



Executive summary

Missionland: User Needs for a Virtual Continent


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As training via distributed mission simulation has the potential to enhance force readiness and operational effectiveness in coalition operation. An essential condition for an effective mission simulation environment is a correlating representation of the real-world natural and cultural environment in the distributed

simulations. Correlating existing environment databases is costly, both in effort and in money, and the end-result will always be hampered by technical incompatibilities. It also does not address security and political limitations. A generic and geo-unspecific, widely available simulation environment could overcome these problems.

This report is based on a presentation held at the EURO SIW, Ottawa, Canada, 13 July 2010.

Description of work

In 2008 the NATO RTO task group MSG-071 Missionland started. Its prime objective is to construct a coherent dataset of the static environment, from which databases can be constructed for a wide scope of simulators – from henceforth this coherent dataset is referred to as Missionland. As a basis for the Missionland user needs analysis, the task group developed and issued a questionnaire. The purpose of the questionnaire was to identify potential users and their requirements for Missionland. The questionnaire answers were analysed by the task group members for three different areas: the intended use of Missionland; the requirements for the data sets; and the development and maintenance of the data sets.

Results and conclusions

The primary intended use of the Missionland dataset will be training, both in distributed and stand alone simulations. In addition, concept development & experimentation and doctrine study are also areas where Missionland can be used. To satisfy the priorities of the different branches in the armed forces, Missionland should contain at least the following 5 terrain types: coast; mountains; urban, eastern; sea; and urban, western. The size of

Missionland will have to be at least 1000x1000 km to satisfy most potential users, although it should be noted that there is a significant group demanding an even larger area. It's no surprise that the users expect the Missionland dataset to provide a complete range of products. For a minimum level of usability the dataset should include: maps, vector data, terrain texture, elevation data, aerial imagery and feature models.

The majority of users expect Missionland dataset delivery format to be supplied using industry standards (e.g. shapefiles, geo-tiff, etc), but there are also requests for CDB, SEDRIS and compiled OpenFlight. The development of the dataset should be a continuous process.

Applicability

The results from this user needs investigation form the basis of the Missionland design. It gives inputs to draw the outline and define the contents of the Missionland continent. With these results the technical design of the Missionland data sets and the data generation process can be developed. Finally it gives a perception of how the users would like to maintain the dataset and how they would like to contribute new elements.



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Missionland: User Needs for a Virtual Continent

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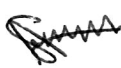


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Missionland: User Needs for a Virtual Continent

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ABSTRACT: Training via distributed mission simulation has the potential to enhance force readiness and operational effectiveness in coalition operations. An essential condition for an effective mission simulation environment is a correlating representation of the real-world natural and cultural environment in the distributed simulations. Correlating existing environment databases is costly, both in effort and in money, and the end-result will always be hampered by technical incompatibilities. It also does not address security and political limitations. Therefore it is preferable to create a generic and geo-unspecific simulation environment, Missionland.

In 2008 the NATO RTO task group MSG-071 'Missionland' started. Its prime objective is to construct a coherent data set from which simulation environment runtime databases can be constructed for a wide scope of simulators operating in air, sea and land domains. As a basis for the Missionland user needs analysis, the task group developed and issued a questionnaire. The purpose of the questionnaire was to identify potential users and their requirements for Missionland. The questionnaire answers were analysed by the task group members for three different areas: the intended use of Missionland; the requirements for the data set; and the development and maintenance of the data set. This paper describes the user needs for the Missionland data set.

1. Introduction

Imagine ... a whole new continent is planted in the middle of the Atlantic Ocean. It is a continent with a variety of climate and eco system types: arctic cold, tropical green, warm deserts and more are represented in this intriguing continent that is populated with a ditto variation of cultures. The most interesting feature of this new continent is that it has a very enthusiastic and well-equipped Modelling & Simulation Geodata Office that is capable of delivering whatever data you need to enable simulated exercises on their continent. Everything is available - remote sensing imagery, ground imagery, terrain elevation data, detailed vector data and all required model libraries - to give your simulators a kick start into (networked) simulation exercises on this continent.

