Platforms Engineering
Strategic Planning Update

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Acknowledgements

Jim Barry
Dave Caress
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Steve Haddock
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Charlie Paull
Steve Rock
John Ryan
Chris Scholin

Presentation Overview

Research
- Planning Process
- Draft Plan
- Environmental Assessment
- Science Input

Analysis
- Core Competencies → Potential Directions
- Challenges → Meeting Challenges

Action

Science Story

Strategic Planning

"Plans are worthless, planning is essential."
- Dwight D. Eisenhower

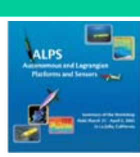
- Objectives for planning process
  - Define our mission and vision of the future
  - Establish common understanding of strategic issues through discussion
  - Define a common vocabulary
  - Create a plan for *implementing* our mission
  - Communicate this to group members and stakeholders

Strategy Stratagem

- Align with MBARI Strategic Plan
- Involve stakeholders (scientists, operations) early and often
- Follow existing practices for documenting our plan

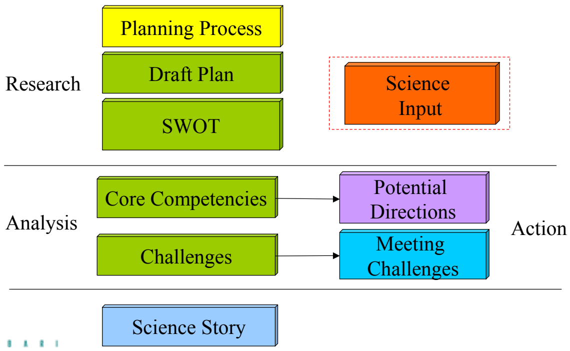
Planning Activities

- Reading list
- SWOT analysis
- Scientist meetings
- Technology survey
- Discussions
- Draft plan



Strengths	**Opportunities**
Weaknesses	**Threats**

Presentation Overview



Andy

Meetings

Held 3 meetings with MBARI Science Staff

<u>Topics:</u>

- Current research interests that would benefit from platform engineering development.
- Concerns related to engineering project selection and structuring at MBARI.
- Methods of improving interactions between the engineering and science divisions.

Research Topics

- Primary Ocean Productivity (K. Johnson)
  - Drifting Profilers (Chem. Sensors on ARGOS Floats)
  - Ocean wide Coverage
- Seafloor Mapping (D. Caress)
  - Multibeam, Sub-bottom, Side-scan
  - Institute Support Necessary
- Marine Geology (Charlie Paull)
  - Flux of Fluids and Gasses Through Seafloor
  - Transport of Sediment Across Seafloor
- 2nd Meeting: Scholin, Barry

Technological Limitations

Energy constraint

Mobile platforms and deployed instruments are limited by energy constraints.

- Deployment Duration, Sample Rates, Communication Rates/Range, …

Lack of measurement techniques

Measuring number of particles in water

No measurement techniques between bulk properties and microscopic assay

Difficult to observe and characterize thin layers (and other morphologies) of water (layers are easiest to find)

Chemical sample processing time

Sensor accuracy

Sensor drift

Reliability

Endurance of platforms/cables/instruments

Biofouling

Size and Scale of Ocean vs available observing technology

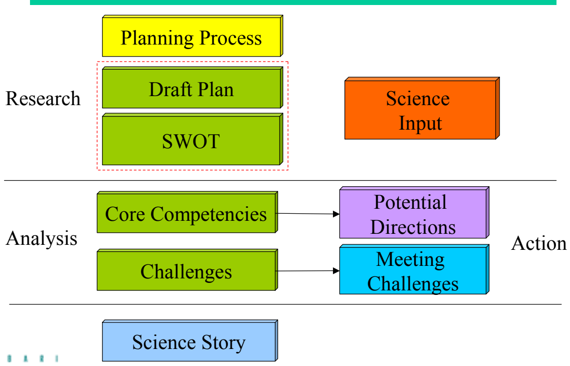
Concerns

- Too many projects, lack of consistent focus.
- Projects take too long, need to find the balance between immediate results and generalized utility.
- Large, engineering driven projects are susceptible to a disconnect between engineering and science.
- Concern that rush to move on to new projects may leave potential of current projects unrealized.
- Concern that new engineering thrusts may neglect importance of ROV developments.

Improving Interactions

- Recognize range of projects that engineering participates in: Small science driven projects on one hand, major engineering initiatives on the other.
- Structure large projects with more incremental implementation steps. Don't start on these projects without refined plans that include shorter duration accomplishments.
- Involve engineering staff in traditional science cruises.
- Improve relevance of new engineering driven proposals to current science interests.

Presentation Overview



Draft Plan

- Mission Statement
  Inform and implement the development of platforms and related technologies at MBARI
- Charter
  - Support MBARI's institutional mission
  - Maintain a strategic plan for ocean observing platforms and technologies
  - Provide expertise and guidance in platforms and related technology
    - Science, Operators, Management, Community
    - MBARI Engineering
- Composition
  - Platforms Engineering representatives (5)
  - Research Engineering representatives (1)
  - Science representatives (?)
  - Operations representatives (?)

What is a platform?

