Somna (Sleep overseer)

Abstract

Since inception mankind has always been limited by sleep. Much more contemporarily, owing to a drastic change from our tree-swinging ancestors in environmental and pychological conditions. This massive void cannot be bridged by evolutionary conditioning of natural selection.

Advanced studies on sleep disorders and on the biological clock has shown humans show disctinctive differences from others in quality, quantity and cycles of sleep. These differences manifest in inability to generalize sleep and hence necessitates custom-tailored sleep programs that can be availed to the general populace at a flick of a thumb.

'Somna' uses various telltale parameters to empirically evaluate a subject and actively profile them. Over days the profile is subsequently used to figure the ideal sleep/work data that is then recommended to the subject for a longer period of time. Succeeding the period re-profiling is done to adjust for gradual deviation over time.

The widget is expected to be imperative to people with non-circadian cases of astronauts and near-pole dwellers among others. Patients of sleep disorder stand to gain from regularized custom sleep, easy diagnosis from medical practitioners from sleep data. Use among general populace to optimize work cycles boosts overall productivity and quality of work, thereby revolutionizing quality of life, work/life balance and perspective on sleep.

Goal:

- Optimal Sleep
- Healthy meal
- Good Exercise Plan
- Better Workflow
- Keeping the rhythm Alive

Hardware:

- Actigraph
- Polysomnograph

Parameters:

1. Blue Light
2. social interactions
3. Chronobiological medication
4. Hypnotic and alertness medication
5. Atmospheric conditions
6. Exercise
7. Eating/drinking patterns
8. Metabolic Rate
9. Food Intake
10. Nutrients
11. Calories Burn
12. Biomarkers
13. Workload
14. Muscle strain
15. Physique

BASAL METABOLIC RATE (BMR)

- BMR is the rate at which energy expenditure takes place per unit time in endothermic animals at rest i.e. it is the amount of calories burned by an endothermic animal per unit time.
- BMR for a male is calculated using the formula

  66.47 + (13.75 X Weight in KG) + (5.003 X Height in CM) – (6.755 X Age in YEARS)
- BMR for a female is calculated using the formula

  655.1 + (9.563 X Weight in KG) + (1.85 X Height in CM) – (4.676 X Age in YEARS)

Parameters: Height, Weight, Age, Gender

Source: https://www.nasa.gov/sites/default/files/atoms/files/stemonstrations_nutrition.pdf

Visualisation

Candidate Criteria(max):

Weight: 80Kg
Age: 46
Height: 177cm

- Data Acquired : Height, Weight,Age,Gender,Calories required for different genders,
- We have cleaned the data in the reference with nasa astronaut criteria and manipulated the data to get the required data.
- Formula used, method pursed are as mentioned in the Nasa resources

Source: https://www.nasa.gov/audience/forstudents/postsecondary/features/F_Astronaut_Requirements.html

NUTRITION

- The every day nutrition plan of an astronaut is measured in "CALORIES". The original definition of a calories is that it is the amount of energy required to raise the temperature of 1 KG of water from 0 C to 1 C.
- The composition of an astronaut's nutrition plan in calories is 55-60% from carbohydrates, 30% from fat and 10-15% from proteins.
- 1 gram of carbohydrates has 4 calories, 1 gram of protein is 4 calories and 1 gram of fat has 9 calories approximately.
- If an astronaut needs 2000 calories every day to sustain the he should be consuming 275 - 300 grams of carbohydrates, 66 - 67 grams of fat and 50 - 75 grams of protein every day.

Parameters: Calories, Cholesterol, Proteins, Fiber

Source: https://www.nasa.gov/centers/johnson/pdf/669816main_Space%20Nutrition.pdf

NUTRITIONAL INTAKE

- Nutritional intake is calculated using the Total Daily Energy Expenditure or TDEE.
- TDEE = BMR + Calories released due to activity
- There can be anomalies here and their and thus the TDEE of a person may start to vary a bit thus leading to a gain or loss in weight. These anomalies can be overcome by continuously monitoring the test subjects and adjusting their nutrition and exercise routine in such a way that they are in peak physical condition.