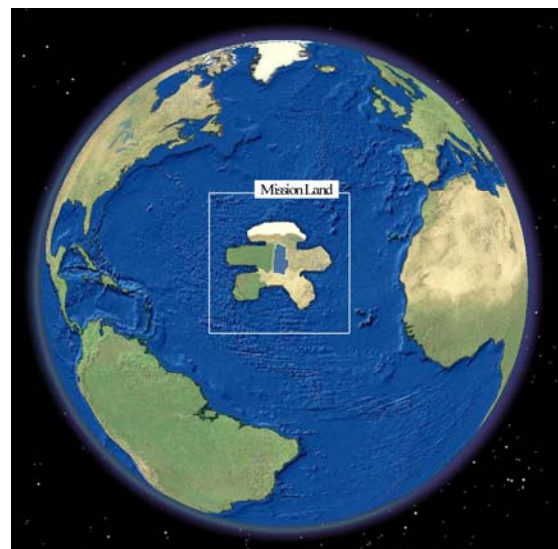


Figure 1: Imagine a new continent: Missionland (shown geography is random, not final)



The name of this new continent is *Missionland* and its creation was initiated in 2008 by the NATO task group MSG-071. The aim of the Missionland task group is to create a common data set of the static environment that can be used for simulation exercises. The focus is on the content itself, not on the way to store or represent it, as for example SEDRIS addresses. For more information on the approach of the Missionland task group see [1].

The paper starts with shortly explaining the rationale and the operational context for Missionland. Then the elicitation of the user needs for Missionland will be described. The intended use of Missionland is analysed and the user requirements for Missionland are derived. The development and maintenance requirements are identified. The paper ends with the following step of the Missionland task group and lays down the initial design of the Missionland continent.

2. Rationale and Operational Context

A simulation environment is a virtual representation of the real-world natural and cultural environment. Such an environment contains dynamic elements, for example weather, time of day and moving vehicles, as well as static elements, for example vegetation, buildings and infrastructure. When performing distributed (joint) simulations a number of problems exist concerning the selection and use of a simulation environment. These problems can either be caused by the different requirements of the participating users or by different technical capabilities.

An example of such a problem, are the different requirements on the level of detail for different forces, while the databases these forces use should still be correlated for the joint simulation. But even if the requirements on the environment database are the same, the difference between the technical implementation in two simulators might still make the reuse of the same simulation environment impossible. Creating different environments for each simulator has its own problems, as it is then required that these databases are correctly correlated with each other. Other limitations arise from a political point of view. For example the distribution of high resolution geographical data of a specific real world area to other countries is often subject to export restrictions due to national security issues.

The NATO RTO task group SAS-034/MSG-001 demonstrated with the Exercise First WAVE that training via distributed mission simulation has the potential to enhance force readiness and operational effectiveness in coalition operations [2]. The task group created a distributed training environment in

which flight simulators and other crew stations in the nations were linked across a secure wide area network. For four days, operational crews planned and briefed daily coalition air missions then flew them in a common synthetic battle space and debriefed the outcome. Many technical, operational and training challenges were encountered and addressed, providing a rich source of experience and lessons, with many deficiencies identified and consequential lessons learned.

To ensure that the correlation issues between the simulator databases were minimised the First WAVE Technical Task Team decided to use a common terrain database source which was used to generate the dedicated visual databases for each of the facilities. Normally, this is the best way to ensure the correlation of environment databases, but it is costly, both in effort and in money. In First WAVE the Canadian organisation Defence Geomatics undertook preparation of the common database, supported by a specialist database working group from the Technical Team. This group addressed issues including the selection of projections and imagery resolution, though this was in fact limited by the availability of source data at the resolution required [2].

These problems with the environment representation should be addressed but also the limited availability of source data due to security and political limitations must be addressed. Therefore it is preferable to create a generic and geo-unspecific simulation environment. Using a geo-unspecific environment, would also overcome the objections that result from using a real world area as basis for the simulation environment. And besides that, it also offers the advantage of combining geologically different environments in the same simulation environment. This makes a generic environment much more flexible in performing different types of missions within the same simulation environment.

