



# Transforming Remotely Conducted Research

## The NSF-INSPIRE “TREET” Partnership

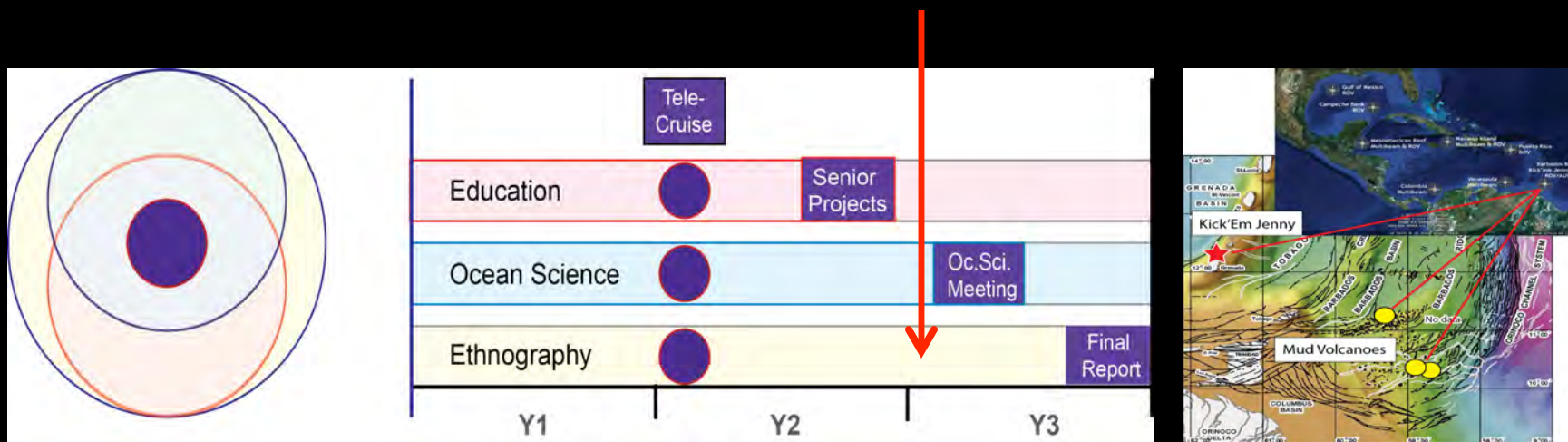
(NSF Directorates: OCE, EHR, CISE)



Chris German (WHOI)  
 Katy Croff Bell (OET) & Amy Pallant (Concord Consortium)  
 Zara Mirmalek & Sheila Jasanoff (Kennedy School, Harvard)

### Goals:

1. Experiment with using telepresence to conduct an entire ROV field program from shore.
2. Use early career scientists, acquiring digital data sets, with no need for sample handling.
3. Treat the ocean science project as an experiment for educational & ethnographic research.





# Transforming Remotely Conducted Research Introduction to DESSC Dec 2015 Report



## TREET Cruise Data Collection: Objectives & Outcomes

### Outcomes:

- 1 & 2: For background on the Ocean Sciences work see
  - last year's report to DESSC (available on-line)
  - next year's special session at AGU Ocean Sciences
- 3. The focus of this year's report to DESSC.

Locale	Science Operations	Data Needs:	Data Needs:						Data Needs:						Amy	Zara	
			Chris R	Eric	Pete	Scott	Anna	Masako	Carly	Cody	Laney	Tyler	Silas	Taylor			Alex
KEJ Crater	Detailed mapping in KEJ Crater		✓						✓	✓							
	Photo-mosaic in KEJ Crater		✓						✓	✓							
	Magnetic Survey of KEJ						✓				✓						
	Laser Spec at somewhere/anywhere			✓	✓	✓											
	Fluid flow somewhere/anywhere		✓														
	Bubble flow in KEJ		✓														
KEJ Flanks	Geology/fluids outside KEJ crater											✓					
	Dive-based studies of KEJ flank										✓						
KEJ Seeps	Animal photos at KEJ seeps													✓			
	Laser spec at KEJ seeps													✗			
BMV Seeps	Laser spec at BMV												✗				
	Bubble & fluid flow at BMV		✓	✓									✓				
Education	Evaluate & Survey UG experience															✓	
Ethnography	Work practice (qualitative) data																✓