A platform provides and manages shared resources to scientific instruments

–Multiple science users, shared resources
- •Energy
- •Physical space
- •Data storage and telemetry
- •Navigation, propulsion, location
- •Access to data

–Common interface standards

–Reconfigurable

Example Platforms

Platform — Not Platform

ROV
AUV
Moorings (MOOS)
Cabled Observatory (MARS)
Gliders

Benthic Rover
AUV Dock (not for science)

BiOSA (may be either)
LOBO Moorings (like OASIS)
OASIS (became platform later)

CTD (access to the data, management)
ESP (being developed as instrument)
Raman Spectrometer
Benthic Respirometer

•Platform status implies responsibilities
- –Development path
- –Engineering methods, quality
- –Operation, Management

•It is important how management views projects

Draft Plan

- Metrics for success
  - Metrics for engineering success in MBARI strategic plan
  - Adoption of platforms technologies and standards by MBARI and community
  - Solicitation and external recognition of expertise in platforms

SWOT

Strengths	**Opportunities**
Weaknesses	**Threats**

SWOT Results

Strengths

Skill sets and experience
Deployment resources
Relatively stable funding
Access to scientists
Latitude in setting direction

Opportunities

Community initiatives
New platform types
Emerging technologies
Collaborations
Proposal process reform

SWOT Results

Weaknesses

Understanding user needs/domains
Diversity of stakeholder needs/agendas
Resource issues
- Fixed size and composition of core engineering
- Number of operational systems
- Limited basic research capability
- Technical support, lab space (excellent quality, need more)

Nature of platforms
- Technology push more than science pull
- Long, expensive, high risk development cycles

Environmental Survey Results

Weaknesses

Skills Related
- –Science literacy (hotly debated)

Tracking tech/science trends

Project Management
- –Quantitative comparison of platforms: economics, science value

Environmental Survey Results

Threats

Rapid changes in technology and science

Mis-alignment with Packard Foundation values

Wider restrictions within marine sanctuary

Competition
- •Institutional
- •Private sector

Presentation Overview

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- SWOT

Science Input

Analysis
- Core Competencies → Potential Directions
- Challenges → Meeting Challenges

Action

Science Story

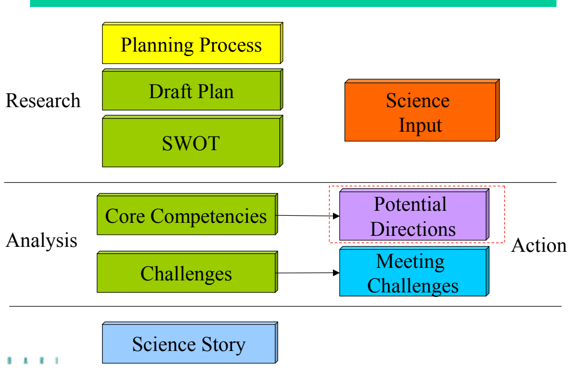
Core Competencies

- Systems architecture and integration
- Structural mechanical design
- Vehicles (operational systems)
- Power systems
- Application layer software
- Embedded software
- Control systems
- Hydrodynamics
- Vehicle dynamics
- Field experience in ocean engineering – designing things for the real world

Playing to Strengths

- High risk projects (difficult to get initial funding)
- Long cycle projects with intermediate science opportunities
- Design for technology transfer
  - Lower barriers to adoption, operation, adaptation
  - Requires investment in engineering, tooling, documentation
- Highly robust systems
  - Grand Challenge: Long maintenance-free deployments
- Low-impact/green engineering
- Deep ocean systems
- Science literacy/specialization

Presentation Overview



Mark

ROV’s, AUVs, Buoy’s and the rest…

Platforms Technical Opportunities

Major MBARI Platform Efforts

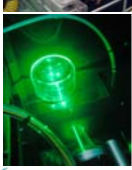
- AUV’s
- ROV’s
- Observatories
  - Cable-to-shore (high power!)
    - New experimental opportunities
  - Buoy based (low power)
    - Upper Water Column
    - Cable-to-the-seafloor
- Vertical profilers

Other Platform Initiatives
…..not necessarily in Engineering or Platforms group

- Lobo
- Broadband Seismometer
- Benthic crawler
- ….and ??

Trends in ROV Use

- Camera platform
- Sample retrieval

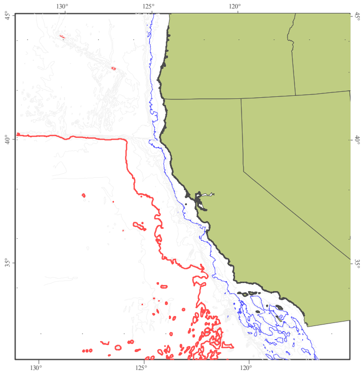


- Complex in-situ experiment installation
- Assembly of seafloor observatories
- Precision mapping

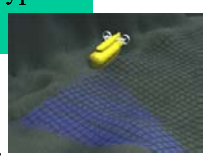
The Future of ROV's

- Vehicle vs payload trends
- Navigation
- Advanced control functions
  - Pilot aids
  - Vision based mapping/mosaic building
  - Quantitative video
  - 3D scene synthesis
- Tiburon upgrade
  - Power increase
  - Payload increase
  - Deeper rating?

Tiburon and Ventana Benthic Coverage



The Future – is it HROV Type Vehicles?



- WHOI HROV, 25kg payload
  - "The HROV will enable routine scientific research from 6,500 meters to 11,000 meters deep"

- Japanese HROV vehicle "UROV7K"

ROV Summary

- What technology advances will enable better ROV science?
  - *Payload, Navigation, Instrument interfaces (ROVUC)*
- How can an ROV come closer to matching the sensory/cognitive experience of an HOV?
  - *Synthetic scene creation from multiple data sources (NAS report)*
- What ROV capabilities are needed to construct and maintain the next generation of ocean observatories?
  - *Payload, Manipulation ability*
- Should MBARI engineering reinvest in ROV development?
  - *Core vehicle development*
  - *Value-added to Tiburon replacement commercial vehicle*
  - *Specialized ROV tools*

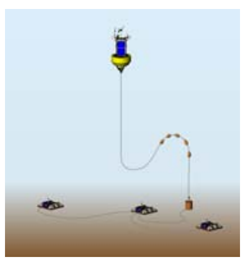
MBARI Observatory Development Programs
MARS - *Opportunities*

- Development of science interface hardware and software.
- Design of individual experiments, i.e. IODP borehole apparatus, etc.
- Participation in the migration of technology to Neptune.
- Exposure to broad range of community initiated observatory experiments.

