Sociotechnical aspects of new code collaborations

March 15, 2023

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Sandia National Laboratories

https://www.sandia.gov/-emraybo/

EXASCALE COMPUTING PROJECT

National Nuclear Security Administration

IDEAS productivity

U.S. DEPARTMENT OF ENERGY | Office of Science

I help teams deepen understanding by being embedded, often in different cultures.

- ERCIM Fellow
- First code team: FhG
- IDEAS-ECP/ECP Hardware & Integration
- Interns: Applied Math and CS

- Cultures: DARPA, DoD (Army, SOF, USMC, OSD, Team Orlando), BT Research, FhG FIT, INRIA, DOE Office of Science, Academia, National Labs
- Research: diffusion of innovations, virtual teams, teams of teams, immersive virtual environments, design of transmedia learning ecosystems, cultural awareness
- Institutional PI for ECP IDEAS Productivity since 2018, transmedia learning since 2010, games, immersive virtual environments, social simulations, and intelligent community systems since 2000
- Passion: ***Seize opportunities that allow us to learn about ourselves and others***
- Favorite question: ***Why not?***

socio-technological

adjective

US /soh-see-oh-tek-nuh-loj-i-kuhl/

- of, relating to, or signifying the combination or interaction of social and technological factors.

- National Academies of Sciences Engineering and Medicine. Fostering responsible computing research: Foundations and practices. The National Academies Press, Washington, DC, 2022. URL: https://doi.org/10.172 26/26507.
- Trist, E. L. (1981). The sociotechnical perspective: The evolution of sociotechnical systems. In A. H. Van de Ven and W. F. Joyce (Eds.), Perspectives on organization design and behavior (pp. 19-75). New York: Wiley.

4 A Sociotechnical Approach

We have argued that as with any ubiquitous and influential technology, HPC scientists, researchers, educators, and practitioners should carefully consider the full impact of its influence and use within larger cultural and sociotechnical contexts, especially when considering the role of HPC in innovations such as smart cities, smart grids, driverless cars, large scale data analytics and other "intelligent" and self organizing systems [34]. We use the term *sociotechnical* in the present paper to express the authors' underlying theoretical perspective that society and technology are intertwined, influence each other, and that when innovating we should iteratively consider the social and cultural contexts of intended use as well as unintended consequences. According to the National Academy of Sciences [22]:

> A sociotechnical approach enables identifying, designing for, and tracking the benefits and risks that arise from introducing novel technologies into social worlds. It draws on social theories and social scientific methodologies, and empirical observations that enable the development of hypotheses about the ways people interact with the world around them.

We posit that a sociotechnical approach is a precursor to practicing responsible computing and innovation. That is to say, while "ethics provides tools for the moral evaluation of behaviors, institutions, and social structures and for dealing with choices among and conflicts between values" [22], before we can adequately address moral evaluations of institutions, social structures, etc., it is necessary to evaluate our *own* behaviors, assumptions, and biases. While early pioneers may

team

noun
US /tiːm/ UK /tiːm/

- A group (2 or more) of people who are interdependent with respect to information, resources, knowledge, and skills and who seek to combine the efforts to achieve a common goal.

Thompson, Leigh (2008). *Making the team : A guide for managers* (3rd ed.). Pearson/Prentice Hall.

TEAMS VS. GROUPS

A group is a collection of people. A **team** is an interdependent group of people working for a shared goal. A work team is a collection of individuals who share responsibility for specific outcomes for their organizations. Not everyone who works together or is in proximity belongs to a team. A team is a group of people who are interdependent with respect to information, resources, and skills and who seek to combine their efforts to achieve a common goal. Teams have five key defining characteristics.[3]

First, teams exist to achieve a **shared goal**. Simply put, teams have work to do. Teams produce outcomes for which members have collective responsibility and reap some form of collective reward. Second, team members are interdependent regarding a common goal. Interdependence is the hallmark of teamwork. **Interdependence** means that team members cannot achieve their goals single-handedly but instead, must rely on each other to meet shared objectives. There are several kinds of interdependencies, as team members must rely on others for information, expertise, resources, and support. Third, teams are bounded and remain relatively stable over time. **Boundedness** means the team has an identifiable membership; members, as well as nonmembers, know who is on the team. **Stability** refers to the tenure of membership. Most teams work together for a meaningful length of time—long enough to accomplish their goal. Fourth, team members have the **authority** to manage their own work and internal processes.

effectiveness

noun

US /əˈfek.tɪv.nəs/ UK /ɪˈfek.tɪv.nəs/

- the ability to be successful and produce the intended results.

- National Academies of Sciences Engineering and Medicine. Fostering responsible computing research: Foundations and practices. The National Academies Press, Washington, DC, 2022. URL: https://doi.org/10.172 26/26507.
- Trist, E. L. (1981). The sociotechnical perspective: The evolution of sociotechnical systems. In A. H. Van de Ven and W. F. Joyce (Eds.), Perspectives on organization design and behavior (pp. 19-75). New York: Wiley.

Definitions

- **Team science** – Scientific collaboration, i.e., research conducted by more than one individual in an interdependent fashion, including research conducted by small teams and larger groups.
- **Science teams** – Most team science is conducted by 2 to 10 individuals, and we refer to entities of this size as science teams.
- **Larger groups** – We refer to more than 10 individuals who conduct team science as larger groups.* These larger groups are often composed of many smaller science teams, and a few of them include hundreds or even thousands of scientists. Such very large groups typically possess a differentiated division of labor and an integrated structure to coordinate the smaller science teams; entities of this type are referred to as organizations in the social sciences.
- **Team effectiveness** (also referred to as **team performance**) – A team's capacity to achieve its goals and objectives. This capacity to achieve goals and objectives leads to improved outcomes for the team members (e.g., team member satisfaction and willingness to remain together), as well as outcomes produced or influenced by the team. In a science team or larger group, the outcomes include new research findings or methods and may also include translational applications of the research.

*Larger groups of scientists sometimes refer to themselves as "science teams."

Tutorial Learning Objectives

At the conclusion of this tutorial you will be able to describe

- **What** are Scientific [research] software teams
  - *What are the challenges?*
  - *What characteristics make teams effective?*
  - *What are the cultural dynamics that influence our communication?*

- **How** to develop engaged and productive (in-person, hybrid, and virtual) teams
  - *How do we build team cultures?*
  - *What are best practices for team communication?*
- **When** you have become Teams of Teams: networks of code collaborations
  - *What are common organizational configurations?*
  - *How do we scale from a small team to a larger team, or team of teams?*
  - *What do the characteristics of a team of teams?*
- **Where** you can find resources for forming and sustaining scientific software (code) communities
  - *Where can I find training resources?*
  - *What lightweight tools may help with productivity?*

Scientific Software Teams

What are their challenges?

What characteristics make teams effective?

What are the cultural dynamics that influence our communication?

Acknowledgements:

Enabling a Culture of Developer Productivity and Software Sustainability
Elaine M. Raybourn, Sandia National Laboratories

Presented at the *Society for Industrial and Applied Mathematics (SIAM) Conference on Computational Science and Engineering (CSE)19*
SAND2019-2224 C

IDEAS productivity

ECP EXASCALE COMPUTING PROJECT

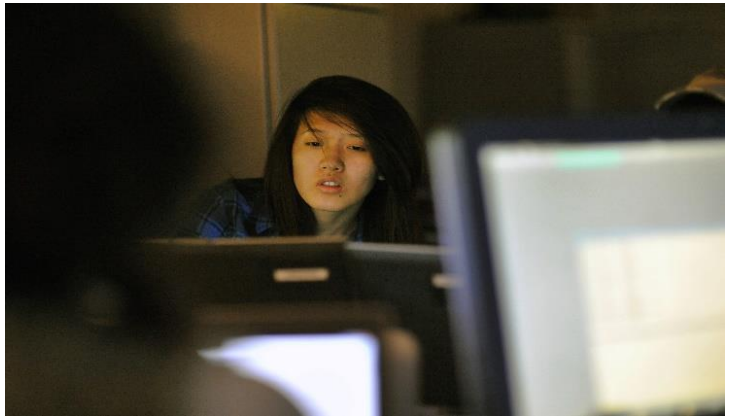
Volatile, uncertain, complex, ambiguous. **Science is VUCA.**

More time spent on software

Projects are increasingly multi-institutional.

Demand for, and consequence of are greater.

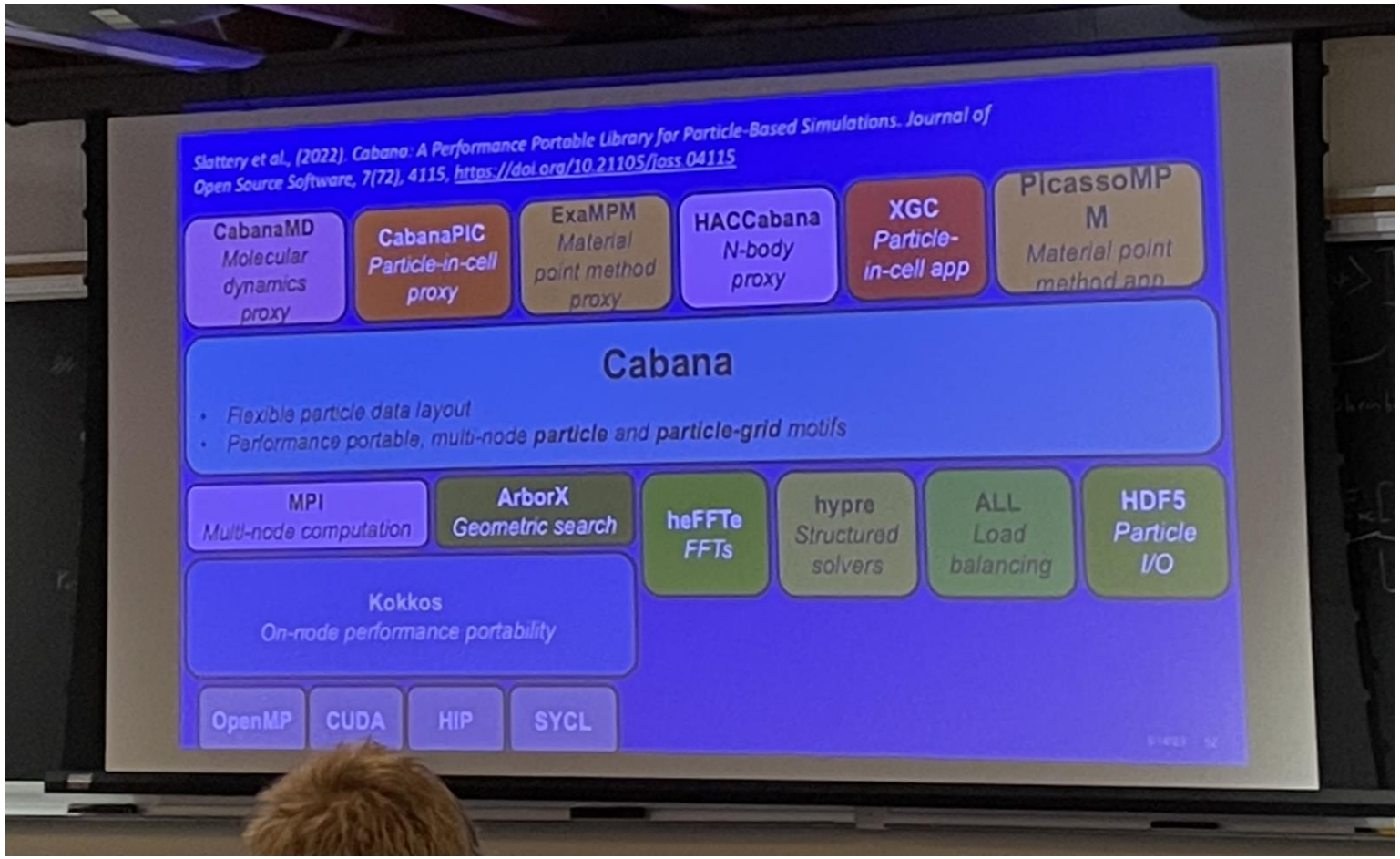
Many practices can not keep up the pace with scale and complexity.