3. Objectives for Missionland

The prime objective of Missionland is to make available a shared coherent data set from which environment databases can be constructed for a wide scope of simulations. These environment databases are generally needed for visual out-of-the-window and sensor views, but also terrain servers and computer generated forces applications often make use of such databases. A development model will be established to ensure that participating nations and industries have full access to the data set and can feed back changes and improvements made to Missionland.

Only static parts of the simulation environment will be addressed by Missionland, i.e. terrain, buildings, infrastructure (roads, railroads, power lines, etc.) and vegetation. Besides including information for creation of visual simulation environments, Missionland will support multi-spectral use, for example for infrared or synthetic aperture radar sensors.

To reduce problems concerning intellectual property rights or problems with a political background, Missionland will be a fictitious environment. Missionland will cover multiple climate zones, various elevation settings, coastal areas and 'large' continuous land masses. This ensures a suitable environment for a large variety of applications, including: training, tactics development, simulation based acquisition, and concept development and experimentation. One application that is not supported by Missionland is mission rehearsal, due to the fact that Missionland cannot be specific to the operational area of interest.

4 User needs elicitation

In 2008 the NATO RTO task group MSG-071 Missionland started. As a basis for the Missionland user needs analysis, the task group developed and issued a questionnaire [3]. The purpose of the questionnaire was to identify potential users and their requirements for Missionland. To this end, the questionnaire was structured around four main questions:

- Who will be the stake-holders and end-users of Missionland?
- How will Missionland be used?
- What are the requirements for Missionland?
- How is Missionland going to be developed and maintained?

The first question was meant to get an overview of the relevant people and programs in the countries for a possible use later in the program. The latter main question included items on the expected capabilities of countries to generate and contribute content for the Missionland data set. The answers to these questions should provide an impression of the feasibility of Missionland.

The Missionland questionnaire was sent out by the task group to relevant people within each country contributing to the project in February 2009. The national Point of Contact (POC) was responsible for collecting the questionnaire results received and ensuring as wide as possible distribution within their own military organization.

A total of 40 questionnaire responses were received by the task group. Because the questionnaires were

sent by email and we did not ask the questions personally, a few (< 5) of the responses were incomplete. However in most cases the incomplete responses were still helpful to the overall requirements analysis. The largest quantity of responses was received from the Netherlands, Norway and Canada. Figure 2 gives the distribution over the different countries.

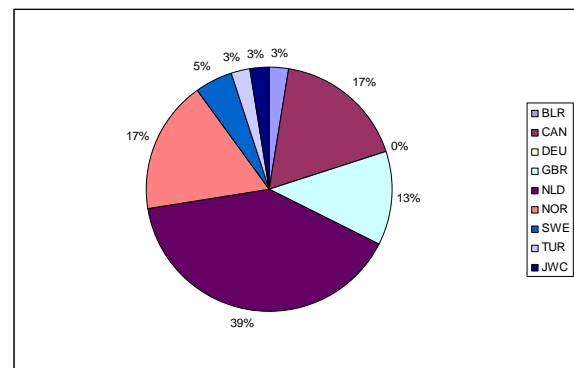


Figure 2: Respondents per country

From the respondents about 50% already has experience with distributed simulation, but only half of those have participated in international distributed exercises before. Most of the respondents however, whether being novice or expert with regard to distributed simulations, said they plan to participate in such exercises in the future.

The questionnaire answers were analysed by the task group members for three different areas: the intended use of Missionland; the requirements for the data sets; and the development and maintenance of the data sets [3].

5 Intended use of Missionland

As expected training will be the most likely used application for the Missionland data set. The fact that Concept Development & Experimentation and doctrine study also score high as possible applications, indicates that there is a need for a data set like Missionland. Fulfilling these user needs will put a high demand on the quality of the data set.