Monterey Accelerated Research System (MARS)

MBARI Observatory Development Programs
MOOS Mooring - *Opportunities*

- Enabling unique seafloor experiments that require medium power and near-real-time data return – *in areas not accessible to MARS*
- Adoption of MOOS technology as DEOS mid-latitude mooring solution
- Maintaining plug compatibility with MARS for low and medium powered experiments
- Solving the observatory time distribution problem (<10msec)

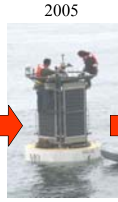


Monterey Ocean Observing System (MOOS) Mooring

1990

2000

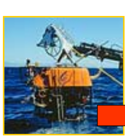
2005



200?

?

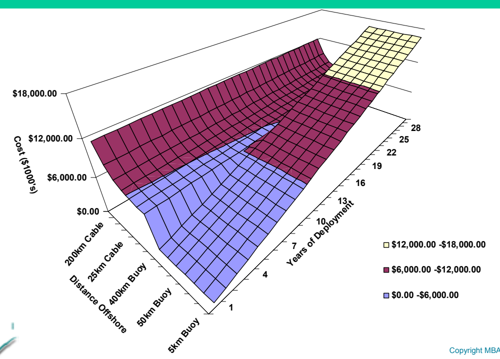
- •Replace M1, M2
- •Low cost array
- •Station-keeping
- •Advances in vertical profiling



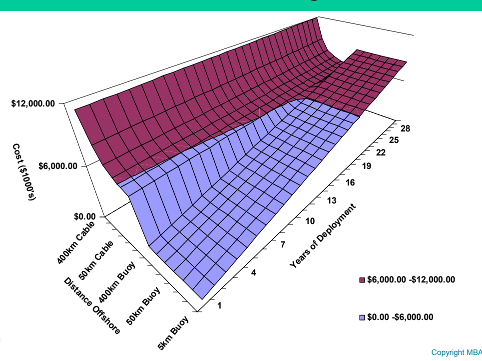
?

- •Beyond MSE Experiment
- •ORION mid-Latitude mooring

Observatory Costs: Shore Cables and Buoys
Annual Servicing



Observatory Costs: Shore Cables and Buoys
2 Year Servicing



Under Sampled Regions and Processes

- Epipelagic ROV sampling
- Near-surface high resolution profiling
- High energy Benthic events

"New measurements result in new discoveries" – Dave Caress

Technologies for capitalizing on opportunities in Platforms

- Systems Engineering of hardware and software
  - Optimize interfaces, distribution of functions, design trade-offs, etc.
- Multi-instrument and multi-platform software systems
- Adaptive sampling
- Integrated sampling schemes (optimized experiment design)
  - Moorings, Gliders, AUV's, Docks
  - Event detection for initiating other sampling methods
- Energy harvesting, storage & distribution
  - Solar, wind and wave energy
  - Fuel cells, batteries.
  - High efficiency voltage conversion

Technologies for Platforms …*continued*

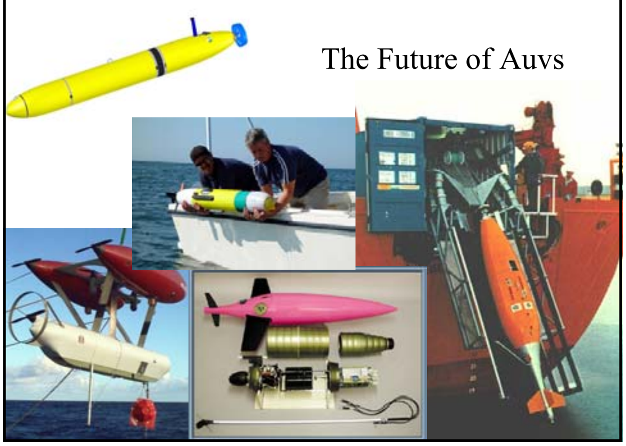
- Copper and Optical communications
- Satellite communications
  - Broadband..still showing promise.
- Acoustic communications
  - Data rates are now >10kb/sec./10km @ 10W (Freitag et. al.)
- Fiber ropes
- Vehicle dynamic modeling & simulation
- Cable dynamic modeling
- Materials science

Which Paths to Follow?

- MBARI has an effort in every major platform technology (except gliders, remote aircraft and a few others..)
- Where can we have the most impact?
  - Given size of MBARI….
  - Our in-house science expertise…
  - Our engineering expertise
  - Our unique facilities

Rob

The Future of Auvs



Outline

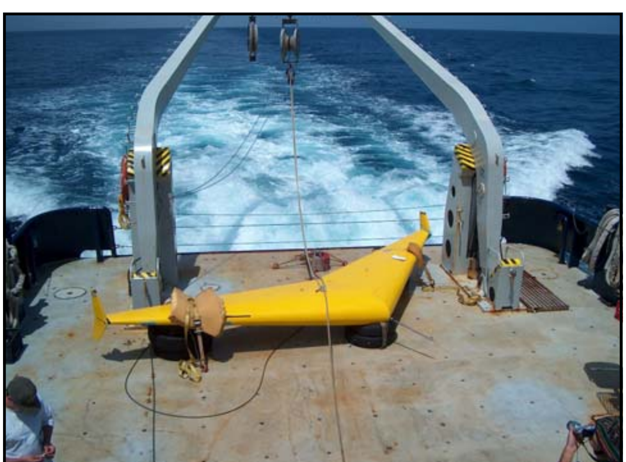
- Fundamental Auv Limitations
- Research Areas
  - General Near and Far Future
  - In Progress at Mbari
  - Example: Maximizing Range
    - Size Tradeoff
    - Efficiency and Energy
- Potential Mbari Auv R&D