"This is an exciting and terrifying time to be doing computational science."

Erik Draeger, Lawrence Livermore National Laboratory
2023 IPAM tutorial – *Future Exascale Architectures*

Humans in the loop: Complex sociotechnical ecosystems



Used with permission. Tim Germann, IPAM, March 14, 2023

Molecular Dynamics 1 IPAM tutorial
Tim Germann,
Los Alamos National Laboratory

Sociotechical challenges for scientific software teams

- Teams are focused on obtaining scientific results from the software they write
  - Funding is *usually* for generating results and not software
  - Funding is a competitive process
  - No provision for time to write software features that don't focus on results
  - Bug fixing and refactoring releases are rare
  - Modest *formal* software engineering training. Understand formal terminology but perhaps incomplete understanding
  - Perception of SPIs being formal and heavy-weight approaches
  - Worry about significant delay to their current scientific activities or need of large investments before seeing benefits.
  - **Any productivity or sustainability improvements must be incremental, integrated into the primary feature development process, lightweight, iterative and informal.**

Sociotechnical challenges of scientific software development

Technical

- All parts of the ecosystem can be under research
- Requirements change throughout the lifecycle as knowledge grows
- Importance of reproducibility, sustainability
- Verification is complicated
- Real world is messy, so is the software

Social

- Competing priorities and incentives
- Limited resources
- Perception of “invisible work” with deferred or no benefit
- Need for interdisciplinary interactions
- Boutique operations must scale!

Science through computing is only as good as the software that produces it.

Reflection: What makes your small or large team effective?

Characteristics of Effective Teams

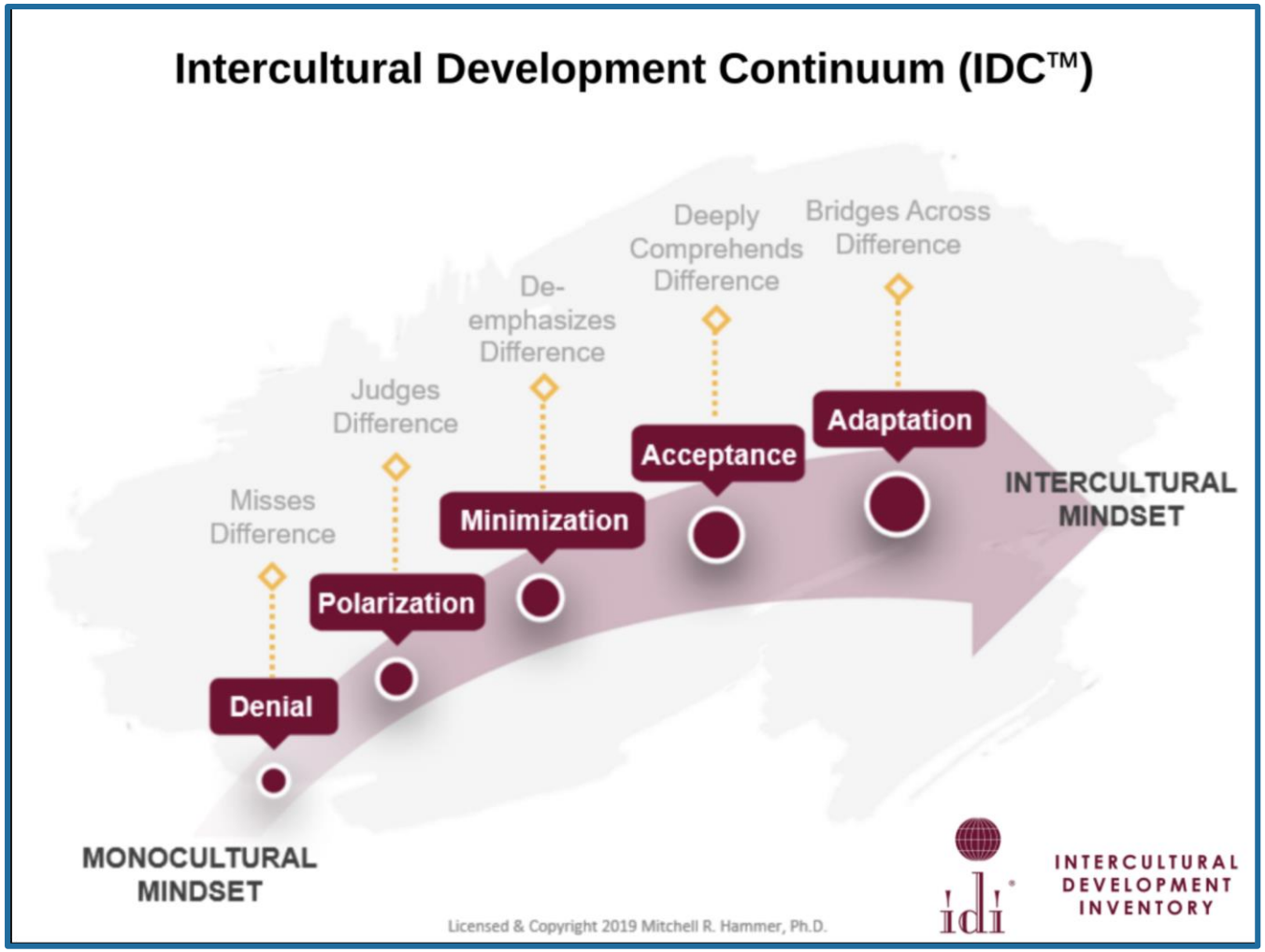
Adaptive Thinking & Leadership

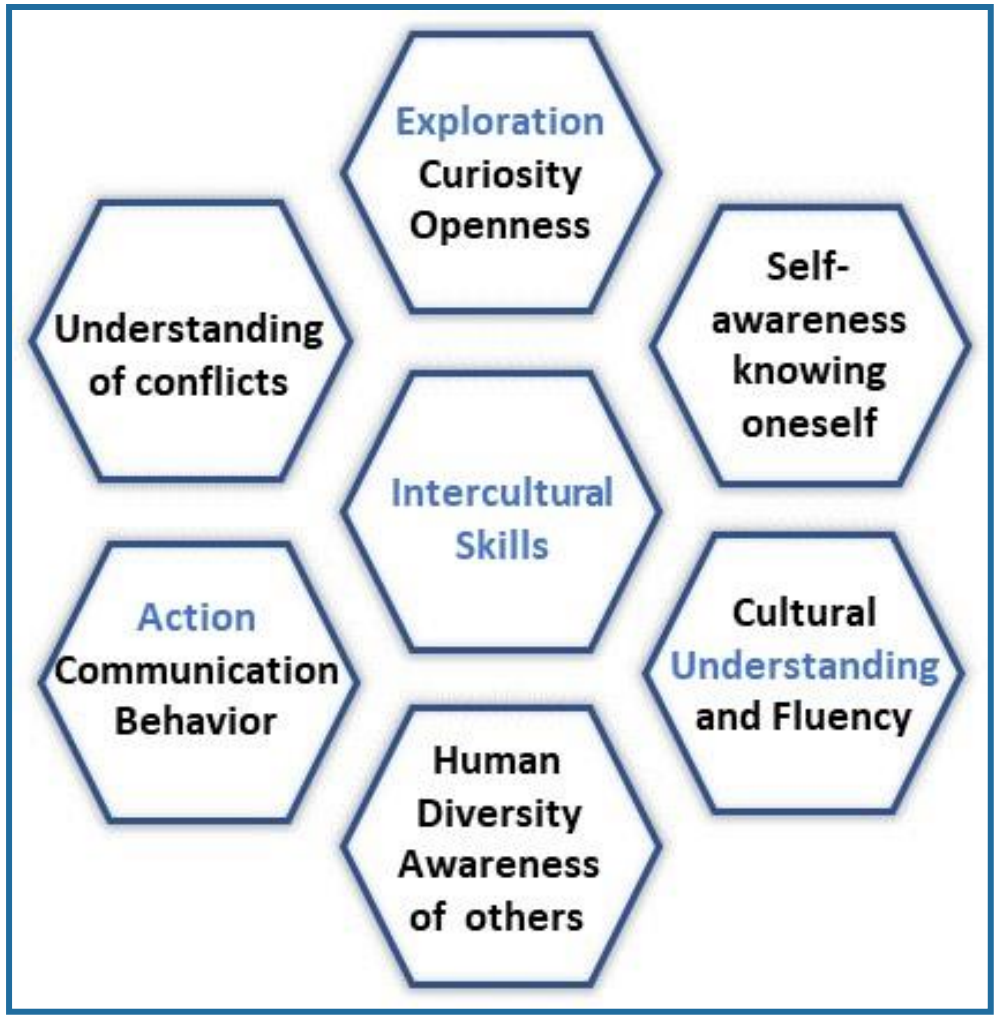
Raybourn, E.M., Deagle, E., Mendini, K., & Heneghan, J. (2005). Adaptive Thinking & Leadership Simulation Game Training for Special Forces Officers. I/ITSEC 2005 Proceedings, Interservice/ Industry Training, Simulation and Education Conference Proceedings, November 28-December 1, Orlando, Florida, USA.