Mission rehearsal and Live Virtual Constructive (LVC) exercises are regarded as medium or not likely used applications for the data set, perhaps due to a general opinion that a high resolution abstract of the operational environment is necessary for these activities. Nevertheless, there are a number of recipients who have chosen LVC as a likely used application. These recipients primarily originate from the air-domain. It may be of interest to address these recipients again to become acquainted with the motives for their choice.



Suggestions for other applications for the data set given by the recipients are Research & Development, emergency management exercises, decision support, and leadership education.

We asked the respondents about the types of operation they will use Missionland for. After sorting the responses by their score, the following priority list results:

1. Air-ground operations
2. Air operations
3. Air-ground-sea operations
4. Ground operations
5. Sea operations
6. Ground-sea operations

25% of the recipients originate from the air domain, probably being the reason that the three highest ranked operations are the ones with the air component involved. The difference between the highest and lowest ranked type of operation is rather small and all are well above 50% (percentage is mean chance that Missionland will be used for this type of operation). Therefore we can conclude that Missionland will be used for all mentioned types of operation. The type of air-sea operations was lacking in the questionnaire, nevertheless this type of operation was not suggested by any of the recipients.

The recipients indicated to use the Missionland data set not only for all kinds of distributed simulation but also for stand alone simulation. The conclusion can be drawn that a high quality coherent Missionland data set will fulfil the common need for a multifunctional simulation training environment.

6 Requirements for Missionland

The next section of the questionnaire dealt with the topic of the end user requirements for the Missionland data set. This includes subjects like the terrain characteristics, the data types and the formats used.

6.1 Terrain characteristics

Based on the questionnaire results we have compiled a list of five terrain types which seem to meet most of the user needs:

1. Coast
2. Mountains
3. Urban, eastern
4. Sea
5. Urban, western

Judging by the questionnaire results, these five are the most important ones to include in Missionland. If more is to be included, 'rough terrain, not dense

urbanised' would be number six on this list. The remaining three types: flat terrain, dense urbanised; arctic and desert are harder to separate using the questionnaire results. Arctic is given an average score of 4 out of 5 by the Navy branch and should probably be prioritized over the other two. Desert is only important to the Army branch, where it is given an average score of 3.5 out of 5. Flat terrain, dense urbanised seems to be more important to this branch, with an average score of four, but this type is similar to urban, western and urban, eastern. The complete, prioritised list is therefore:

1. Coast
2. Mountains
3. Urban, eastern
4. Sea
5. Urban western
6. Rough terrain, not dense urbanised
7. Arctic
8. Flat terrain, dense urbanised
9. Desert

The first five items in this list should all be included, judging by the user needs.

Regarding the size of Missionland it should, judging by the questionnaire results alone, be at least 1000 km x 1000 km. In the Air Force and Joint branches there were also a significant number of people who preferred a Missionland size of 5000 x 5000 km.. Choosing 1000 km might suffice in most cases, but some uses will probably be dependent on a larger area.

Due to the significant number of potential users requiring large areas of land to operate in, the size of Missionland may prevent compiled databases of the whole area to be used on systems not supporting database paging. The level of detail in the data set also affects the total size (in bytes) and the need for database paging. There are many systems currently supporting database paging, and most future systems will probably support it as well. If Missionland is created with a size and level of detail that prevents non-paging systems from loading the whole area, databases of selected areas of Missionland can be compiled for use by the affected systems.

6.2 Data types

The questionnaire results show that the end user expect Missionland to be a truly multi-spectral data set. The visual, infrared and radar spectra were all requested by most respondents. Other spectra suggested by the respondents include night vision and underwater acoustics.