Updated 12-Dec

Key	✓	Achieved
	✗	Attempted
	✗	To Be Done
	✗	Not Done

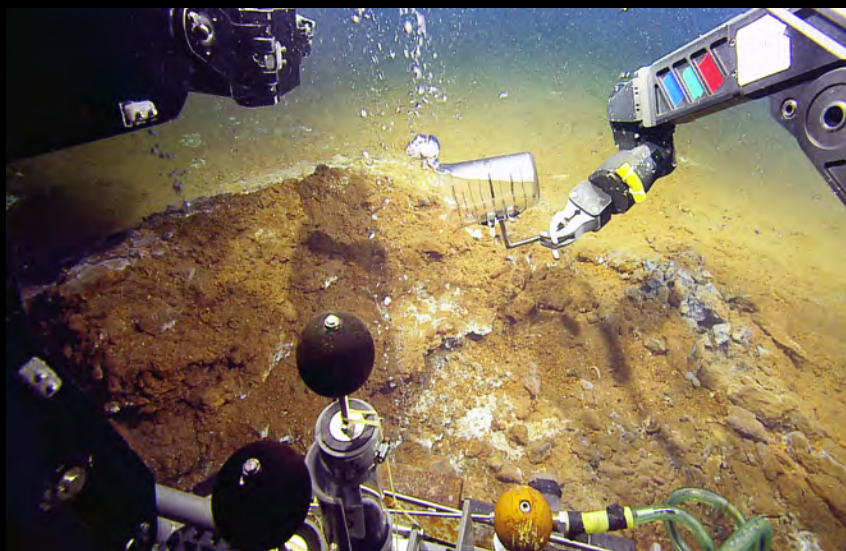


# Transforming Remotely Conducted Research Introduction to DESSC Dec 2015 Report



## Ocean Sciences Re-Cap

- 13-week *synchronous* pre-cruise semester (7 locations, 4 time zones)
- 2-week cruise completed 10 of 12 projects across 4 locations to satisfy science requirements of 6 Early Career Scientists & 7 UGrad Students.
- 5-week *synchronous* post-cruise semester (8 locations, 10 time zones)  
[See *AGU Ocean Sciences 2016 Special Session abstracts for details*]







# Transforming Remotely Conducted Research Educational Research (Slide 1 of 2)



- Concord Consortium explored the degree to which undergraduates conduct ALL aspects of the research.
- Students utilized the pre-cruise hybrid learning environment to prepare to conduct research remotely.
- They were exposed to real-world scientific discourse throughout the project: they engaged in the scientific process and learned substantial scientific content.



- Use of telepresence allowed for extended exposure to real-world scientific problem-solving.
- Remote interactions with senior scientists were sufficiently similar to what happens at sea that they added to the authenticity of the students' experience.



## Transforming Remotely Conducted Research Educational Research (Slide 2 of 2)



### Education Findings

- Undergraduates don't have the same flexibility as grad students and post-docs: important to keep academic calendars in mind and to support students in thinking about coursework over multiple semesters.
- Clear project planning is essential to ensure students receive data promptly.
- TREET students were able to direct collection of their own data, but:
  - This was new for all parties and challenging for many scientists.
  - Students lacked situational awareness about ship and ship conditions.
  - Ship-board personnel lacked situational awareness about shore party.
- Scientists & shipboard staff (e.g. Captain, ROV team) need to all be aware of the students' goals and project structure, including involvement in mentoring.
- There may be other ways to conduct undergraduate remote research, but important not to retreat too far, into just passive observation/mild questioning.



## Transforming Remotely Conducted Research Educational Research (Slide 3 of 2)



### Further Analysis In Progress (HKS, Harvard)

- Telepresence capabilities allow ocean scientists to train undergraduate students, via real-time activities, in the development of professional vision, scientific deliberation & social communication.
- Because TREET undergraduate participants included students with varying degrees of interest in pursuing ocean science, it was not a forgone conclusion that there would be 100% follow-through or further interest in ocean science. Beyond the 100% follow-through of TREET requirements during the TREET cruise and post-cruise activities\*, students sought out opportunities that demonstrate an increase in active interest in ocean science.

\*One student withdrew from the program early in Y1



# Transforming Remotely Conducted Research Ethnographic Research (Slide 1 of 4)



## What *is* Ethnography?

- Ethnography is the study of culture – the practices through which a community understands itself. Those practices include habits, values, social norms, assumptions and languages/vocabularies that community members use to make sense of their behaviour and to guide behaviour and relationships.