- "A team of experts does not make an expert team." *Nancy Cooke, University of Arizona*
- It's interaction, not the components, that make an effective team.
- Explicit communication is at the foundation of team cognition (shared mental model).
- Serendipity, side bars, sharing food have all been shown to enhance team interactions
- Adapting to novel change or some adversity presents opportunities to develop more resilient teams [however there are limits]
- A single team mate can impact team process positively or negatively, and serve as a model for team (anticipating needs)
- Effective teams respond quickly to perturbation and are more resilient, adaptive

Cooke, N.J., Gorman, J.C., Myers, C.W. and Duran, J.L. (2013), Interactive Team Cognition. Cognitive Science, 37: 255-285. https://doi.org/10.1111/cogs.12009

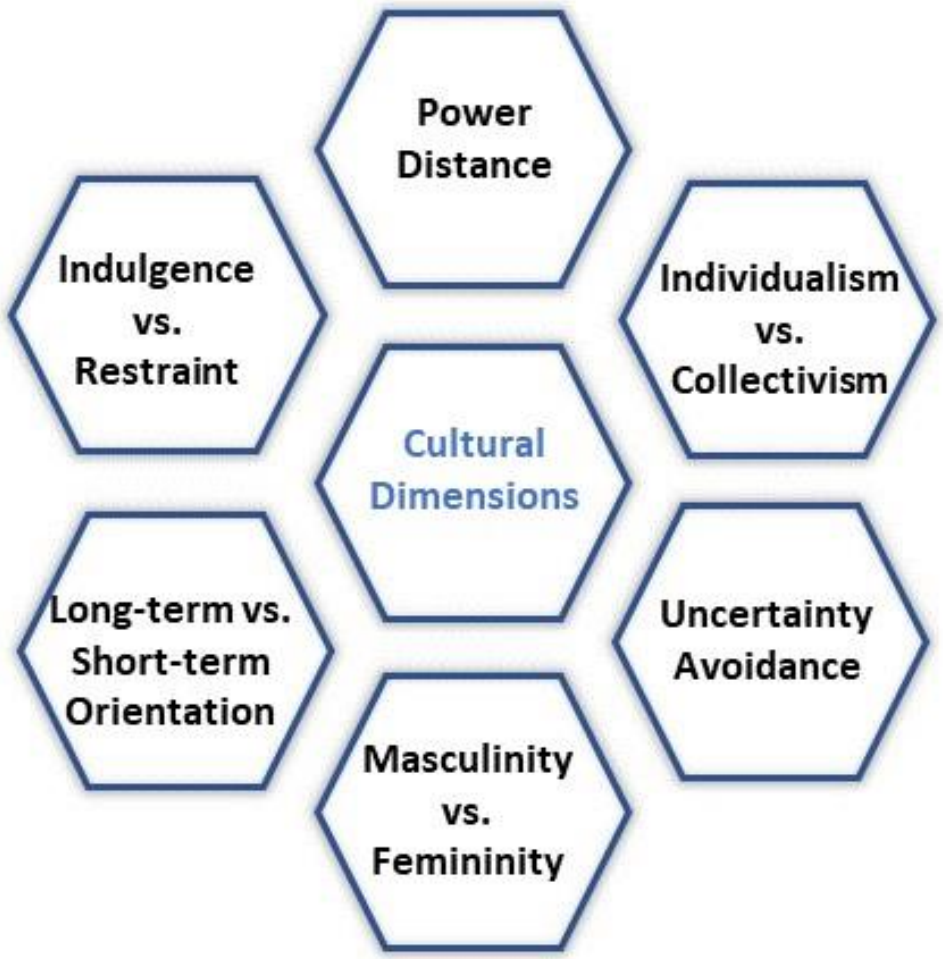
Intercultural competence and cultural fluency





Source: https://idiinventory.com/

Dimensions of culture

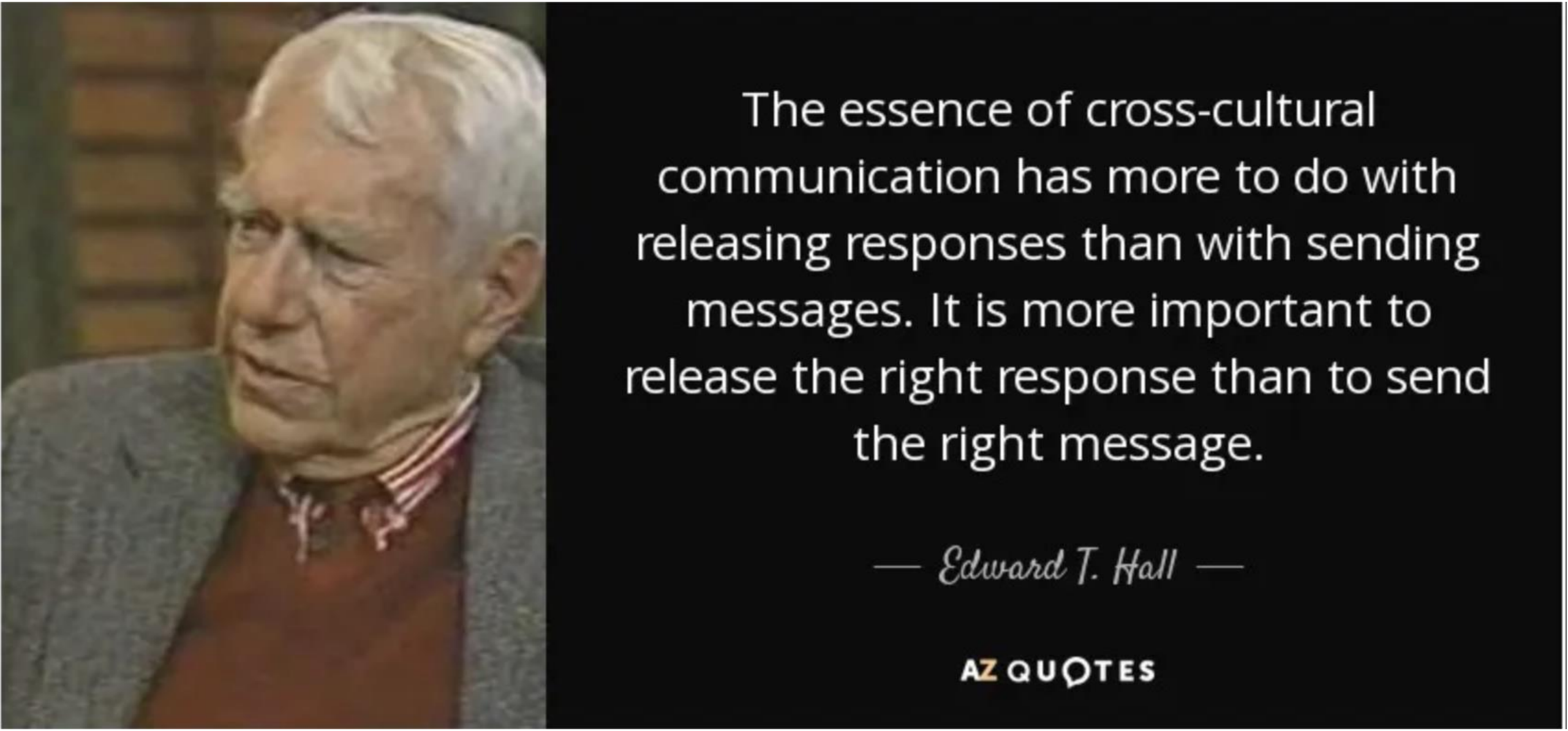


- Locus of control and attribution for failure
- Use of nonverbal communication
- Expression of reaction
- Group cohesion
- Use of time
- Communication style
- High / low context cultures

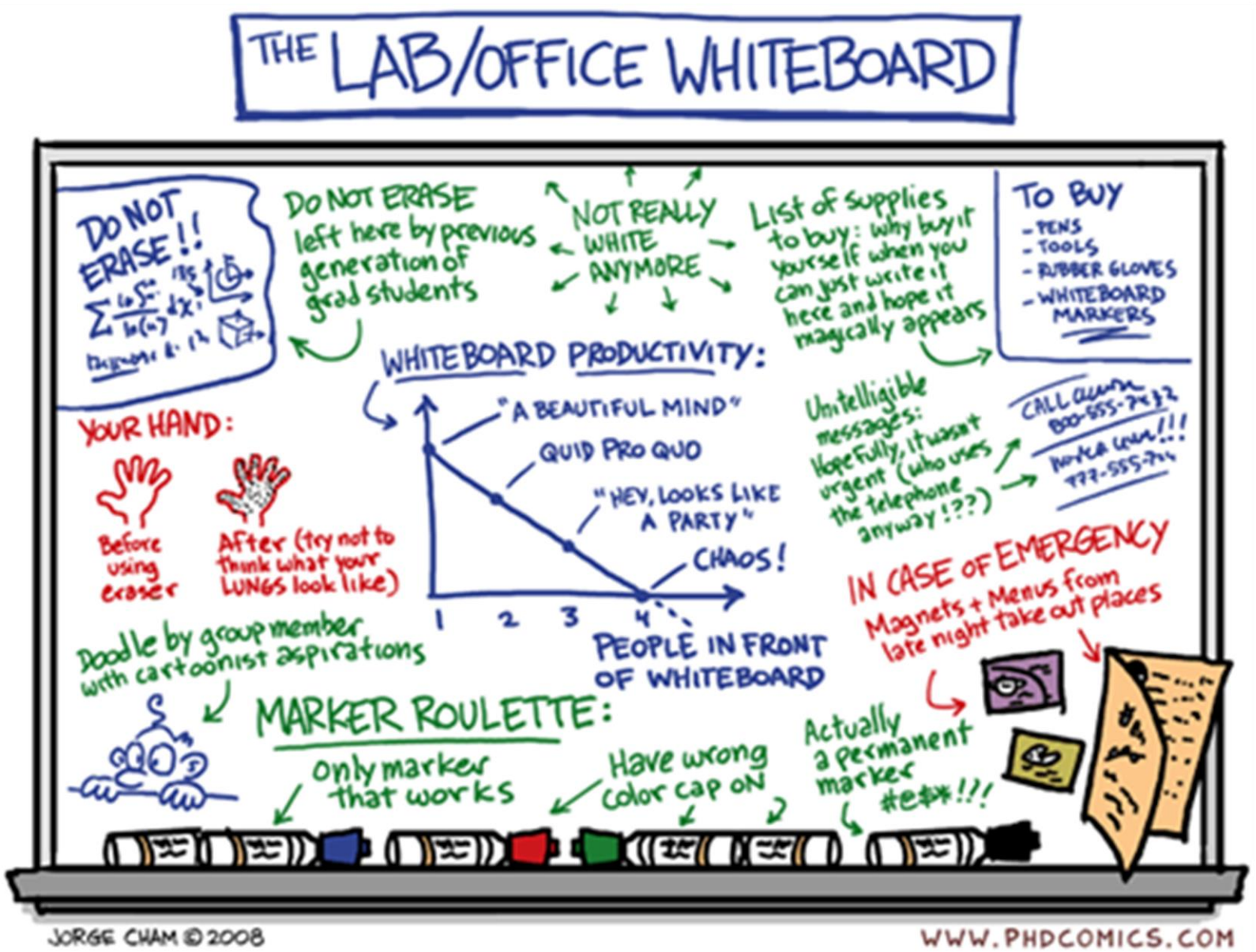
To improve your team, first work on yourself

- Teams are complex adaptive systems of individuals with different preferences, skills, experiences, perspectives, and habits.
- The odds of improving that complex system in a meaningful and sustainable way are higher if every team member — including the leader — learns to master these three foundational capabilities:
  - internal self-awareness
    - What are the facts vs. my interpretations, assumptions, about another person or the situation?
    - What are my core values, and how might they be impacting my reactions?
  - external self-awareness
    - What am I doing that is helpful, not helpful?
  - personal accountability
    - Accept your role in the problem, and the solution, take responsibility for solving the problem.