When asked which products the Missionland data set should contain, the answers showed that the respondents would like everything. Figure 3 gives a

graphical overview of the scores of the different products and it can be seen that all of them score higher than 3.5 out of 5. When a list is compiled from these results of the absolute minimum set of products that Missionland should contain, it follows:

- Medium resolution elevation data
- Medium resolution aerial imagery
- Vector data
- Terrain textures
- Terrain feature models
- Maps

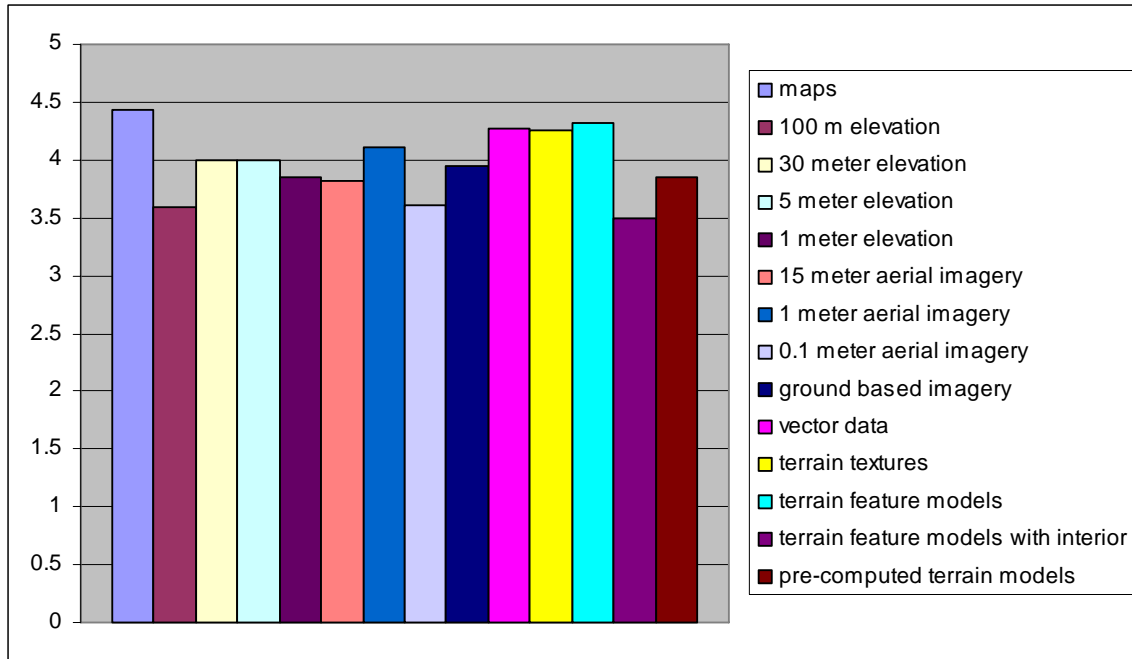


Figure 3: Preferred products

When asked which attributes the end user would prefer for the feature models and terrain no clear preference was given. Visible light reflectance, material type and soil type all received similar scores. The options to provide these attributes as polygons or textures also received similar scores. So the users have no clear preference on this subject and possibly Missionland should support both approaches. It should also be noted that 25% of the respondents did not answer this question, which probably indicates they do not have the technical knowledge of how this is supported in their simulation system.

That Missionland should be a multi-spectral data set was shown before already, but when the respondents were asked how the information for the different sensors should be represented in the data set no clear preference was shown. Both the option material types and multispectral data and the option pre-cooked textures received a similar amount of votes. So possibly the Missionland data set should support both of these approaches. It should also be remarked that many respondents did not answer this question, so not everybody might know the technical details of how sensor information is dealt with in their simulation system.

Half of the respondents indicated that they expect underwater data to be a part of the Missionland data set. One third did not expect so and the rest had no opinion. So this is a clear indication that underwater data should be included. When asked what kind of underwater data they expected, the respondents gave a wide range of answers. Bathymetry and sea bottom type are the most commonly mentioned types of underwater data, but also salinity levels and temperature levels were mentioned multiple times.

60% of the respondents expect atmospheric data to be part of the data set as well. When asked what kind of atmospheric data was needed the most heard answer is weather data.

The requests for products like salinity levels, temperature levels of the water and weather data are interesting, since it is unclear whether these are within the scope of the Missionland project to make a data set of a static environment. In many simulation systems this kind of data would be part of the scenario and not of the environmental database. The responses from the end users indicate that these elements are important for their usage of the simulation systems and if the task group decides that this kind of data is outside of the Missionland

scope we have to explain clearly to the end users why this is the case.

