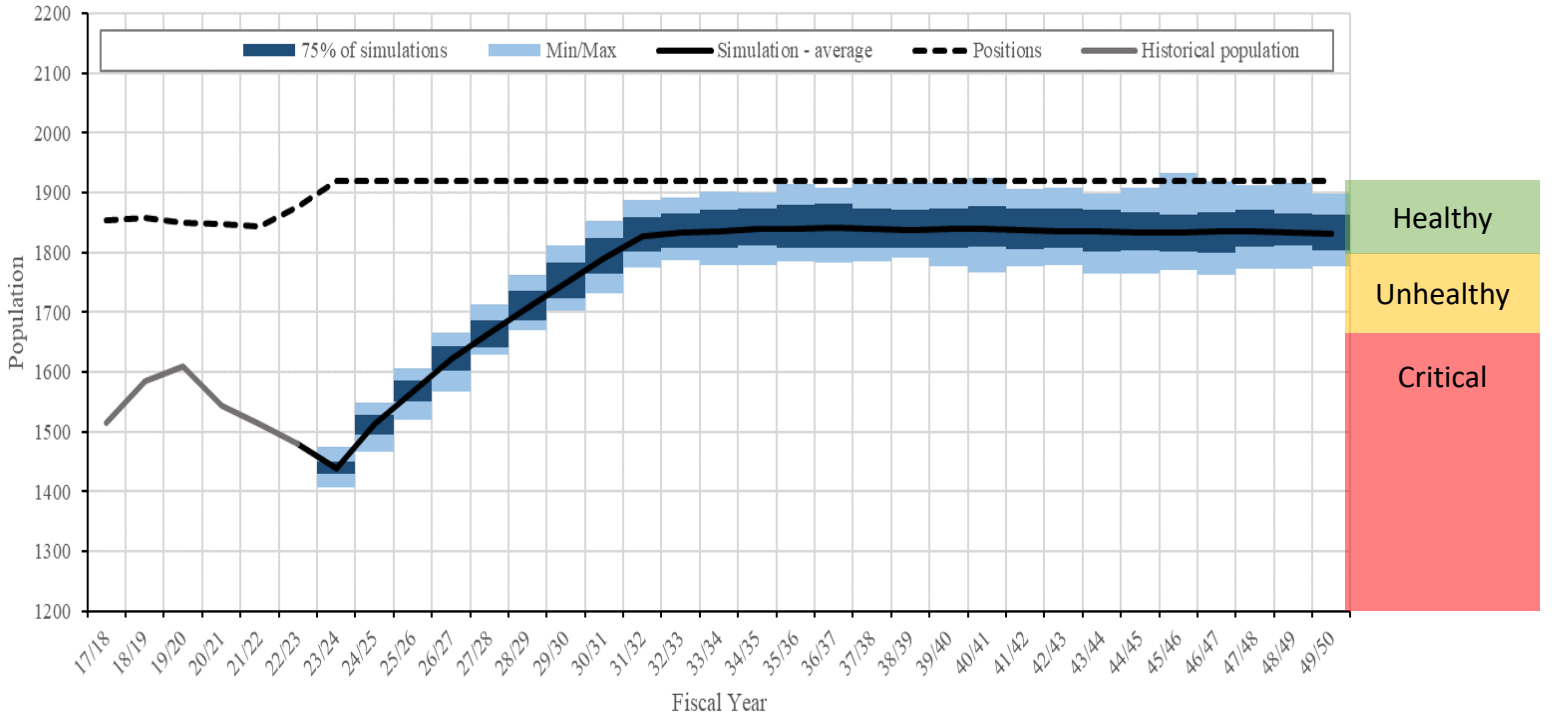
# Workforce Modelling: What Can it Do?

- Simulations show projections of the health of the workforce, given some assumptions, and allows to prepare for or alter possible scenarios.
- It can be used to explore the effects of changing policies by including events modifying intake, attrition, promotions, transfers and training.
- It can also identify key warning signs that can potentially lead to problems or validate that recovery is on the right path.

# Example of Results (100 simulations)*

Note: The outcome of not achieving SIP is fairly straightforward. Missing the target by 1% consistently leads roughly to a 1% drop in the staffing level.




*Assuming SIP is achieved every year