Porter, J. (2019). To Improve Your Team, First Work on Yourself, Harvard Business Review
https://hbr.org/2019/01/to-improve-your-team-first-work-on-yourself



Source: https://www.azquotes.com/



Raybourn, E. M. (2021). It's Not the Whiteboard We Missed, It's How It Made Us Feel. figshare. Conference contribution. https://doi.org/10.6084/m9.figshare.19929941.v1

Raybourn, E.M., (2020). Why We Need Strategies for Working Remotely: the Exascale Computing Project (ECP) Panel Series The International Conference for High Performance Computing, Networking, Storage, and Analysis, SC20 https://www.osti.gov/search/identifier:1818020

What is creativity?

Thinking is creative if it leads to original and adaptive ideas, solutions, or insights.

What is innovation?

…combining existing science and technology with new ideas to solve a problem, or to introduce an entirely new capability.

M. R. Ackerman (2021). Innovation. SAND2021-2376.

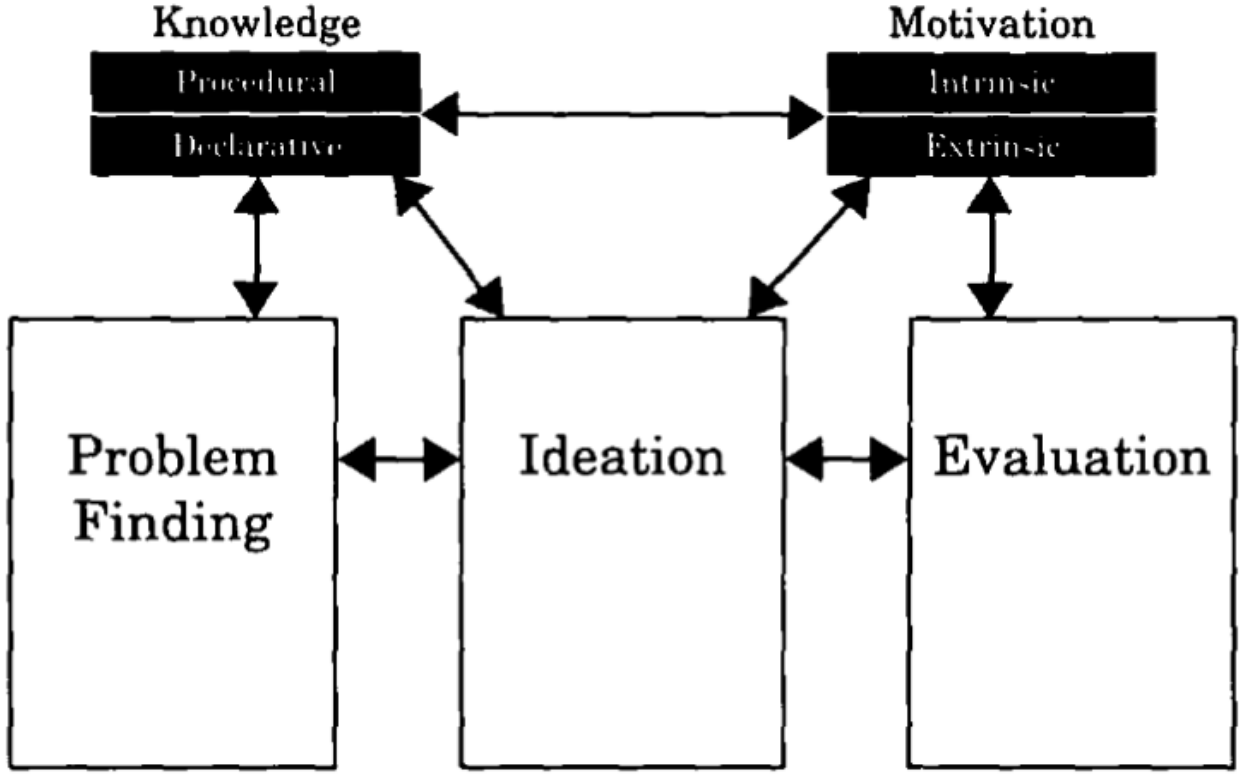


Fig. 1. Two-tier model of creative thinking. The three boxes on the primary tier each represent sets of skills. Problem finding represents problem identification, problem definition, and so on. Ideation represents ideational fluency, originality, and flexibility. Evaluation represents valuation and critical evaluation.

M. A Runko and I. Chand (1995). Cognition and Creativity. Educational Psychology Review, Vol. 7, No. 3, 243-267.

How to develop engaged and productive (in-person, hybrid, and virtual) teams

How do we build team cultures?

What are best practices for team communication?

Acknowledgements:

Developing Engaged and Productive Virtual Teams

Elaine M. Raybourn, Sandia National Laboratories
J. David Moulton, Los Alamos National Laboratories
Todd Munson, Argonne National Laboratories

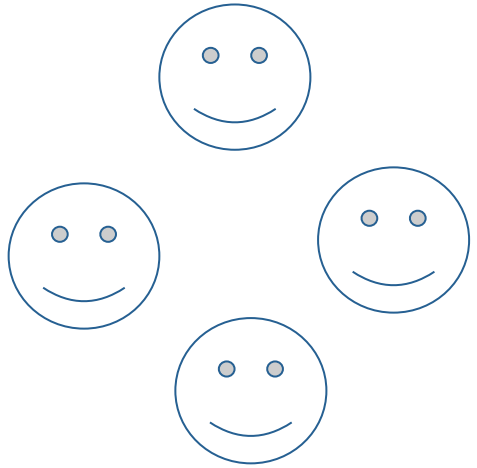
Presented at the *Exascale Computing Project Annual Meeting*, 2020
SAND2020-5000 C

IDEAS productivity

ECP EXASCALE COMPUTING PROJECT

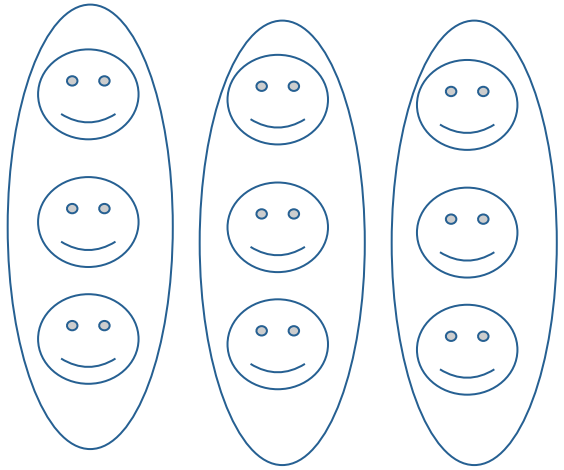
Configurations of remote working add complexity

Fully Dispersed



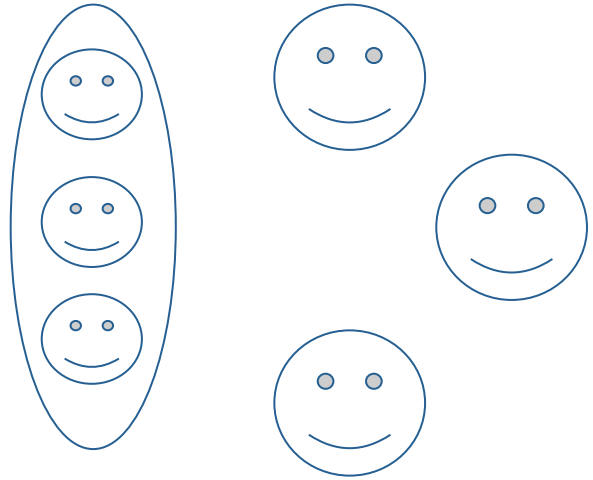
Least conflict, most trust

Subgroups



Most conflict, least trust

Group + Dispersed



???

Adapted from Martin Fowler (2015) Remote versus Co-located Work, Sekou Bermiss (2019) Leading and Motivating Dispersed Teams.

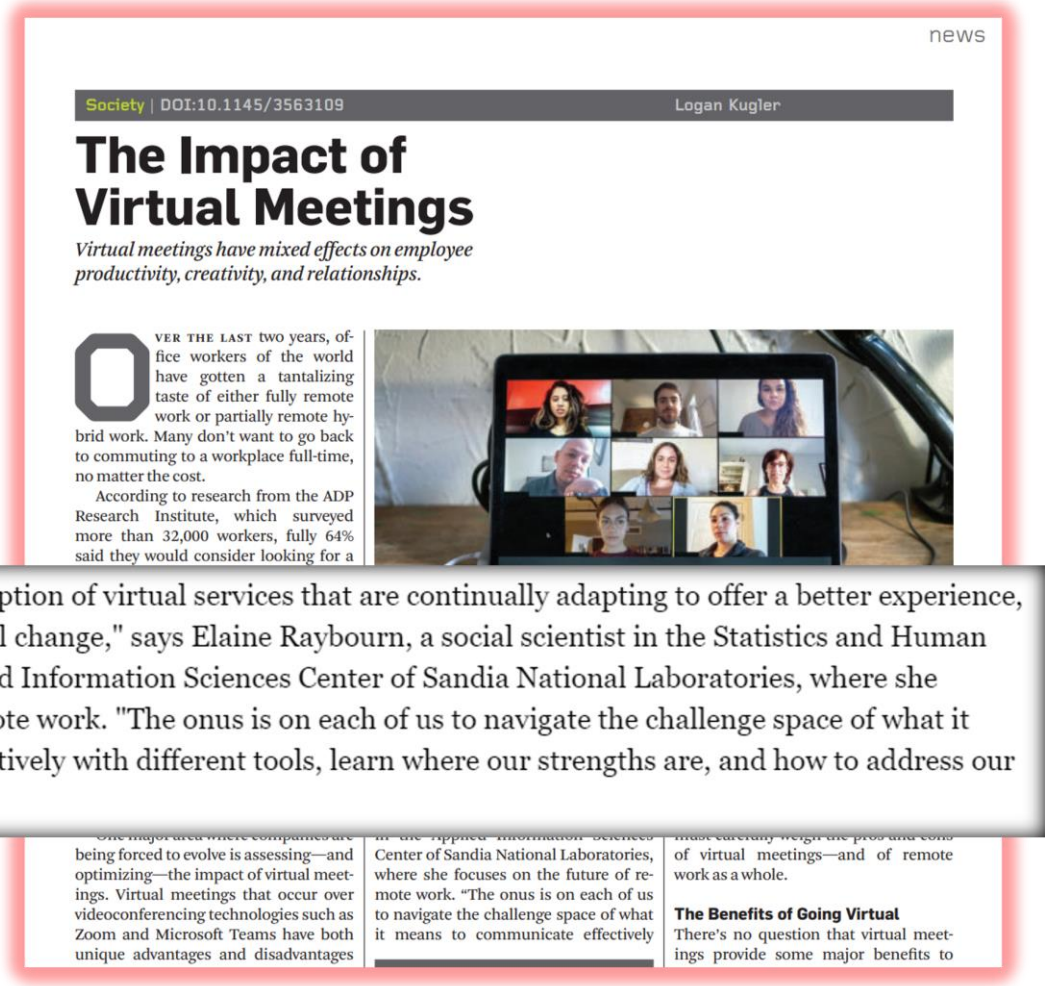
“There isn’t a simple dichotomy of remote versus co-located work, instead there are several patterns of distribution for teams each of which has different trade-offs and effective techniques suitable for them.”