Parameters:Vitamin D,Vitamin K,Vitamin C,Vitamin A,Vitamin B, Protein,Calcium,Iron,Caffeine

Primary	Secondary
Vitamin D	Vitamin C
Vitamin K	Vitamin A
Calcium	Iron
Protein	Caffeine
Vitamin B	

Source: https://www.nasa.gov/pdf/143163main_Space.Food.and.Nutrition.pdf

Vitamin D	Vitamin K	Vitamin C	Vitamin A	Vitamin B	Protein	Calcium	Iron	Caffeine
Mexican Scrambled Eggs	Asparagus	Applesauce	Apricot Cobbler	Corn	Barbecued Beef Brisket	Apple Cider	Apple Cider	Chocolate Breakfast Drink
Scrambled Eggs	Butter Cookies	Vitamin C	Bran Chex	Cornbread Dressing	Beef Fajitas	Broccoli au Gratin	Baked Beans	Cocoa
Seafood Gumbo	Butterscotch Pudding	Berry Medley	Carrot Coins	Crackers	Beef Pattie	Chicken Teriyaki	Black Beans	Decaf. Coffee Black
Seasoned Scrambled Eggs	Candy Coated Almonds	Blueberry Raspberry Yogurt	Chicken w/ Corn & Black Beans	Crawfish Etouffee	Beef Steak	Milk	Chicken Consomme	Decaf. Coffee w/ A/S
Shrimp Cocktail	Cashews	Candied Yams	Chicken Pineapple Salad	Decaf. Coffee Black	Beef Stew	Rhubarb Applesauce	Chicken Teriyaki	Decaf. Coffee w/C & A/S
Shrimp Fried Rice	Cauliflower w/ Cheese	Cherry Blueberry Cobbler	Cornbread Dressing	Granola w/ Raisins	Beef Tips w/ Mushrooms	Rice Pudding	Dried Apricots	Decaf. Coffee w/C & S
Tomatoes & Eggplant	Cranapple Dessert	Cherry Drink w/ A/S	Curry Sauce w/ Vegetables	Grilled Pork Chop	Breakfast Sausage Links	Shortbread Cookies	Chicken Fajitas	Decaf. Coffee w/ Cream
	Grape Drink	Chicken Noodle Soup	Fruit Cocktail	Homestyle Potatoes	Candy Coated Peanuts	Waffles	Red Beans & Rice	Decaf. Coffee w/ Sugar
	Grape Drink w/ A/S	Citrus Fruit Salad	Granola	Homestyle Potatoes	Chicken Consomme			Green Tea
		Cranberry Peach Drink w/ A/S	Green Beans w/ Mushrooms	Italian Vegetables	Chicken Fajitas			Kona Coffee Black
		Creamed Spinach	Mango Peach Smoothie	Lasagna with Meat	Chicken in Pouches			Kona Coffee w/ A/S
		Dried Peaches	Minestrone Soup	Milk	Chicken w/ Corn & Black Beans			Kona Coffee w/ C & A/S
		Granola w/ Blueberries	Mixed Vegetables	Nut & Fruit Granola Bar	Chicken w/ Peanut Sauce			Kona Coffee w/ Cream
		Lemon Curd Cake	Pasta w/ Pesto Sauce	Peanuts	Fiesta Chicken			Tea
		Lemon Meringue Pudding	Pears	Peanut Butter	Lasagna with Meat			Tea w/ Cream & Sugar
		Lemonade	Sweet & Sour Chicken	Potato Medley	Macadamia Nuts			Tea w/ Lemon & A/S
		Lemon-Lime Drink	Sweet & Sour Pork	Potato Soup	Macaroni & Cheese			Tea w/ Lemon & Sugar
		Mashed Potatoes	Tomato Basil Soup	Potatoes au Gratin	Meatloaf			Tea w/ Sugar
		Peach-Apricot Drink	Tomatoes & Artichokes	Rice Pudding	Noodles & Chicken			Tea with A/S
		Pears	Tomatoes & Eggplant	Salmon	Pasta w/ Shrimp			Tea with Cream
		Pineapple	Tropical Punch	Smoked Turkey	Rice & Chicken			Tea with Lemon
		Pineapple Drink	Tuna	Southwestern Corn	Sausage Pattie			
		Strawberries	Tuna Salad Spread	Teriyaki Vegetables	Split Pea Soup			
		Strawberry Drink	Vegetarian Vegetable Soup	Tomatoes & Artichokes	Sweet & Sour Chicken			
				Tropical Fruit Salad	Sweet & Sour Pork			
				Tropical Punch	Teriyaki Beef Steak			
				Turkey Tetrazzini	Teriyaki Chicken			
				Vegetable Quiche	Tortillas			
				Vegetarian Vegetable Soup				
				Yogurt Covered Granola Bar				