Fundamental Auv Limitations

- Range & Energy
- Autonomy & Intelligence
- Speed of Response

Auvs – Near (<5 Yrs.) Research Areas

- Increase Autonomy
  - Guidance (AI), obstacle avoidance, safemodes
- Acoustic Communications
- Adaptive Sampling
- Increase Auv Endurance and Range
  - Increase Propulsion Efficiency: Gliders
    - Horton Wing at Scripps. Bigger & Faster
  - Hybrid Glider/Propeller
  - (Mbari: Reduce drag and hotel load)
- Smaller Auvs (Remus, Ranger)



Auvs – Further Ahead (>5 Yrs)

- Energy Scavenging AUVs: Solar; Thermal Glider
- Improved synoptic (simultaneous) sampling with multiple AUVs. (AOSN)
- Increase Auv Endurance and Range
  - Higher energy density batteries or fuelcell
  - Increase propulsion efficiency (?) - Bio-memetic Propulsion (Flapping Fins, Robotuna)
- Autonomous Intervention. Auv Operates Like an Rov.
  - Hovering AUV with robotic arm (Stanford, Otter)
- Rapid Event Response
  - Network of AUVs triggered from docking stations (Larger?)
  - (Another way is a small Auv launched by small boat or aircraft)

Solar Powered Auv

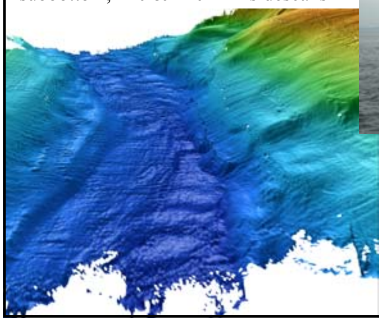
Auvs – Ongoing R&D at Mbari

- Gulper. 12x1-liter sample and return with the AUV.
- Real-time assimilation of Auv data into ocean models for ocean prediction and adaptive sampling (AOSN)
- Obstacle Avoidance & Bottom Following
  - Unattended operations
- Prototype Dock and Vehicle
- Mapping Auv Development

MBARI Mapping AUV

Efficient high-resolution seafloor mapping in the deep ocean

200 kHz multibeam, 2-16 kHz subbottom, 110 & 410 kHz sidescans



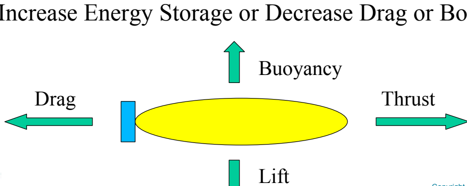
Most recent near-bottom ROV-based survey achieved 1 m lateral resolutionand 0.3 m vertical precision

Fundamental Auv Tradeoff: Large or Small?

- Large
  - More efficient: longer range and endurance
  - Deep-capable vehicles tend to be bigger
    - Heavier housings, denser foam (Remus vs. S MS)
  - Larger and more varied payload capacity
  - Easier to maintain
- Small
  - Easily Launched; Facilitates Rapid Event Response
    - Small, fast and inexpensive boat
    - Ease of launch can avoid the necessity of a dock
    - Increased range with aircraft launch
  - Easy to transport and ship
  - Miniaturization (electronics, Mems) may greatly increase advantage in near future
  - Significantly Lower cost of support equipment (Ship, L&R)

Maximizing Auv Range

- Gliders More Efficient But Slower
  - Seaglider: 6000km, 2.7 kWh, 0.25 m/s
  - Remus (propeller driven): 100km, 1kWh, 1.5 m/s
- Airplanes and Submarines Governed by the Same Equations for Mach < .3
- Increase Energy Storage or Decrease Drag or Both

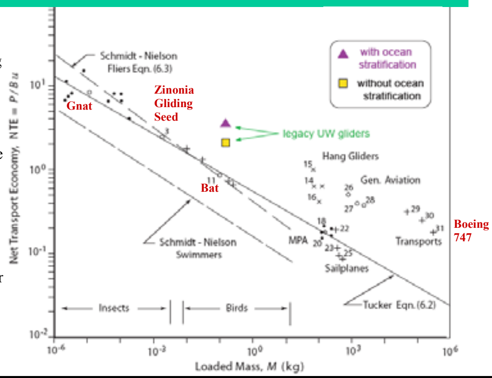


Net Transport Economy for Winged Flight

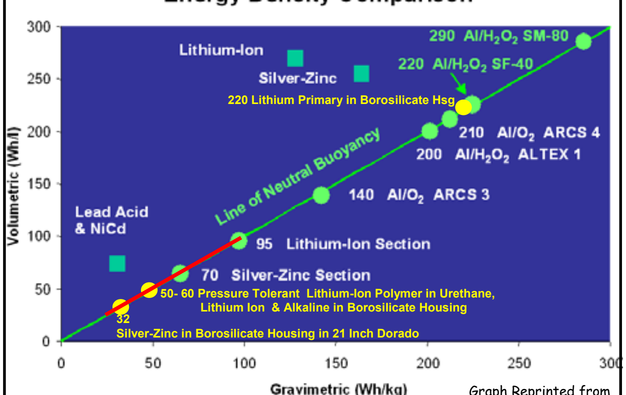
- Joules/Newton/m
- Includes Hotel
- 12 Orders of Mag
- Heavier vehicles are more efficient
- BUT:

Propeller driven Auvs don't require lift

From "Underwater Glider System Study"



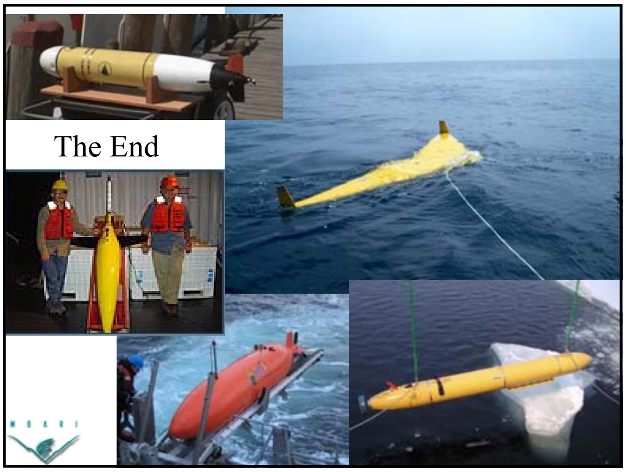
Energy Density Comparison



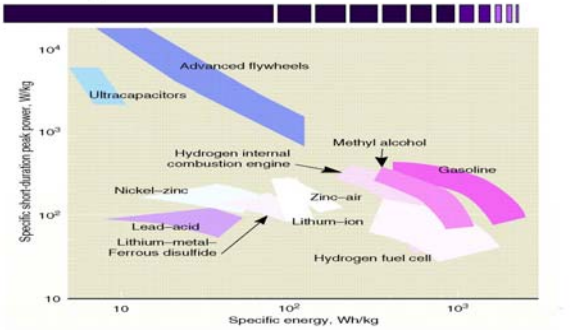
Graph Reprinted from Fuel Cell Technologies

Mbari Auv Opportunities

- Increase Autonomy
  - Unattended Operations
- Docking
  - Event Response
- Multiple Auvs & Real-Time Ocean Model
- Increase Range
- Continue to Improve and Develop Mapping & Ctd Auvs based on Operational Performance



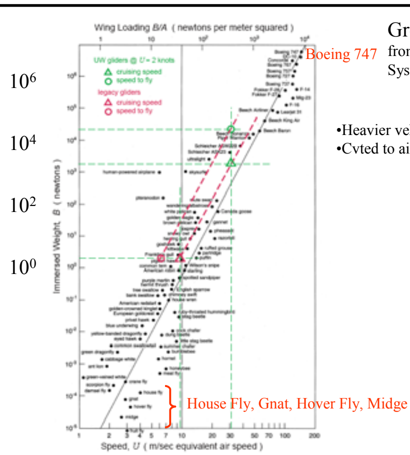
Comparison of Different Energy-Storage Technologies Regarding Peak Power and Specific Energy Characteristics



From http://www.eere.energy.gov/distributedpower/pdfs/review2q01pres/epripeacb_q2.pdf

Great Flight Diagram

from "Underwater Glider System Study"



- Heavier vehicles go faster
- Cvted to airspeed

$$U_A = \sqrt{\frac{\rho_W}{\rho_A}} U_W$$

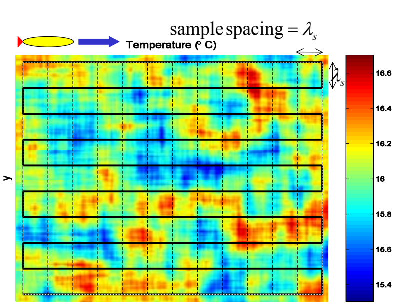
$$43 = \sqrt{\frac{1025}{1.25}} 1.5$$

Yanwu

Sampling the Ocean with Autonomous Underwater Vehicles

- An AUV survey design tool *.
- Ongoing work.

* J. G. Bellingham and J. S. Willcox, “Optimizing AUV Oceanographic Surveys”, *Proc. IEEE Symposium on Autonomous Underwater Vehicle Technology*, Monterey, CA, pp. 391-398, June 1996.



$$\text{AUV traveled distance } L \approx \frac{\text{survey area } A}{\lambda_s}$$

$$\text{Survey duration } \tau = \frac{L}{V} = \frac{A}{\lambda_s V}$$

AUV Sampling Strategy Optimization

Objective:
Reconstruct a synoptic ocean field by non-synoptic AUV samples

Energy consumption analysis

Reconstruction error analysis

Survey parameters optimization

AUV Energy Consumption

$$E = (P_{propulsion} + P_{hotel})\tau$$

survey duration

hotel power: control and sensors

propulsion power = $\dfrac{\rho C_d S V^3}{2\eta}$

AUV speed

AUV Survey Error

Spatial aliasing (undersampling) error :

$$\varepsilon_\lambda = \frac{\text{spectral power over Nyquist wavenumber } k_{\text{Nyquist}}}{\text{total spectral power}}$$

where $k_{\text{Nyquist}} = \frac{1}{2} \cdot \frac{2\pi}{\lambda_s}$

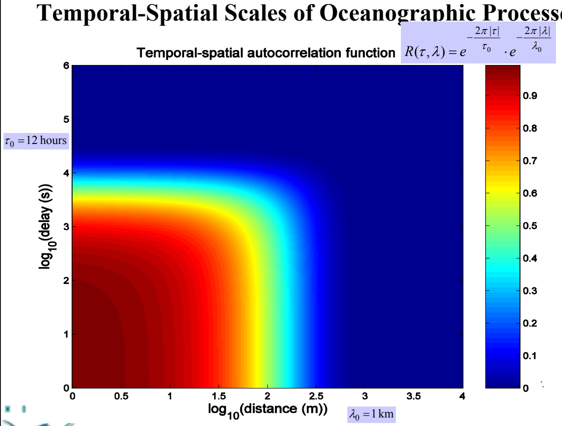
Temporal smearing (non-synoptic) error :

$$\varepsilon_\tau = 1 - \frac{1}{\tau}\int_{-\frac{\tau}{2}}^{\frac{\tau}{2}} R_t(q)\, dq$$