Thoughtworks Chief Scientist Martin Fowler, October 19, 2015

Factors influencing virtual teams

- Physical location, geography
- time (more time zones = more difficult to lead)
- team configuration
- size (smaller = easier to lead)
- commitment, common goals, expertise
- communication (verbal, visual, nonverbal)
- Technology, technology literacy
- asynchronous
- synchronous decision making
- culture
- seniority
- language
- experience with virtual teaming
- Technical hurdles
- Technical disagreements— concensus on how to do it (prioritizing paths)

(Lokeski & Reilly (2008), Adapted from Sekou Bermiss, John Daly 2019, UT Executive Education Managing Dispersed Teams



news

Society | DOI:10.1145/3563109 Logan Kugler

The Impact of Virtual Meetings

Virtual meetings have mixed effects on employee productivity, creativity, and relationships.

OVER THE LAST two years, office workers of the world have gotten a tantalizing taste of either fully remote work or partially remote hybrid work. Many don't want to go back to commuting to a workplace full-time, no matter the cost.

According to research from the ADP Research Institute, which surveyed more than 32,000 workers, fully 64% said they would consider looking for a

"With increased use and adoption of virtual services that are continually adapting to offer a better experience, the way we communicate will change," says Elaine Raybourn, a social scientist in the Statistics and Human Systems Group in the Applied Information Sciences Center of Sandia National Laboratories, where she focuses on the future of remote work. "The onus is on each of us to navigate the challenge space of what it means to communicate effectively with different tools, learn where our strengths are, and how to address our weaknesses."

being forced to evolve is assessing—and optimizing—the impact of virtual meetings. Virtual meetings that occur over videoconferencing technologies such as Zoom and Microsoft Teams have both unique advantages and disadvantages

Center of Sandia National Laboratories, where she focuses on the future of remote work. "The onus is on each of us to navigate the challenge space of what it means to communicate effectively

of virtual meetings—and of remote work as a whole.

The Benefits of Going Virtual

There's no question that virtual meetings provide some major benefits to

Kulger, L. "The impact of virtual meetings." The Communications of the ACM, November 2022, Vol. 65 No. 11, Pages 19-21 https://cacm.acm.org/magazines/2022/11/265812-the-impact-of-virtual-meetings/fulltext.

Department of Energy (2022). "Work shift: A Sandia researcher looks at how COVID-19 has reshaped the computational science community and remote work – in lasting ways." https://ascr-discovery.org/2022/06/work-shift/

Building (virtual) team culture

Create shared responsibility and accountability

- Provide more explicit direction than in F2F teams
  - Get agreement and buy-in on goals, objectives, processes
- Negotiate norms for communication and virtual presence
  - Frequency of feedback, communication flows
  - Availability: promptly return phone calls, emails
- Use clear communication to define team identity, task, goals, documentation, redundancy
  - Clarify expectations, plan communication (choose right medium, communication channel)
  - Establish reliable workflows and processes
  - Establish regular expectations
- Help teams feel part of a community
  - Listen, turn on video if possible
  - Trust your colleagues and employees
- Identify individual/group rewards

Establish norms for meetings and artifacts

- Meetings
  - Send out a clear meeting agenda in advance
  - Team configuration: have roles for individuals during meetings (facilitator, note taker, time keeper, etc.)
  - Team members post in workflow tools in advance/ during to augment discussion
  - Start each meeting with social relationship building
  - Perform check-in's with participants during meetings to help engagement, and inclusion
  - Ensure the minutes and future work plan is documented and accessible to all
- Artifacts
  - Utilize and regularly populate collaborative workspaces
  - Report outcomes
  - If applicable, document retrospectives

Adapted from Sekou Bermiss and John Daly (2019) Leading and Motivating Dispersed Teams, Duric (2019) How to manage remote IT teams: 3 tips to build trust.

Scaling Productivity and Innovation on the Path to Exascale with a “Team of Teams” Approach

Acknowledgements:

Scaling Productivity and Innovation on the Path to Exascale with a “Team of Teams” Approach

Elaine M. Raybourn, Sandia National Laboratories
J. David Moulton, Los Alamos National Laboratory
Aimee Hungerford, Los Alamos National Laboratory

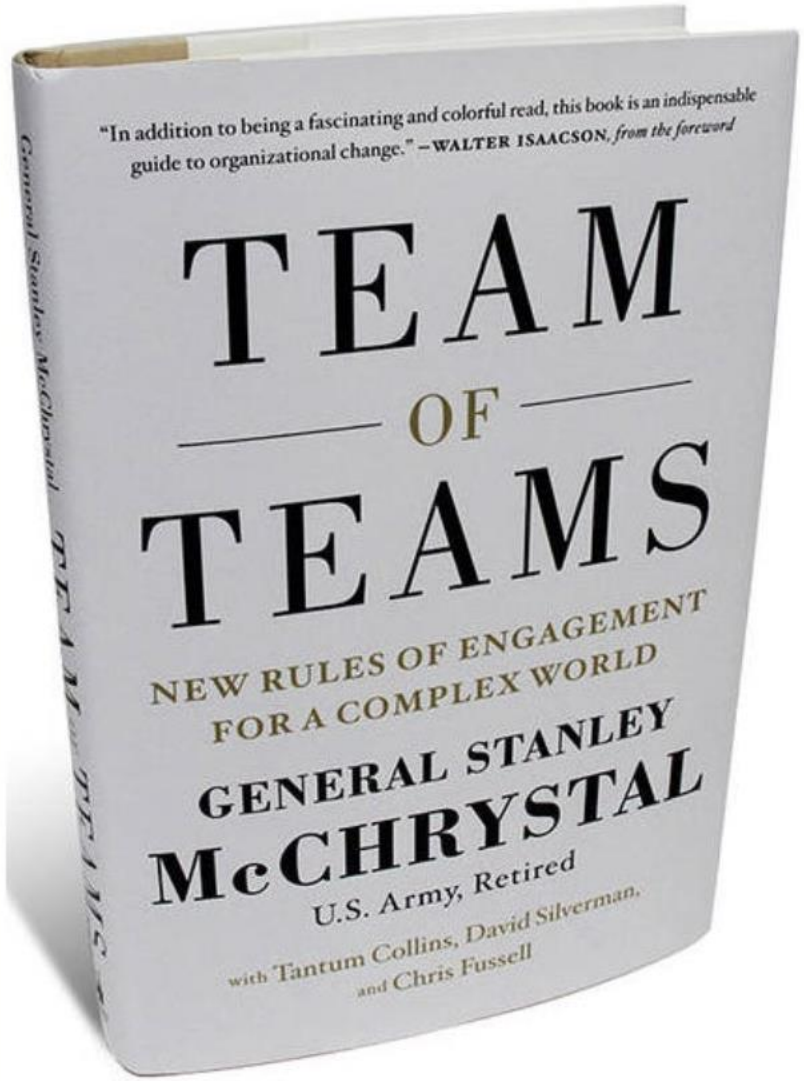
Presented at *HCI in Business, Government and Organizations (HCIBGO)*
Human Computer-Interaction International (HCII) July 29, 2019
SAND2019-8389 C

IDEAS productivity

ECP EXASCALE COMPUTING PROJECT

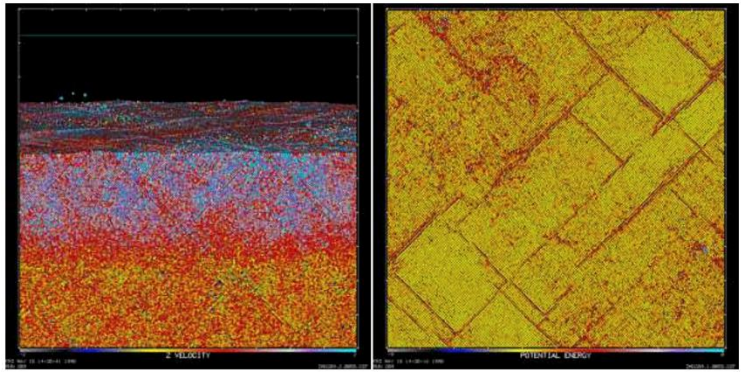
Talk Outline

- Motivation and introduction
- Scaling teams to a ***Team of Teams***
  - Shared Consciousness
  - Empowered Execution
  - Humble Gardener
- Enhancing productivity and innovation
- Conclusion



Small teams: Critical, effective, but just a part of a greater whole.

- The mythical hero programmer/developer is (or is becoming) extinct.
- If you've been on an effective small team you are likely a believer already.
- This day in history (almost) 25 years ago:
  - A small team, built Avalon the first Linux cluster to break into the Top500 Super Computer list
  - A small team, demonstrated its application to MD simulations in a Gordon Bell entry

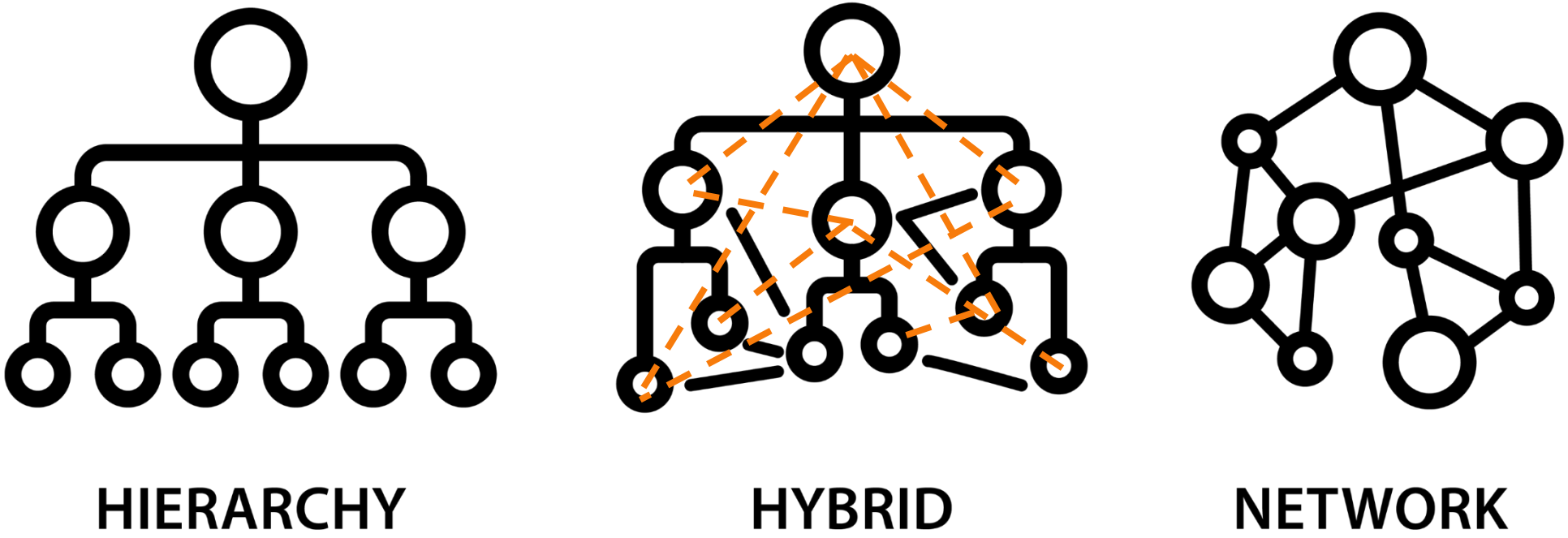


M. S. Warren et al., *Avalon: An Alpha/Linux Cluster Achieves 10 Gflops for $150K*, SC 1998.

- Characteristics of an effective, small team:
  - Trust, common purpose, shared consciousness, decentralized decisions and autonomy.