Main course	Sides	Extras	Drinks
Apricot Cobbler	Asparagus	Baked Beans	Cherry Drink w/ A/S
Barbecued Beef Brisket	Beef Pattie	Banana Pudding	Chicken Consomme
Beef Fajitas	Blueberry Raspberry Yogurt	Berry Medley	Chocolate Breakfast Drink
Beef Steak	Breakfast Sausage Links	Black Beans	Chocolate Pudding
Beef Stew	Candied Yams	Bread Pudding	Cranberry Peach Drink w/ A/S
Beef Tips w/ Mushrooms	Cauliflower w/ Cheese	Brownie	Decaf. Coffee Black
Bran Chex	Chicken in Pouches	Butter Cookies	Decaf. Coffee w/ A/S
Broccoli au Gratin	Chicken w/ Corn & Black Beans	Butterscotch Pudding	Decaf. Coffee w/C & A/S
Brown Rice	Chicken w/ Peanut Sauce	Candy Coated Chocolates	Decaf. Coffee w/ C & S
Cheese Grits	Citrus Fruit Salad	Candy Coated Peanuts	Decaf. Coffee w/ Cream
Cheese Tortellini	Corn	Carrot Coins	Decaf. Coffee w/ Sugar
Chicken Fajitas	Creamed Spinach	Cashews	Fruit Cocktail
Chicken Noodle Soup	Curry Sauce w/ Vegetables	Cheddar Cheese Spread	Grape Drink
Chicken Teriyaki	Dried Peaches	Cherry Blueberry Cobbler	Green Tea
Cornflakes	Grilled Pork Chop	Chicken Pineapple Salad	Green Tea w/ Sugar
Crawfish Etouffee	Homestyle Potatoes	Chipotle Snack Bread	Hot and Sour Soup
Fiesta Chicken	Lasagna with Meat	Cocoa	Lemonade
Granola w/ Raisins	Macaroni & Cheese	Cornbread Dressing	Lemon-Lime Drink
Italian Vegetables	Mashed Potatoes	Crackers	Milk
Noodles & Chicken	Meatloaf	Cranapple Dessert	Minestrone Soup
Pasta w/ Pesto Sauce	Mixed Vegetables	Dried Apricots	Orange Drink
Pasta w/ Shrimp	Peaches	Granola Bar	Orange Drink w/ A/S
Red Beans & Rice	Peanut Butter	Granola w/ Blueberries	Orange Juice
Rice & Chicken	Pears	Grape Jelly	Orange-Grapefruit Drink
Rice Pilaf	Peanuts	Green Butter	Orange-Mango Drink
Seafood Gumbo	Potato Medley	Lemon Curd Cake	Orange-Pineapple Drink
Smoked Turkey	Potatoes au Gratin	Lemon Meringue Pudding	Peach-Apricot Drink
Sweet & Sour Pork	Rhubarb Applesauce	Macadamia Nuts	Potato Soup
Sweet & Sour Chicken	Salmon	Nut & Fruit Granola Bar	Shrimp Cocktail
Teriyaki Beef Steak	Sausage Pattie	Peanuts	Shrimp Fried Rice
Teriyaki Chicken	Scrambled Eggs	Rice Pudding	Split Pea Soup
Tomatoes & Artichokes	Seasoned Scrambled Eggs	Shortbread Cookies	Strawberry Drink
Tortillas	Southwestern Corn	Strawberries	Tomato Basil Soup
Tuna	Teriyaki Vegetables	Tropical Fruit Salad	Tropical Punch
Turkey Tetrazzini	Tuna Salad Spread	Vanilla Pudding	Tropical Punch w/ A/S
Vegetable Quiche		Waffles	Vanilla Breakfast Drink
Wheat Flat Bread		Yogurt Covered Granola Bar	Vegetarian Vegetable Soup