### Background:

- Ethnographic studies of science & engineering workplaces create robust accounts of social practices used in the achievement of scientific breakthroughs and technological innovations.
- These accounts, referred to as “thick descriptions”, provide insight into day-to-day work practices of scientists at the micro-level and their relation to larger institutional, political and historical context.

(For more background info see Ethnography section at [www.who.edu/treet](http://www.who.edu/treet))





# Transforming Remotely Conducted Research Ethnographic Research (Slide 2 of 4)



TREET Data collection: 2 years of continuous observations: at sea (on & off-shore in 2013, 2014) during on-line seminars (2014, 2015). Additional Interviews were conducted continuously, Summer 2013 to Summer 2015.

TREET Human Subjects: All TREET participants (Senior Scientist Mentors, Early Career Scientists, Undergraduate Students), plus non-TREET Scientists, Engineers & Project Administrators.



- (1) TREET participants at the Inner Space Center (ISC) connected to *Nautilus* & *Herc* ROV (left, lower).
- (2) TREET participants at the ISC working with colleagues on *Nautilus* in instrument repair (right, upper).
- (3) TREET participants at WHOI connected to both the ISC and the EV *Nautilus*/ROV *Herc* at the seafloor (right, lower).







## Transforming Remotely Conducted Research Ethnographic Research (Slide 3 of 4)



### Analysis To Date

- Telepresence enables scientific research in remote environments
  - via a *20<sup>th</sup> Century* defined usage with scientists on ship using camera-equipped remotely operated vehicles
  - via a *21<sup>st</sup> Century* defined usage with scientists on ship and on shore using camera-equipped remotely operated vehicles
- Telepresence for Ocean Science does not represent a radical relocation of scientists with respect to the human-machine relationship and the use of information communication technologies (e.g. ROVs and AUVs both involve scientists using video/data streams in their work) .
- The TREET study identifies “sites of friction” in the telepresence work process that can be addressed by adjustments in key areas: communication & decision-making habits; new technologies; situational awareness.



# Transforming Remotely Conducted Research Ethnographic Research: Slide 4 of 4



## Continuing Analysis: Ocean Science Themes

- Communication in the computer-mediated environment (e.g. social and technical networks that support, order or complicate discussions and decision-making among the science team).
- Professional culture, habits and values informing telepresence human-machine relationships (work practices).
- Decision making practices among science team members in the telepresence work environment (observed from multiple perspectives).
- Expanding and improving Situational Awareness - outlining specific technologies for robust connections across the distributed telepresence work environment.



TREET Participants working together in real time at the ISC (foreground) and on board *Nautilus* (lower right corner, background).



# Transforming Remotely Conducted Research Future Directions (Slide 1 of 2)



## TREET Project: Publication Plans

### Priority #1: Project-Wide Overview

- TREET article for a non-specialist audience on the value of telepresence as demonstrated through ocean sciences. Journal: *TBD – EOS? Science/Nature?*

### Education: 2 peer-reviewed journal articles currently being written

- A.Pallant et al., Journal: Journal of Geoscience Education
- A.Pallant et al., Journal: International Journal of Science Education

### Ethnography: 2 future publications in peer-reviewed journals

- Z.Mirmalek & S.Jasanoff, “Accessing and Representing Remote Environments for Science & Society. Journal: *Science, Technology & Human Values*
- Z.Mirmalek et al., “Science collectives and 21<sup>st</sup> Century socio-technological connections”. Journal: *Science as Culture*



## Transforming Remotely Conducted Research Future Directions (Slide 2 of 2)



### TREET Project Team: New Directions Already Identified

- Future development of telepresence for deep ocean research needs to change focus from understanding the ocean science work environment (involving ROVs, AUVs) as a wholly contained ship-board work environment to understanding that it is a **distributed workgroup environment** in which information flow is bi-directional across several sites, including both ship-to-shore and shore-to-shore.
- Deep ocean telepresence research work practices could inform the work design for future **space exploration** which also employs: distributed work groups; remotely operated vehicles; and real-time decision making.
- Future work in the area of **Citizen Science** should draw on the experience of telepresence enabled ships that have already introduced real-time access to the general public. The next step would be to draw upon both that experience and contemporary studies of collaboration between specialist and non-specialist observers as already demonstrated to be successful in ornithology and fisheries management studies.
- Telepresence may have important potential to prevent fieldwork demands impacting upon both **career retention and diversity** in the ocean sciences.