But how can we scale it up?

From few to few, toward many to many.



- **Hierarchies:** Efficiency focused, can only leverage silos in predictable ways.
- **Networks:** Agile, adaptable, and resilient, well suited to uncertain environments.
- **Hybrid:** Bring adaptability and resilience of networks to existing organizations.

ECP by the Numbers

A seven-year, $1.8 B R&D effort that launched in 2016

Six core DOE National Laboratories: Argonne, Lawrence Berkeley, Lawrence Livermore, Los Alamos, Oak Ridge, Sandia

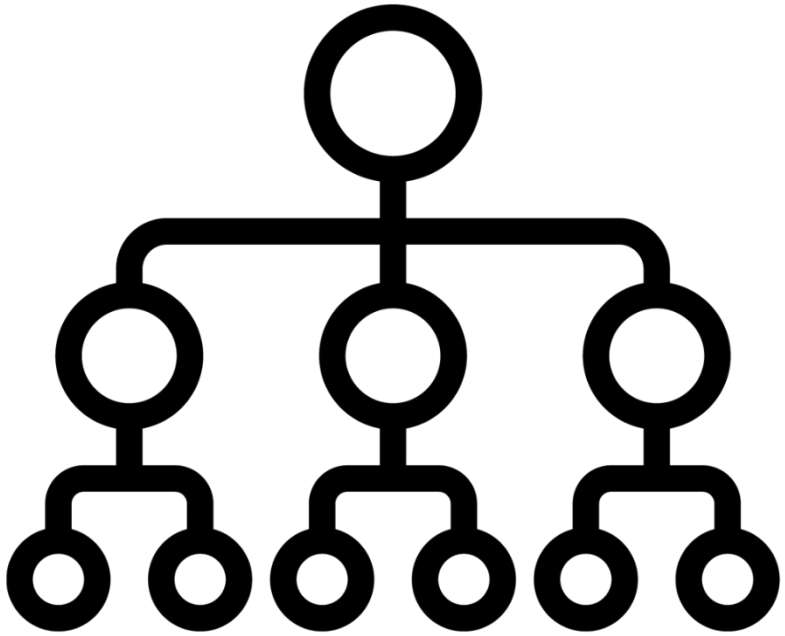
- Staff from most of the 17 DOE national laboratories take part in the project

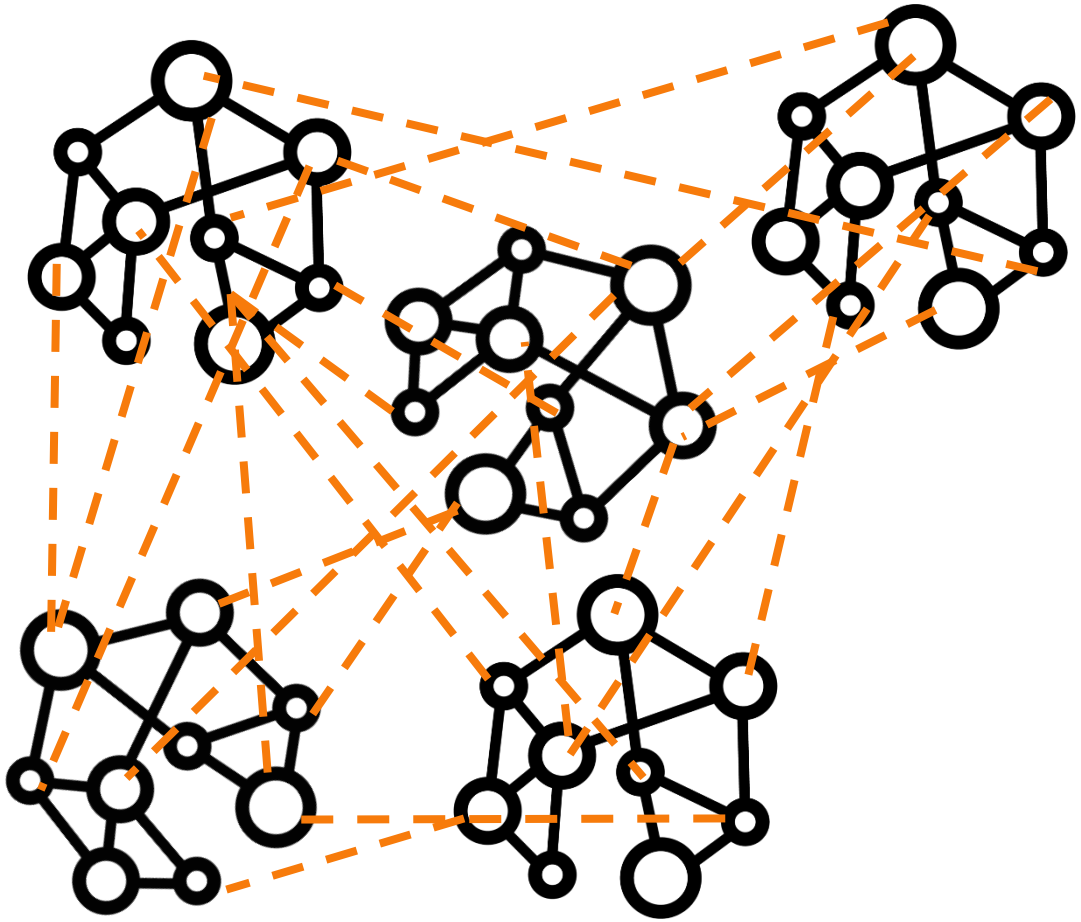
Three technical focus areas (Application Development, Software Technology, Hardware and Integration)

81 R&D teams, approximately 10 researchers per team

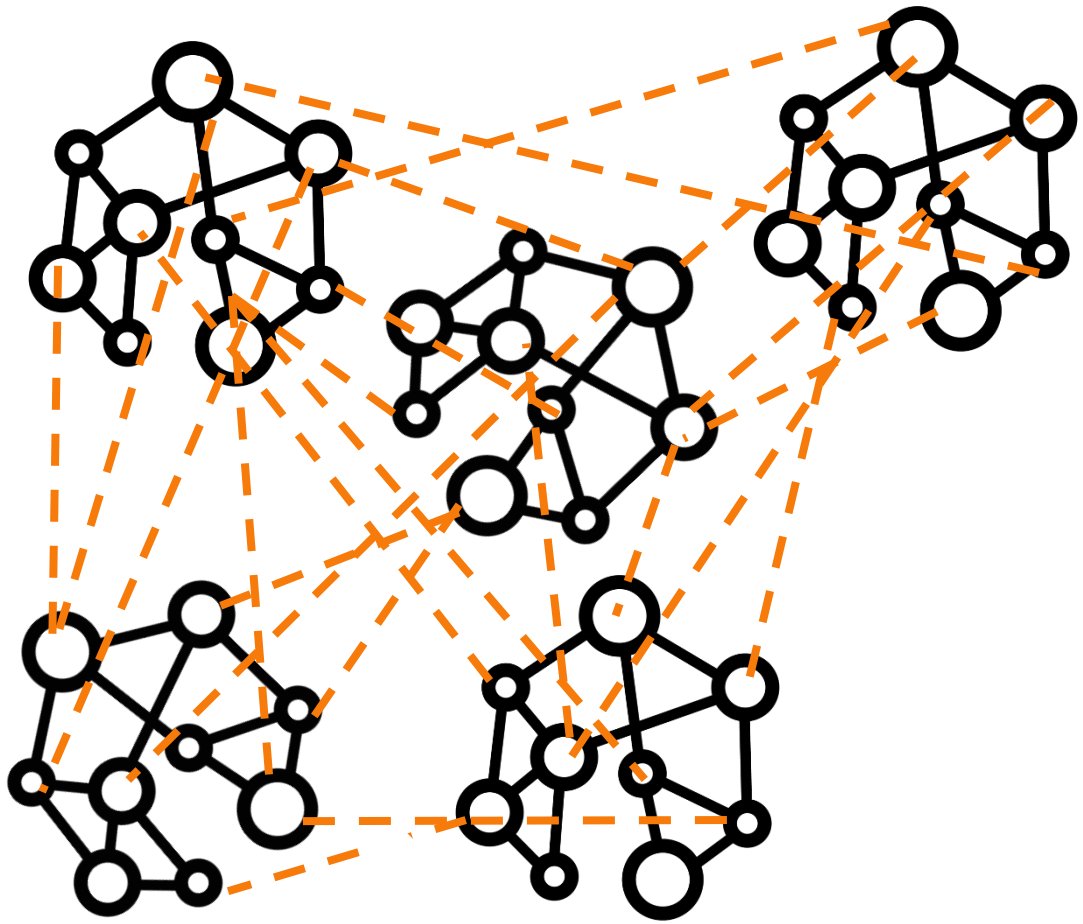
- Hundreds of consequential milestones delivered on schedule and within budget since project inception

Command of Teams vs. Team of Teams





Team of Teams: Scale the productivity of small teams and leverage the accelerated communication of a large network



Several key ingredients include:

- Shared consciousness, aligning narrative
- Empowered execution
- Leading like a gardener (shift focus from moving pieces to shaping the ecosystem)
- Embedded members or liaisons build the network and breakdown silos

Provide opportunities for our teams to foster this culture, and develop these skills

- McChrystal, S., Collins, T., Silverman, D., Fussell, C. (2015). Team of teams: New rules of engagement for a complex world. Penguin Random House LLC: NY.
- Raybourn, E.M., Moulton, J.D., Hungerford, A. (2019). Correction to: Scaling Productivity and Innovation on the Path to Exascale with a "Team of Teams" Approach. In: Nah, FH., Siau, K. (eds) HCI in Business, Government and Organizations. Information Systems and Analytics. HCII 2019. Lecture Notes in Computer Science(), vol 11589. Springer, Cham. https://doi.org/10.1007/978-3-030-22338-0_39

Scaling to a Team of Teams: Shared Consciousness

As CSE teams work toward next-generation challenges—they may be composed of multiple, previously successful, existing teams, where software is a primary means of collaboration.