- We have classified the food based on the richness and sorted out the food into different Courses Data provided in the Nasa data portal

Source1: https://www.nasa.gov/sites/default/files/atoms/files/stemonstrations_nutrition.pdf
Source2: https://www.nasa.gov/sites/default/files/space_nutrition_book.pdf

Algorithm Plot:

1. The candidate will taste different foods during 5 months training period and after the training they will try out the selected foods(packed) in the Model Station which is located in the planet earth and they will list out the final choice.

2. After the selection, the desired food will be loaded up and they will consume the selected foods in the space.

3. After short intervals, Blood test and urine test will be taken and the acquired data will be compared with the data which is obtained in the 5 months training period.If there is any deficiency/lack of nutrients, the deficient parameters/nutrients will be noted and uploaded in the application.

4. Here we have two options, either the medic can upload the data or the candidate can directly choose the deficiency after going through the report.
5. After selecting deficient parameter/nutrients, the user needs to decide the courses

Example: Take the deficient parameters as Vitamin A, Vitamin K, Calcium and Protein.Now the candidate can choose a main course which is rich Vitamin A or Vitamin K or Protein or calcium, that's upto them. Similar method applies for the side dish, extras and drinks. One thing to keep in mind is, If the candidate selects main dish which is in rich in Vitamin A, he/she cannot select the sides or other courses which has similar richness, even the application will extrude the vitamin c food from all other courses.Meanwhile the application will analyse the deficiency and will show up with a suitable meal plan.Candidate can customise there own menu or they can just go with the suggested meal plan posted by the application.

6. After meal selection, the total amount of the Tertiary parameter will be calculated by the application.

Tertiary Parameter: Mass, Kcals, Proteins ,Cholesterol ,Fat.

7. The reason to calculate such data is, there are some restriction which is to be followed strictly in order to stay healthy.

Mass	*Based on the candidate requirement*
Kcals	*Based on the candidate requirement*
Proteins	270-275 gm
Cholesterol	60 - 75 gm
Fat	66 gm

8. The over-consumption of fat and alcohol that may contribute to the development of obesity and alcoholism. Linked to fat and alcohol, are galanin (GAL), the opioid peptides enkephalin (ENK) and dynorphin (DYN), and the orexins (ORX).

9. Since there is no weather up there, we cant keep a track of cycle's calorie requirement.If you eat too much, or exercise too little, you gain weight. If you gain too much weight, you may put yourself at risk for diabetes or a host of other health problems.

10. Nasa claims that overdose of proteins we cause a adverse health effect and affects the food rhythm.

11.Most foods that are rich in cholesterol are also high in saturated fatty acids and thus may increase the risk of CVD due to the saturated fatty acid content.

Source1: https://www.nasa.gov/sites/default/files/human-adaptation-to-spaceflight-the-role-of-nutrition.pdf
Source 2: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2077813/

11. After comparing the Tertiary parameters with the threshold, if any one value is higher than the threshold, the candidate need to refresh the meal plan and once again the application will come up with a good suggestion.

12. After picking up the meal plan, the time in which the meal is consumed will be recorded and the clock will start ticking to intimate the next meal hour.

