

# HI-SEAS (Hawai'i Space Exploration Analog and Simulation) Space Exploration and Analog Environments

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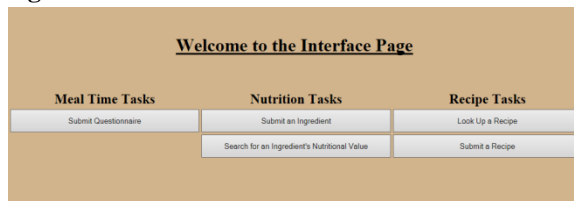
**Note: This project is for future missions**

## Abstract

NASA has funded HI-SEAS to study food preparation strategies for long-term space exploration. To find the best ways for astronauts, researchers at Cornell University and Hawaii University have designed a study to take place in Hawaii. Six scientists were chosen to participate in the study. This study will allow scientists to perform their research as well as participating in the food study. The main goal of this research is to combat food boredom. Food boredom leads to consuming fewer calories and loss of energy. As this mission is a four month long mission this is an extremely important problem. In order to keep track of the food being consumed and numerous recipes to eliminate food boredom, you need a database and interface with various capabilities.

Space Exploration Analog and Simulation) is a planetary surface exploration analog site at ~8500 feet on the Mauna Loa side of the saddle area on the Big Island of Hawaii. HI-SEAS is funded for its first season of operation by a grant from the NASA Human Research Program, for research focusing on new forms of food and new food preparation strategies for long-term space exploration. This first mission will involve six astronaut-like (in terms of education, experience, and attitude) crewmembers living in the habitat for 120 days under Mars-exploration conditions (e.g. with communication latencies and blackouts, in close quarters, under strict water-use rules etc.). The crew has been selected from over 700 applicants, and the 120-day simulated mission is scheduled to begin in early 2013.

**Figure 1** shows the main interface



## Introduction

The NASA Human Exploration & Operations Mission Directorate has identified a number of risks associated with long-term human space exploration. Many of these can be fruitfully investigated in an Earth-bound analog environment – that is, somewhere on Earth that is similar to the target space environment in relevant ways. HI-SEAS (Hawaii

## Questionnaire

Ideally each crew member will receive a tablet. On the tablet each crew member will answer various questions about each meal consumed throughout the day. The food study questionnaire is aim to achieve the following objectives:

- To learn how subjects' liking for foods changes under "mission conditions" of confinement and isolation
- To learn how subjects' food intake, food consumption patterns, and nutrient intake change under mission conditions

- To learn if subjects' ability to identify food-related odors changes under mission conditions
- To learn if subjects' liking for the same food-related odors changes under mission conditions
- To measure the preparation time for two different kinds of diet under mission conditions: pre-packaged, pre-prepared foods such as those astronauts consume, and foods prepared by crewmembers from ingredients that can be stored without refrigeration ("shelf-stable" ingredients).
- To learn whether the dimensions of the nasal passages, and ease of air flow when breathing through nose (together called "nasal patency") are related to any changes in the ability to identify odors.
- To learn whether food intake, food liking and mood are related to each other under mission conditions

In order to submit and store the information above, it is important to construct a database as well as a user interface. In Figure 2, the crew member will fill out the questionnaire and for user efficiency auto-complete assists the user to select recipe names that are within the database.

**Figure 2**

**Food Interest Questionnaire: PRE-MEAL**

Meal (breakfast, lunch, dinner, snacks) Breakfast  Your ID #  If Breakfast Record your Weight

Hunger Satety Ratings: Please rate your degree of hunger or fullness (satiety) before consuming your meal, according to the following scale and record your answer.

-3  -2  -1  0  1  2  3

Extremely Hungry Hungry Semi-Hungry No particular feeling Semi-Satisfied Satisfied Extremely Full

Please write the name of each food or beverage of the meal into the table below.  
[Click Here to view the entire food Database](#)

Food or Beverage	Appearance of the food (1-9)	Aroma of the food (1-9)	Interest in consuming this food (1-9)	Optional comments on appearance and aroma (Limit 50 Characters)
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Please take a moment to look at, and smell, the foods and beverages in this meal, then rate the appearance and aroma of each food item above, according to this 9 point scale. If cannot smell the food, enter a 0 in the aroma field.