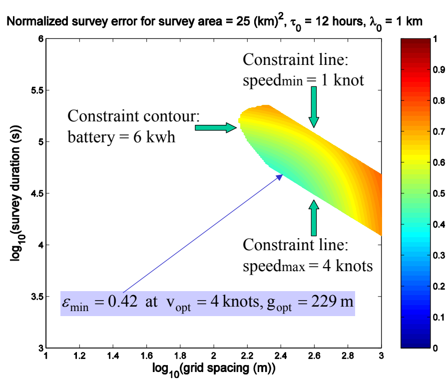
where $R_t(q) = E[X(t,r)\, X(t-q,r)]$

Total error $\varepsilon_{total} = 1 - (1-\varepsilon_\lambda)(1-\varepsilon_\tau)$

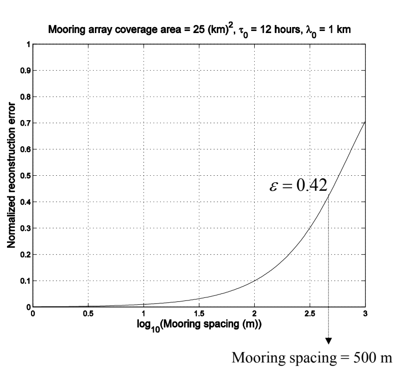
Temporal-Spatial Scales of Oceanographic Processes



AUV Survey Error Example



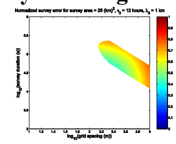
Reconstruction Error when Using an Array of Moorings



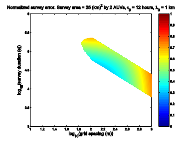
Mooring spacing = 500 m
Number of moorings = 100

Reducing Survey Error by Running Multiple AUVs

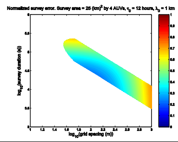
Running one AUV:
$\varepsilon_{\min} = 0.42$



Running two AUVs:
$\varepsilon_{\min} = 0.32$



Running four AUVs:
$\varepsilon_{\min} = 0.24$

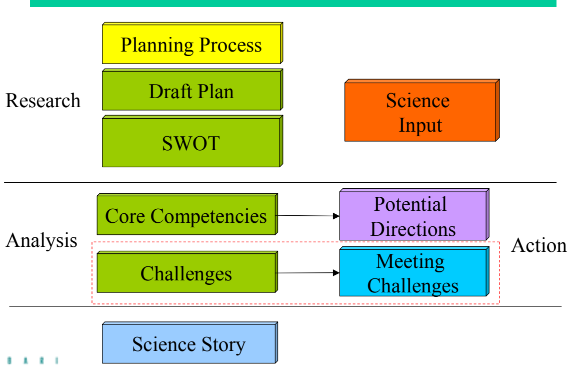


Ongoing Work

- Generalize the temporal-spatial survey error analysis by employing the Mingled Spectrum Principle*.
- Assimilate AUV data into an ocean model. Extend the AUV survey error analysis to ocean prediction error analysis.

* Y. Zhang, A. B. Baggeroer, and J. G. Bellingham, "Spectral-Feature Classification of Oceanographic Processes Using an Autonomous Underwater Vehicle", *IEEE Journal of Oceanic Engineering*, Vol. 26, No. 4, pp. 726-741, October 2001.

Presentation Overview



Tom

Meeting the Challenges

- The Roadmap
- Evaluation of proposals and projects
- Project execution
- Staying current on science and technology trends
- Resource issues
- Maintaining communication with science and operations

The Roadmap

- Produced with active science participation
- Identify most promising platform-related science and technical developments
- Evaluate science impact, economics, social relevance, other criteria (quantitative where possible)
- External reviews of the roadmap?
- Distributed to institute
- Update as needed (~ every few years?)

Evaluation of proposals and projects

- Strategic council – consists of engineers (from instruments, SDS, platforms), scientists, DMO
- Council evaluates and ranks submitted proposals - using roadmaps as *guides*
- *Does council have a role to recommending existing project/system termination?*
- Communicate findings to management, in advisory role
- Recognize that some off-the-roadmap proposals may be very worthy of support

Project execution

- Platform project design and schedule has major impact on many users – very important to get this right!
- *Tiburon, MOOS,* others, provide valuable lessons
- Length of development cycles, slipped milestones are a major problem
  - Users move on to other projects
  - External technology continues to evolve
  - Project becomes irrelevant
- Designs perceived by users as not meeting requirements, or meeting wrong requirements

Project execution

- Committed *team* of developers and science/ops users is *critical* to project success
  - Users provide continuous feedback to developers – answers "Are we building something useful?"
  - Science/ops management must buy into commitment
- Developers and users jointly define project milestones, including science deployments of prototype
  - Provide as much science payoff as possible
  - Keeps user involved, success stories attract more users