13. The meal choose by the candidate will be recorded and then will be evaluated for the future process.

14. If any particular food starts to disturb the candidate, that particular food will be removed from the future meal plans and a replacement of the food will be provided.

EXERCISE

- Energy expenditure due to exercise depends on the amount of work done per unit time. If the amount of work done produces enough heat to raise 1KG of water from 0C – 1C then 1 calorie of energy is released.
- The amount of energy released depends on the intensity of the exercise.
- Low intensity walking or cycling => 4 calories/minute
- Brisk walk or brisk cycling => 5 calories/minute
- Jogging => 7-8 calories/minute

Equipments Used:

1. VELO Ergomoeter Bike (VB-3)

2. Combined Operational Load Bearing External Resistance Treadmill

3. Cycle Ergometer with Vibration Isolation System (CEVIS)

4. Advanced Resistive Exercise Device (ARED)

Source1: https://technology.nasa.gov/patent/MSC-TOPS-59
Source2: https://nasa.tumblr.com/post/136706596374/exercising-in-space

Algorithm Plot:

1.Based on the Work Load, type of Work and food consumption the exercise will be scheduled.

2. Different schedules causes strains in the different part of the muscle. Even though the NASA restricted the repair/investigating work beyond the shuttle, there are sum cases where the Astronauts has to got the outer to part. For example, If there is blockage in the A/C vent either then need to reboot the system or they to clear the vent manually. If the rebooting isn't successful the astronauts has to move out of the shuttle to repair the A/C vent.In those cases, Muscle strain will be more, In that particular day we need to reduce the exercise in order to maintain the muscle strain.

3.We have collected the working egg & heart rate to predict working hours and we have allotted exercise and its timing based on both food consumption and work load.

4. There are some restriction in the timing.

Average workout time(in hrs)	2
Maximum Workout time(in hrs)	2.5

5. So we have taken the reference timing from nasa and we have manipulated time within the stipulated period.

6. We have predicted the time period and the type of exercise from the previous nasa experiments.

7. We will construct a personalised plane for each and every candidate based on the pre-flight performance.

Orbit 1 – 7 consecutive nightshifts with lead-in

Key

	SLEEP	M	TAKE MELATONIN
	TRY TO SLEEP OR NAP		PRIORITIZE BRIGHT LIGHT EXPOSURE
	WEAR SUNGLASSES – AVOID LIGHT		DO NOT WEAR SUNGLASSES - SEE LIGHT
N C	NOT WORKING ON CONSOLE	O 1	WORKING ON CONSOLE FOR ORBIT 1

3c: Seven Orbit 1 shifts with 2-day gradual lead-in

JSC CDT	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Not on Console										N C	N C	N C	N C	N C	N C	N C	N C							
Not on Console										N C	N C	N C	N C	N C	N C	N C	N C							
3 days prior to O1																								
2 days prior to O1																								
1st O1 shift																			NAP	NAP				O 1
2nd O1 shift	O 1	O 1	O 1	O 1	O 1	O 1	O 1	O 1		M									NAP	NAP				O 1
3rd O1 shift	O 1	O 1	O 1	O 1	O 1	O 1	O 1	O 1		M									NAP	NAP				O 1
4th O1 shift	O 1	O 1	O 1	O 1	O 1	O 1	O 1	O 1		M									NAP	NAP				O 1
5th O1 shift	O 1	O 1	O 1	O 1	O 1	O 1	O 1	O 1		M									NAP	NAP				O 1
6th O1 shift	O 1	O 1	O 1	O 1	O 1	O 1	O 1	O 1		M									NAP	NAP				O 1
7th O1 shift	O 1	O 1	O 1	O 1	O 1	O 1	O 1	O 1		M									NAP	NAP				O 1
Post-O1	O 1	O 1	O 1	O 1	O 1	O 1	O 1	O 1		M														M
Post-O1 NC										N C	N C	N C	N C	N C	N C	N C	N C							M
Post-O1 NC										N C	N C	N C	N C	N C	N C	N C	N C							M
Post-O1 NC										N C	N C	N C	N C	N C	N C	N C	N C							
Post-O1 NC										N C	N C	N C	N C	N C	N C	N C	N C							
Off																								
Off																								