6.3 Formats

The questionnaire also asked the respondents which format they would prefer the Missionland data set to be delivered in. Using industry standards formats was the most received answer, while SEDRIS and CDB were mentioned less frequent. It should however be noted that many people marked multiple or even all three formats, while also one third of the respondents gave no answer to this question. Figure 4 gives a graphical representation of the answers, showing for each of the formats the percentage of the respondents that marked it.

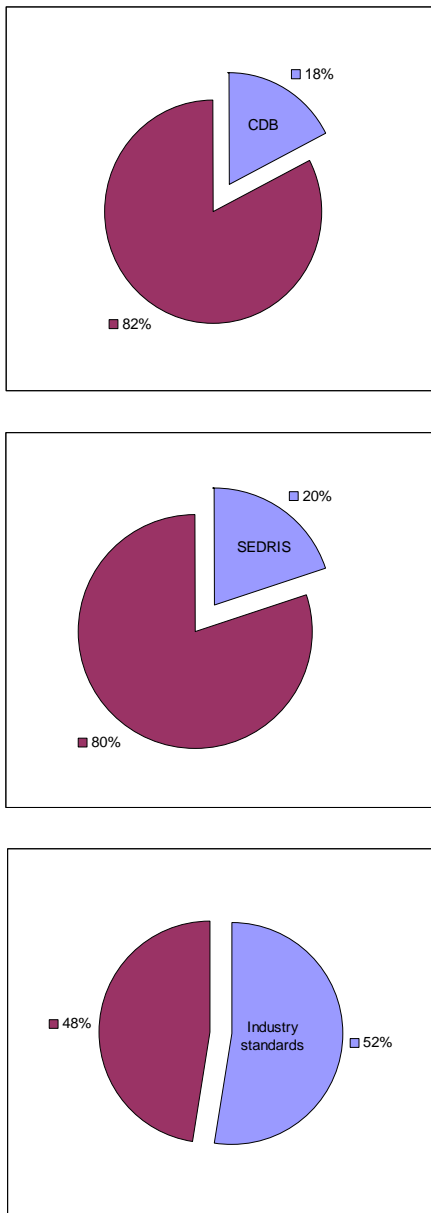


Figure 4: Data format preferences

When asked about the classification schema to be used in the data set SEDRIS EDCS received more votes than DIGEST FACC/DFDD. But once again it should be noted that the majority of the respondents did not or could not answer the question.

Later in the process the task group could choose to use a different format or classification to internally represent the data set in order to make it easier to work with or contribute data. The questionnaire shows the formats and classification as the end users would like to receive. This way they can create an environmental database for their simulation systems.

7 Development and maintenance

98% of the respondents indicate that they expect Missionland to be a continuously evolving product. It is also expected that Missionland is available to all NATO countries, PfP countries and Australia. Only a small portion of the respondents prefers a more restrictive distribution.

Since Missionland is a fictitious continent, the data set as delivered by the task group will only contain unclassified data. However 45% of the respondents still indicate that they expect Missionland to be a mixture of classified and unclassified information. It is not sure if they expect the data set itself to contain classified data or if the classified data comes from other aspects of their simulation system.

When asked about the facilities and tools the respondents have available for developing areas for Missionland, the answers show a lot of variation. Many of the tools available are specific to a simulation system or they are dependant on the simulation supplier to develop new environmental databases. The only tools mentioned frequently are ESRI ArcGIS for working with geo data and Presagis Creator and TerraVista for working with 3D models and terrain databases.

8 Next steps for Missionland

The following step for the Missionland task group is to create the design of Missionland. The initial sketches have already been produced, marking the location of Missionland in the real world. This will be in the middle of the North Atlantic, because that is a real-world location that offers enough space for a new continent. Besides that the Northern Atlantic Ocean seems a suitable location for NATO activities.