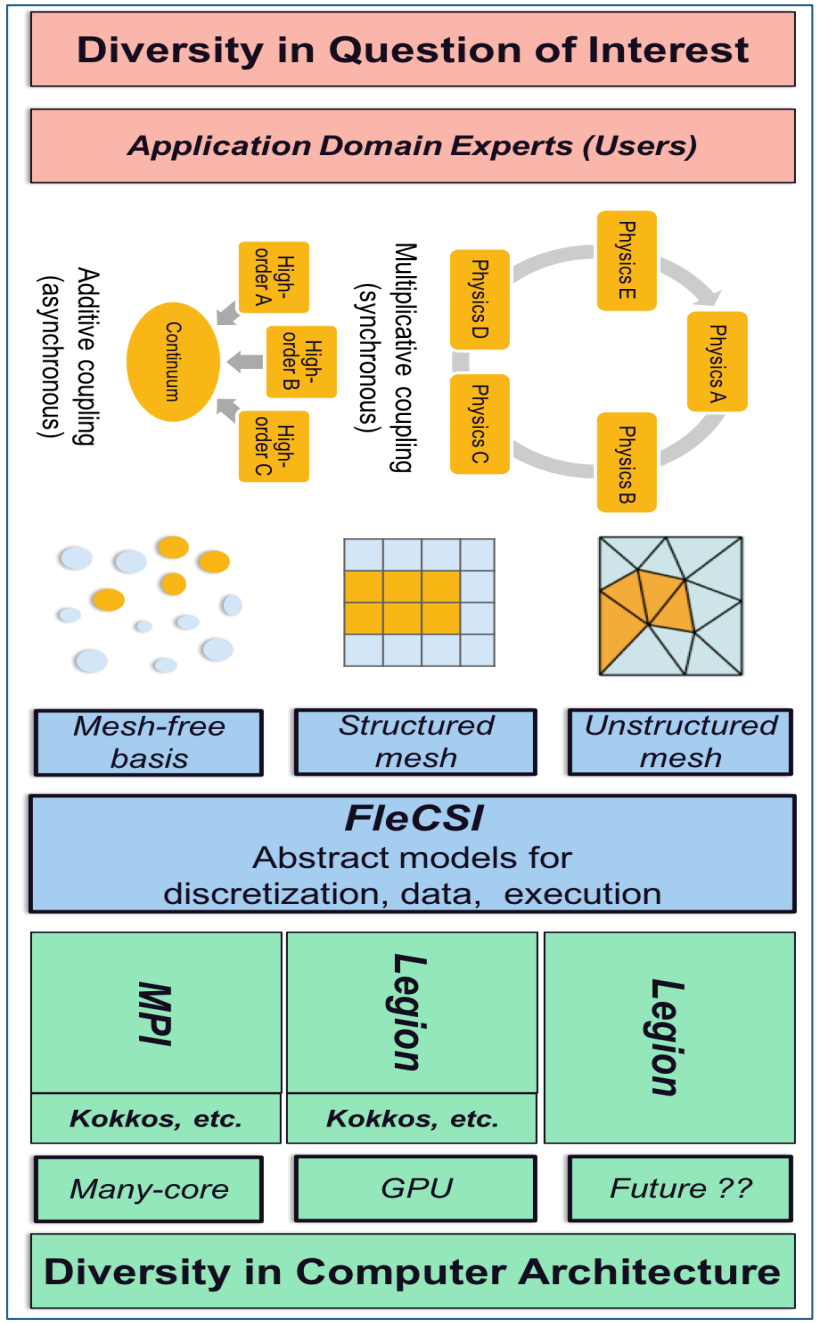
This aggregate team is best viewed as *a Team of Teams* that needs to develop ***shared consciousness:***

- A common conceptual model or big picture understanding of the entire interconnected project is necessary.
- Built on information sharing that is transparent and efficient
- Since teams are increasingly distributed and virtual, demanding increased use of cloud-based development tools and video/whiteboard meeting tools, and inclusive ways of using these tools
- The best cadence of project-wide meetings is project dependent.

ASC Ristra: New Code from Existing Components

Ristra Next Generation Code project is part of the ASC Advanced Technology Development Mitigation (ATDM) program.

- Vision is to support diverse science applications and compute architectures through easily swapped components.
- ***Code team was inherited from existing teams***
  - Production code support and development teams
  - Academic research teams
- ***Cultures differ between the component teams***
  - **Coding styles, Vocabulary / Jargon, Expected timelines**
  - **Reporting requirements** – publications … informal conversations with the Project Lead
  - **Communication avenues** – in person … social media
  - **Software development environments** – tar file … git repository
- Past efforts with these goals and these initial conditions have mostly failed (historical success rate < 10%)
- Starting under a cloud! How to proceed?



Courtesy of the Ristra Project, A.Hungerford and D. Daniel

ASC Ristra: Overcoming Cultural and Technical Changes

Cultural Changes:

- Ignore the naysayers
- Unstructured collaboration time is key to gelling as a team (of teams).
- Pay attention to the balance of staff (diversity, experience, personality)
- Management support for the kick-off phase is critical
  - Shield from delivering a product just for delivery's sake
  - Exploration without product delivery is important
- Stable collaboration environment
  - Say no to the shiny new tool unless it really fixes a problem

Illustration by www.vecteezy.com

Technical Tools:

- Dedicated collaboration area for impromptu meetings
- Atlassian development tools: Confluence, Jira, Bitbucket
- Tutorials for adopted development tools
- Docker containers

Atlassian

docker

Scaling to a Team of Teams: Empowered Execution

- Reconsider hierarchical “command structures” that are not effective at scale for a more agile, networked configuration.
- Foster authority of sub-teams and individuals to act without explicit senior leadership consultation.
- Provide opportunities for team members to understand each of the interdependent parts of the system so that generalized awareness can be fused with specialization.
- Introduce transparency to establish a culture of shared consciousness.
- Synchronization of team cadence (hybrid model) to reaffirm the aligning narrative.

Realizing Empowered Execution in ECP projects

- Most in this community have strong entrepreneurial tendencies, so why is empowered execution challenging?
- Empowered Execution:
  - ***Is not*** independent wild west hero style bug creation, or random API updates.
  - ***Is*** disciplined focused autonomous development within smaller teams ***that is*** guided by, and well aligned with, the by the big picture.
  - ***Is*** consistent with the accepted best practices, styles, etc. of the broader team.
- Projects are experimenting with a range of methodologies that foster hands-off:
  - Bull pens, sprints, virtual scrums (with extended schedules)
  - Various workflows (e.g., pull requests) balance supervision and autonomy.
- Eyes-on reflects an overall situational awareness, and may be captured by the interaction and logging that development creates through these tools and workflows.

From chess master to gardener: Lead like a gardener

- New software development and communication tools increase our ability to observe, analyze and even control our teams:
  - But centralized control is too slow, it hinders cross-fertilization, and stifles innovation
  - Complexity of science today makes our expectations of leaders unrealistic, and attempts to micro manage ineffective.
- Avoid the temptation to lead as a chess master, with a reductionist view that has each team categorized and controlled.
- Lead like a humble gardener:
  - Create and nurture an environment (i.e., culture, structure, and processes) to enable smart autonomy and shared consciousness.
  - Gardening is not passive: it drives the rhythm and transparency, and builds and maintains the trust needed for cross-functional cooperation.

Enhancing Productivity and Innovation

https://www.youtube.com/watch?v=yHR1kK1_cE0

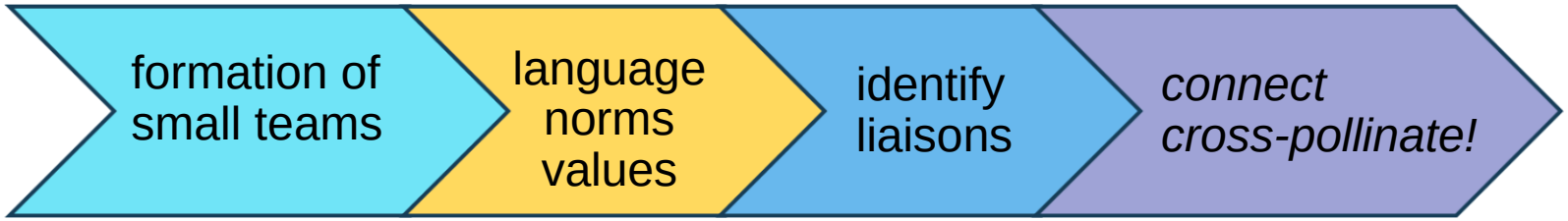
Forbes: Lead like a humble gardener, by Chunka Mui

- Are your “regular” large team meetings as effective as McChrystal’s O&I (operations & intelligence brief)?
  - Is attendance mandatory, engage staff at all levels, always considerate and encouraging, …
  - Logistics, agenda run by assistant, avoids mixed message from multi-tasking leader
  - Is the frequency right to balance synchronization with empowered execution.
  - Is there real open discussion, evaluation, development …

Conclusions

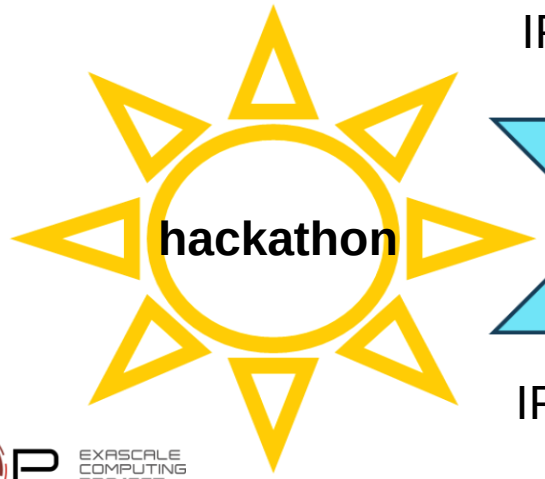
- Do you have an aligning narrative on which you can build ”shared consciousness”?
  - Start with why (Simon Sinek), capture the belief or purpose that attracts people to your team. https://www.youtube.com/watch?v=u4ZoJKF_VuA
  - Does the ecosystem you’re building, provide the adaptability and sustainability needed?
- Do you have the right people in critical roles?
  - Embedded members or Liaisons build the network that tears down the silos. They need to be your best people, highly motivated with a reputation of selflessness and excellence.
  - Do the small teams have effective leadership and suitable culture?
    - Empowered execution depends on shared consciousness
    - Build trust across and within teams

