Comparison of Traditional and Innovative Techniques to Solve Technical Challenges

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Disclosure Information

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I have the following financial relationships to disclose:

- Employee of: NASA Johnson Space Center

I will not discuss off-label use and/or investigational use in my presentation

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The Current Space Food System

Refrigerators and freezers not available to maintain food safety and quality

Natural Form Foods

Rehydratable Foods

Intermediate Moisture Foods

Beverages

Irradiated & Thermo-stabilized Foods

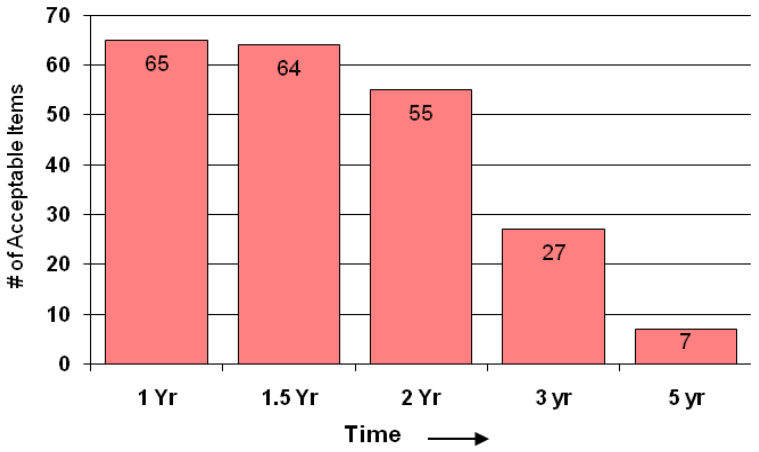
Not pictured: Extended shelf-life breads and fresh food (limited basis)

Overview of Hypothetical Mars Expedition

- Approximately 2.5 year mission
  - Earth-to-Mars transit: ~6 months
  - Mars surface stay: ~18 months
  - Mars-to-Earth transit: ~6 months
- A 5-yr shelf life requirement is expected
  - Food prepositioning may be required to accommodate high mass and volume of food
  - Production and stowage will take time due to volume
- The current food system would become unacceptable before the mission ended
  - No refrigerators or freezers available for food preservation

FOOD SYSTEM

No. of organoleptically-accepted thermostabilized space foods as shelf life extends to 5 years



The Food Packaging Material Used Contributes to the Shelf Life of the Food

- Shelf life of foods is determined by:
  - Bacterial growth – e.g., spoilage, pathogens
  - Nutritional degradation – e.g., loss of vitamins
  - Quality degradation – e.g., sensory qualities
- Packaging can:
  - Prevent contamination by microorganisms
  - Protect food from physical hazards
  - Control transmission of oxygen and water from outside environment into food
    - Nutrient, flavor, and aroma changes through oxidative reactions
    - Texture and color changes due to increase water content

NASA Packaging Technical Requirements

- Requirements
  - High barrier packaging – low oxygen and water vapor transmission rates
  - No aluminum layer
  - Mass - $\leq$145 grams per m^2
  - Flexible
  - Puncture resistant
  - Approved for food use
  - Amenable to sterilization
  - Able to be heat sealed
- Preferred (not required)
  - Transparent
  - Retortable, microwavable, high pressure use

10 Year Effort to Improve Food Packaging

- Small Business Innovative Research Program – 7 years
  - 8 Phase I contracts
  - 4 Phase II contracts
- Two Workshops to bring together food packaging experts
- Three internal research tasks
- Public Outreach – average of 3 presentations/yr for 8 years describing NASA's challenges
- Department of Defense Collaboration – Combat Feeding Program

No significant improvement in food packaging capabilities after these efforts

Innovation Techniques

- It was unlikely that a food packaging solution could be found within the food science community
  - There was a need to go outside to other industries such as pharmaceutical or electrical
  - Although a positive result was preferred, a negative result would also be useful
- Two Innovation Techniques were used as a comparison
  - InnoCentive – Theoretical Challenge to identify new technologies
  - Yet2.com – A matchmaker between NASA and commercial packaging manufacturers

NASA JSC Challenges Summary

Challenge Partner	Challenge Type / Award	Posted / Deadline	Final Numbers	Challenge Status
InnoCentive	Theoretical-IP / $15,000	December 18, 2009 / February 28, 2010	-174 Project Rooms from 33 Countries -22 Submissions from 10 Countries *16 for Evaluation*	A partial solution was identified and is still under Due Diligence for Solver Verification.
Yet2.com	Matching of commercial company and Technical Need Owner	July 2010/ October 2010	23 investigated; 5 researched; *2 for Evaluation*	Items still under Due Diligence for Solver Verification.

Conclusion: Both InnoCentive and Yet2.com provided good results. It really depends on what your required final outcome is and the state of the art of the technologies required.


Questions??