The Missionland continent should provide a wide range of climates. To ensure more realistic transitions between these different climate zones and to assist in positioning the different areas on the Missionland continent a high-level definition of the climate zones has been defined (see Figure 5). The following climate zones have been defined: arctic, temperate, arid and tropical.

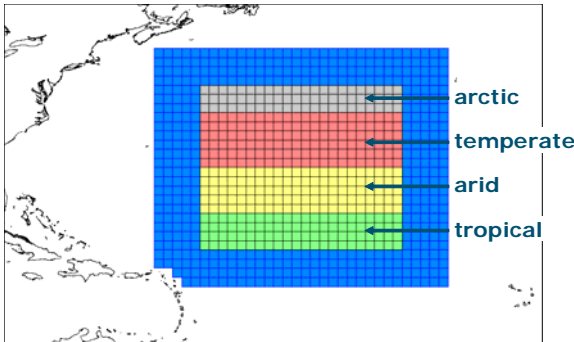


Figure 5: Missionland climate zones

The Missionland continent should provide a wide range of terrain characteristics. This is partly defined by the elevation profile of the terrain. To ensure that there is a realistic transition between the different elevation profiles, a high-level design of zones with a certain elevation profile has been created (see Figure 6). The following elevation profiles have been defined: flat, hilly, mountainous and cliff/fjord.

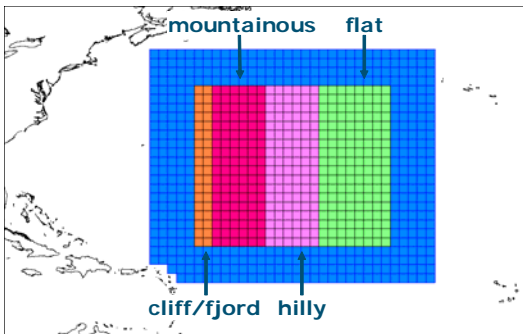


Figure 6: Elevation profile for Missionland

Using this initial design, the Missionland task group is working on the detailed design. In this detailed design the requirements for the content of the data set are described. This for example includes the different features that are required in each zone and the minimum size of certain features. The results of the user needs analysis are an important input for this phase.

Parallel to the detailed design the task group is also performing a tools survey. The aim is to find suitable tools that can be used for the development of the Missionland data. The fact that the Missionland continent is fictitious, means that not

all existing tools for environmental database creation are also suitable for Missionland.

The third activity the task group is performing, before the actual production of the data for the data set can begin, is to define the structure of the data set. This includes topics like which products are contained in the data set, how they are stored and how they depend on each other.

9 Conclusions

Based on a questionnaire sent out to potential stakeholders and end-users, the user needs for a Missionland data set have been analysed. The respondents of the questionnaire show a good coverage over the nations participating in the Missionland task group and over the different branches of the armed forces and it can be concluded that they form a representative group.

The primary intended use of the Missionland data set will be training, both in distributed and stand alone simulations. In addition, concept development & experimentation and doctrine study are also areas where Missionland can be used. To satisfy the priorities of the different branches in the armed forces, Missionland should contain at least the following 5 terrain types: coast; mountains; urban, eastern; sea; urban, western. The size of Missionland will have to be at least 1000x1000 km to satisfy most potential users, although it should be noted that there is a significant group demanding an even larger area.

It's no surprise that the users expect the Missionland data set to provide a complete range of products. For a minimum level of usability the data set should include: maps, vector data, terrain texture, elevation data, aerial imagery and feature models. Also when looking at the spectra that should be available in the Missionland data set it can be concluded that the users expect a truly multi-spectral data set, including not only visual data, but also infrared, radar, night vision and the data required for CGF applications. The majority of users expect the Missionland data set delivery format to be supplied using industry standards (e.g. shapefiles, geo-tiff, etc). But there are also requests for CDB, SEDRIS and compiled OpenFlight. The development of the data set should be a continuous process.



Acknowledgements

The authors would like to thank the members of the Missionland task group as eliciting of the user needs and writing the user needs report was an effort of the whole task group. This paper summarises the main results of the user need report for Missionland.

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