## Recipe

To eliminate food boredom, another database and web interface was created. In Figure 3, a table is created called Recipe. Recipe has a number of

entities (more than what is listed). Recipe\_num is the primary key and it is represented by a number that is auto-incremented. Recipe\_name is defined as a unique entity because it is unlikely there will be a recipe with the same name. Nutrition\_num serves as a foreign key and it links the Nutrition table to the Recipe table. This means Nutrition\_num is the primary key of the Nutrition table.

	Recipe
PK	Recipe_num
Unique	Recipe_name
	Ingred1
	Serv_amt1
	Ingred2
	Serv_amt2
FK	Nutrition_num

**Figure 3**

The interface allows the crew member to look up over 8,000 food recipes imported from the USDA nutritional database and prepare different recipes. In addition to preparing recipes, the interface also allows the crew member to submit a recipe in which they have created.

## Nutrition

It is imperative the crew members consume the proper amount of nutrients, especially for long term space missions. Therefore, it is extremely important to keep track of the crew member's intake. Keeping track of the crew member's nutritional consumption with require another database and web interface to be created.

	Nutrition
PK	Nutrition_num
Unique	Nutrition_name
	Water
	Protein
	Carbs
	Vitamin_A
FK	Recipe_num

**Figure 4**

In the table above (Figure 4), a table is created called Nutrition. Nutrition has a number of entities (more than what is listed). Nutrition\_num is the primary key and it is represented by a number that is auto-incremented. Nutrition\_name is defined as a unique entity because it is unlikely there will be a recipe with the same name. Recipe\_num serves as a foreign key and it links the Recipe table to the Nutrition table. This means Recipe\_num is the primary key of the Recipe table.

The recipe and nutrition interface is very similar. The HI-SEAS nutritional database also retrieves information from the USDA nutritional database and converts the serving amount to per 100 grams. This allows the nutritionist to review the intake of the crew member depending on what he/she ate. The interface also allows the nutritionist the insert many different nutrients.

**Figure 5** shows the nutrition pull page

**Nutritional Information for FAST FOODS SUBMARINE SNDWCH W/TUNA SALAD**

Name: FAST FOODS SUBMARINE SNDWCH W/TUNA SALAD

Water in Grams: 54  
Energy per KiloCalorie: 228  
Protein per Gram: 12  
Total Lipid per Gram: 11  
Ash per gram: 2  
Carbohydrates per gram: 22  
Fiber per gram: 0  
Total Sugar per gram: 0  
Calcium per milligram: 29  
Iron per milligram: 1  
Magnesium per milligram: 31  
Phosphorous per milligram: 86  
Potassium per milligram: 131  
Sodium per milligram: 505  
Zinc per milligram: 1  
Copper per milligram: 0  
Manganese per milligram: 0  
Selenium per milligram: 24  
Vitamin C per milligram: 1  
Thiamin per milligram: 0  
Riboflavin per milligram: 0  
Niacin per milligram: 4  
Panto Acid per milligram: 1  
Vitamin B6 per milligram: 0  
Total folate per microgram: 40  
Folic Acid per microgram: 18  
Food folate per microgram: 22  
Folate DFE per microgram: 53  
Total Cholesterol per milligram: 0  
Vitamin B12 per microgram: 1  
Vitamin A IU: 73  
Vitamin A RAE: 18  
Retinol per microgram: 17  
Alpha Carot per microgram: 0  
Beta Carot per microgram: 0  
Beta Crypt per microgram: 0  
Lycopene per microgram: 0  
Lutein Zea per microgram: 0  
Vitamin E per milligram: 0  
Vitamin D per microgram: 0  
Vitamin D IU: 0  
Vitamin K per microgram: 0

## Results

There was no data to be recorded. The project is an application, and research will be executed and recorded for future missions to come. However, everything is debugged and executed to the liking of Dr. Binsted.

## Conclusion

The HI-SEAS nutritional database is fully functional and efficient. It will serve as a vital component for nutritionists aboard the HI-SEAS's future missions as well as any other researchers whom are interested in nutrition. All the recipes and nutritional information is exceedingly accurate and is ready for further testing.

## References

"HI-SEAS." *HISEAS*. N.p., n.d. Web. 19 Aug. 2013.

"NDL/FNIC Food Composition Database Home Page." *NDL/FNIC Food Composition Database Home Page*. N.p., n.d. Web. 19 Aug. 2013.