Project execution

- Rapid development of working prototypes
  - Continuous, frequent user evaluation
- Be willing to adopt adaptive development techniques
  - Software requirements often change based on user evaluations of prototype, intermediate deployments
  - New science opportunities may emerge during platform development
- Missed milestones: accountability
  - Team must objectively determine why milestone was missed, adjust process as necessary
  - Critical to maintain credibility, user involvement/commitment

Staying current with science and technology trends

- Seminars (many free local opportunities)
- Conference attendance
  - Authorship is a goal, but not necessarily a requirement
- Technical society memberships, participation
- Technical courses
- Contingency time for research
- Must be commitment by engineers and management to make the necessary investment

Resources

- More than one major project per engineer jeopardizes schedule and quality
  - Industrial practices back up this claim
  - Some excellent development techniques (e.g. Agile programming) only work when engineer dedicated to single project
  - Particularly important, given MBARI goal of technology innovation – project may become irrelevant if effort is diffused
  - Lack of engineer focus may encourage MBARI scientists to go elsewhere for engineering talent

Resources: external collaborations

- Bring external platforms expertise to bear; disseminate MBARI technology
  - Mission planning, simulation and scheduling: Ames, JPL
  - Autonomy: Stanford, Ames, JPL
  - Observatory infrastructure: SIO, Intel, Indiana University, LOOKING team
  - Doubtless many others…

Ed

Platforms Engineering: *Building the Science Connection*

- This section is about *process* (how we connect with ocean science)… not about *content* (what we build for ocean science).
- Review: Goals of Re-Org
- Role of Platforms Strategic Council
- Interaction strategies
  - Incremental Development
  - Technology Briefings
  - Lab Leads
  - Informal Interactions

Mission of MBARI: *Make the Connection*

- "… to achieve a position as a world center for advanced research… and to do so through better instruments, systems, and methods…" (David Packard, 1995)
- The key to MBARI's success is the nucleation of good technology that enables leading-edge science. Neither alone will do.
- This implies a close working relationship between science and engineering (and operations)… NOT an arms-length contract-house ("just give me the specs") relationship.

Why Re-Organize?

- Before Re-Org:
  - EE/ME/SE organization, project teams; difficult to maintain focus on a science field other than on an ad-hoc basis.
  - Science world-view (experiment -> measurements -> instruments -> systems) did not map onto Engineering organization; no designated points-of-contact other than ad-hoc basis.
- After Re-Org:
  - Engineers in "product line" teams; encouraged to focus on specific science field
  - **Strategic Council** provides formal focus and point-of-contact for Science/Engineering interaction

How Platforms Will Build the Science Connection

- Strategic Council
- Proposal Process
- Incremental Development
- Technology Briefings
- Informal Interactions

Role of the Platforms Strategic Council

- Provide a designated forum to which both Science and Engineering can bring platform-related *issues*.
- Composed of 3-5 staff from Science and Engineering.
- Example *issues* could include:
  - Future science directions – needs – emphases
  - Emerging technologies and trends
  - Evaluation, comment, prioritization of platform-related proposals
  - Monitoring progress, mid-course corrections for ongoing projects

Role in the Proposal Process

- Platforms Strategic Plan should be developed and/or endorsed by the Platforms Strategic Council
- Strategic Plan should identify science areas of emphasis and technology focus… near-term and long-term views.
- Strategic Plan should form backbone of the proposal evaluation process (like a town's General Plan)… help reject outlier proposals and keep limited resources focused.
- Strategic Council should have role in commenting on platform-related proposals (input to Management)

Other Interaction Strategies

- Incremental Development
  - *Require* all projects to deliver yearly (or more often) testable technology demonstrators. Keeps builders and customers focused; enables mid-course corrections; avoids "Five-Year Syndrome"

Informal Interactions

- Technology Briefings
  - Designated engineers present latest tech in key areas (nav, batteries, AUVs, etc) to Strategic Council. Occasional basis, or after conferences (Oceans, etc).
- Science Briefings
  - Designated scientists summarize latest research thinking and directions to Strategic Council. Occasional basis (as above… after AGU, etc).

Informal Interactions (cont'd)

- Friday afternoon 4 PM "round table talks" – "teach-ins" and chance for free-ranging discussion & gossip
- Oceanography 101

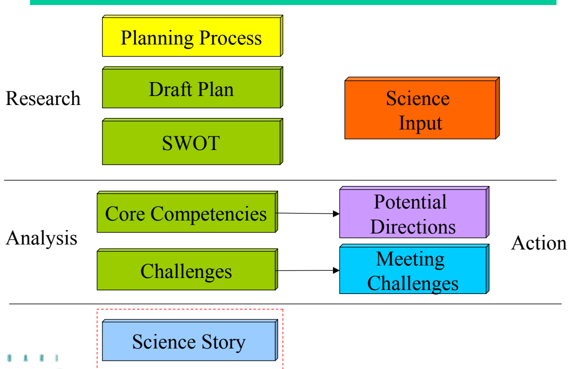
Lab Leads

- Platforms Engineering members assigned to follow activities (experiments, equipment development, cruises, papers, results) of specific scientists and/or labs… report to whole Platforms Group.
- Possibly extend concept to include main DMO groups (Flyer/Tiburon, Lobos/Ventana, Zephyr/AUVs, OSG)

Cruise Participation

- Can be a valuable opportunity for in-the-trenches view of research.
- Depends on first establishing good rapport with a lab or investigator.
- Role on cruise must be chosen carefully: must have a job, job should be non-menial.
- Example roles would be to field test a new off-the-shelf gadget, or to design and test a simple upgrade to some existing equipment.