3d: Seven Orbit 1 shifts with 2-day gradual lead-in and extra recovery day

JSC CDT	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Not on Console										N C	N C	N C	N C	N C	N C	N C	N C							
Not on Console										N C	N C	N C	N C	N C	N C	N C	N C							
3 days prior to O1																								
2 days prior to O1																								
1st O1 shift																			NAP	NAP				O 1
2nd O1 shift	O 1	O 1	O 1	O 1	O 1	O 1	O 1	O 1		M									NAP	NAP				O 1
3rd O1 shift	O 1	O 1	O 1	O 1	O 1	O 1	O 1	O 1		M									NAP	NAP				O 1
4th O1 shift	O 1	O 1	O 1	O 1	O 1	O 1	O 1	O 1		M									NAP	NAP				O 1
5th O1 shift	O 1	O 1	O 1	O 1	O 1	O 1	O 1	O 1		M									NAP	NAP				O 1
6th O1 shift	O 1	O 1	O 1	O 1	O 1	O 1	O 1	O 1		M									NAP	NAP				O 1
7th O1 shift	O 1	O 1	O 1	O 1	O 1	O 1	O 1	O 1		M									NAP	NAP				O 1
Post-O1	O 1	O 1	O 1	O 1	O 1	O 1	O 1	O 1		M														M
Off																								M
Post-O1 NC										N C	N C	N C	N C	N C	N C	N C	N C							M
Post-O1 NC										N C	N C	N C	N C	N C	N C	N C	N C							
Post-O1 NC										N C	N C	N C	N C	N C	N C	N C	N C							
Off																								
Off																								

SLEEP

- Sleep is one of the most important parameters that determines the daily well being of a person. Sleep depends on the aforementioned factors namely nutrition and exercise.
- The main parameters in sleep are Deep sleep, Shallow sleep and REM (Rapid Eye Movement) Sleep. To be in peak shape the astronaut needs to get a good amount of deep sleep.
- The quality of sleep is assessed using a wearable tracking device that monitors sleep and stores the data.

Parameters:

1. Blue Light
2. social interactions
3. Chronobiological medication
4. Hypnotic and alertness medication
5. Atmospheric conditions
6. Biomarkers
7. Workload

Algorithm Plot:

1. According to the candidates suitable light exposure they can alter the blue light spectrum in cabin. For an instance, the suitable light exposure will be set, if they need increase/decrease the light exposure the can do it with the application.

2.The emotions have a direct impact in the sleep. they tend control the parameters like sleep latency, REM sleep, Sleep duration and even there are chances for the candidate to fall in deep sleep (rather than a shallow sleep) who just had a happy conversations. So we have imparted a special tab to monitor the emotions of the candidates, through which we will provide tasks.For example, one must go and ask a particular candidate about the prettiest incident happened in their life, so that both will have a positive emotion flow, with which we can improve the sleep latency and sleep duration of both the candidate.Depending upon the task performed, corresponding points will be allotted.

3. We tried to reduce the effect of circadian rhythm, by altering the blue light with respect to each individual, by rescheduling the work plan, imparting the work to another member when the corresponding member’s rhythm is affected and by providing adequate amount of medication.

4. When the sleep latency of a person is prolonged for a period of time, we recommend them ti listen to there favourite bed time songs and by adding melatonin(a biomarker) boosting food elements in their meal plan.

5. Based on the working hours and preferred sleeping hours, the sleep scheduling will be carried out. Basically, in the pre-flight most the data we will acquired, So we just need to apply the data and monitor the sleep. In most of the times, when we compare pre-flight sleep and Dive sleep, the are differences in the sleeping hours and the difference is small tho.