Presentation Overview



John Ryan

Autonomous Event Response: Harmful Algal Blooms

Discussion

Platforms Engineering
Strategic Planning Update

M. Chaffey - A. Hamilton - K Headley
R McEwen - E Mellinger
T O'Reilly - Y Zhang

MBARI Offsite Meeting
March 21-23, 2005
Napa, CA

Planning Activities

- Reading list
- SWOT analysis
- Scientist meetings
- Technology survey
- Discussions
- Draft plan

Strengths	**Opportunities**
Weaknesses	**Threats**

Meetings

Held 3 meetings with MBARI Science Staff

Topics:

– Current research interests that would benefit from platform engineering development.

– Concerns related to engineering project selection and structuring at MBARI.

– Methods of improving interactions between the engineering and science divisions.

Research Topics

- Primary Ocean Productivity (K. Johnson)
  - Drifting Profilers (Chem. Sensors on ARGOS Floats)
  - Ocean wide Coverage
- Seafloor Mapping (D. Caress)
  - Multibeam, Sub-bottom, Side-scan
  - Institute Support Necessary
- Marine Geology (Charlie Paull)
  - Flux of Fluids and Gasses Through Seafloor
  - Transport of Sediment Across Seafloor
- 2nd Meeting: Scholin, Barry

Technological Limitations

Energy constraint
- Mobile platforms and deployed instruments are limited by energy constraints.
- - Deployment Duration, Sample Rates, Communication Rates/Range, …

Lack of measurement techniques
- Measuring number of particles in water
- No measurement techniques between bulk properties and microscopic assay
- Difficult to observe and characterize thin layers (and other morphologies) of water (layers are easiest to find)
- Chemical sample processing time

Sensor accuracy
- Sensor drift

Reliability
- Endurance of platforms/cables/instruments
- Biofouling

Size and Scale of Ocean vs available observing technology

Concerns

- Too many projects, lack of consistent focus.
- Projects take too long, need to find the balance between immediate results and generalized utility.
- Large, engineering driven projects are susceptible to a disconnect between engineering and science.
- Concern that rush to move on to new projects may leave potential of current projects unrealized.
- Concern that new engineering thrusts may neglect importance of ROV developments.

Improving Interactions

- Recognize range of projects that engineering participates in: Small science driven projects on one hand, major engineering initiatives on the other.
- Structure large projects with more incremental implementation steps. Don't start on these projects without refined plans that include shorter duration accomplishments.
- Involve engineering staff in traditional science cruises.
- Improve relevance of new engineering driven proposals to current science interests.

Draft Plan

- Mission Statement
  Inform and implement the development of platforms and related technologies at MBARI
- Charter
  - Support MBARI's institutional mission
  - Maintain a strategic plan for ocean observing platforms and technologies
  - Provide expertise and guidance in platforms and related technology
    - Science, Operators, Management, Community
    - MBARI Engineering
- Composition
  - Platforms Engineering representatives (5)
  - Research Engineering representatives (1)
  - Science representatives (?)
  - Operations representatives (?)

What is a platform?

A platform provides and manages shared resources to scientific instruments

–Multiple science users, shared resources
- •Energy
- •Physical space
- •Data storage and telemetry
- •Navigation, propulsion, location
- •Access to data

–Common interface standards

–Reconfigurable

Draft Plan

- Metrics for success
  - Metrics for engineering success in MBARI strategic plan
  - Adoption of platforms technologies and standards by MBARI and community
  - Solicitation and external recognition of expertise in platforms

SWOT Results

Strengths	Opportunities
Skill sets and experience Deployment resources Relatively stable funding Access to scientists Latitude in setting direction	Community initiatives New platform types Emerging technologies Collaborations Proposal process reform

SWOT Results

Weaknesses

Understanding user needs/domains
Diversity of stakeholder needs/agendas
Resource issues
- –Fixed size and composition of core engineering
- –Number of operational systems
- –Limited basic research capability
- –Technical support, lab space (excellent quality, need more)

Nature of platforms
- –Technology push more than science pull
- –Long, expensive, high risk development cycles

Environmental Survey Results

Weaknesses

Skills Related
- –Science literacy (hotly debated)

Tracking tech/science trends
Project Management
- –Quantitative comparison of platforms: economics, science value

Environmental Survey Results

Threats

Rapid changes in technology and science
Mis-alignment with Packard Foundation values
Wider restrictions within marine sanctuary
Competition
- •Institutional
- •Private sector

Core Competencies

•Systems architecture and integration
•Structural mechanical design
•Vehicles (operational systems)
•Power systems
•Application layer software
•Embedded software
•Control systems
•Hydrodynamics
•Vehicle dynamics
•Field experience in ocean engineering – designing things for the real world

Playing to Strengths

•High risk projects (difficult to get initial funding)
•Long cycle projects with intermediate science opportunities
•Design for technology transfer
  –Lower barriers to adoption, operation, adaptation
  –Requires investment in engineering, tooling, documentation
•Highly robust systems
  –Grand Challenge: Long maintenance-free deployments
•Low-impact/green engineering
•Deep ocean systems
•Science literacy/specialization

Next Steps

- Determine structure and interfaces to council
- Coordinate with other groups to make a single roadmap
- Gather more strategic information
  - Science input
  - Operations input
  - Technology Survey
  - Review of previous projects
  - Identify technology limits, common threads

Next Steps

- Connections with science
  - Cruise participation
  - Lab Leads
  - Oceanography 101
- Address resource issues

- Proposal process
  - Evaluating opportunities
  - Influencing Proposals: before, during and after proposal process
- Work on systems engineering processes