In a perfect world…



IPAM Weeks 1 - 3

IPAM Weeks 4 - 10



IPAM Weeks 11 - 14

Resources for forming new scientific software (code) collaborations

Acknowledgements:

Better Scientific Software tutorial

David E. Bernholdt, Oak Ridge National Laboratory
Anshu Dubey, Argonne National Laboratory
Patricia A. Grubel, Los Alamos National Laboratory

Presented at SC22

IDEAS productivity

ECP EXASCALE COMPUTING PROJECT

The IDEAS-ECP team improves developer productivity and software sustainability as key aspects of increasing overall scientific productivity

1 Customize and curate methodologies

- Target scientific software productivity and sustainability
- Use workflow for best practices content development

3 Establish software communities

- Determine community policies to improve software quality and compatibility
- Create Software Development Kits (SDKs) to facilitate the combined use of complementary libraries and tools

2 Incrementally and iteratively improve software practices

- Determine high-priority topics for improvement and track progress
- *Productivity and Sustainability Improvement Planning (PSIP)* *https://github.com/bssw-psip*

4 Engage in community outreach

- Strategies for Working Remotely Series
- HPC Best Practices Webinar Series
- Tutorials Better Scientific Software site
- PSIP Tutorials

For more about our work see this report: https://doi.org/10.2172/1606662

Building an Online Community

https://bssw.io

- **New community-based resource for scientific software improvement**
- A central hub for sharing information on practices, techniques, experiences, and tools to improve developer productivity and software sustainability for computational science & engineering (CSE)

Goals

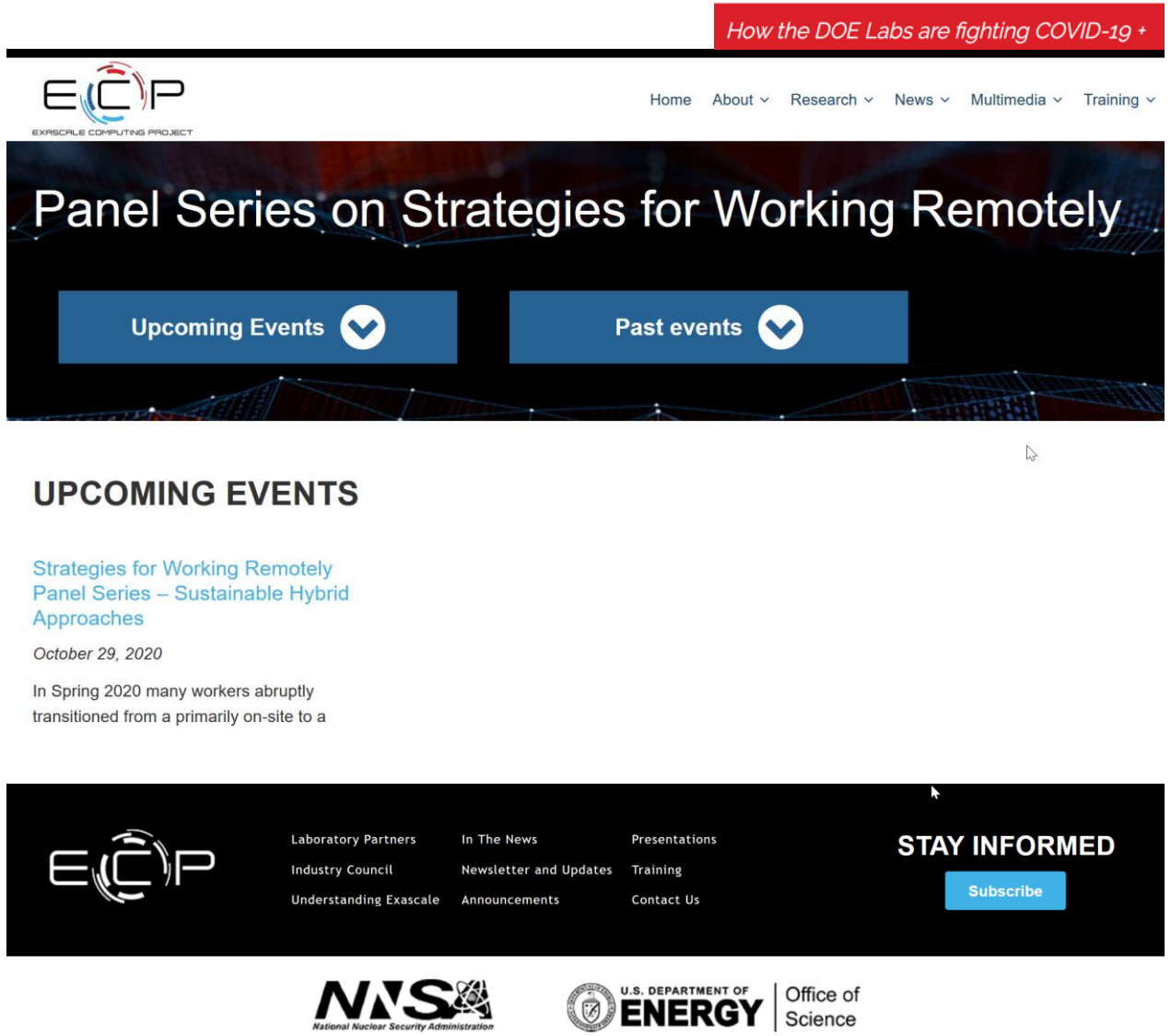
- Raise awareness of the importance of **good software practices** to scientific productivity and to the quality and reliability of computationally-based scientific results
- Help CSE researchers **increase effectiveness** as well as leverage and impact
- **Facilitate CSE collaboration via software** in order to advance scientific discoveries

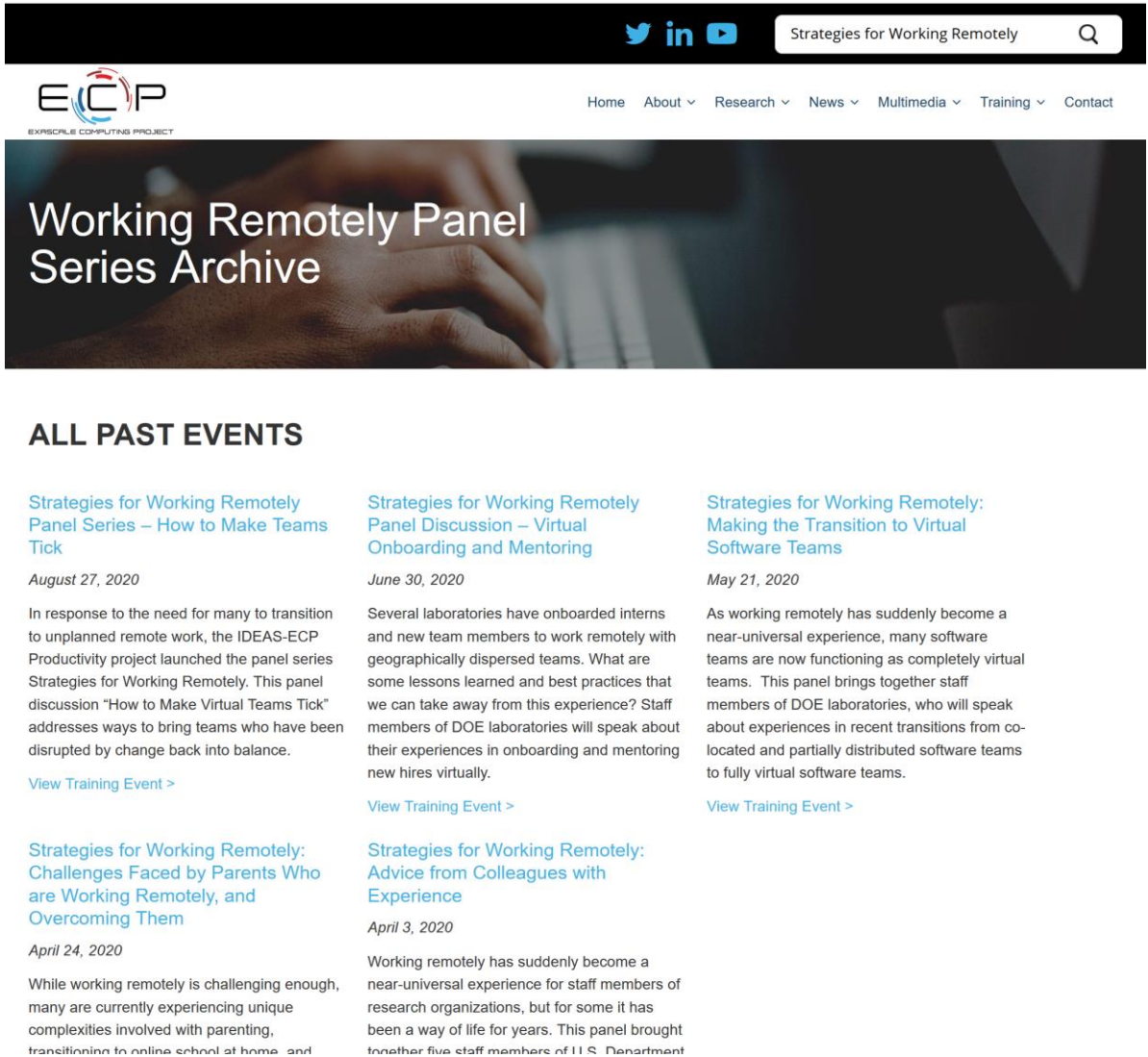
Site users can…

- **Find information** on scientific software topics
- **Contribute new resources** based on your experiences
- Create content tailored to the unique needs and perspectives of a focused scientific domain

The ECP Panel Series – Community Dialog

https://www.exascaleproject.org/strategies-for-working-remotely/





Many ECP Software products are available (many on GitHub)

For example…

Programming Models and Runtimes Produc

Legion	http://legion.stanford.edu
ROSE	https://github.com/rose-compiler
Kokkos	https://github.com/kokkos
DARMA	https://github.com/darma-tasking
Global Arrays	http://hpc.pnl.gov/globalarrays/
RAJA	https://github.com/LLNL/RAJA
CHAI	https://github.com/LLNL/CHAI
Umpire	
MPICH	
PaRSEC	
Open MPI	
Intel GEOPM	
LLVM OpenMP compiler	
OpenMP V&V Suite	
BOLT	
UPC++	
GASNet-EX	
Qthreads	

Development Tools (19)

SICM	https://confluence.exascaleproject.org/display/STSS07
QUO	https://github.com/lanl/libquo
Kitsune	https://github.com/lanl/kitsune
SCR	https://github.com/llnl/scr
Caliper	https://github.com/llnl/caliper
mpiFileUtils	https://github.com/hpc/mpifileutils
Gotcha	http://github.com/llnl/gotcha
TriBITS	https://tribits.org
Exascale Code Geneneration Toolkit	
PAPI	http://icl.utk.edu/exa-papi/
CHiLL Autotuning Compiler	
Search using Random Forest	
	hpctoolkit.org
	www.paradyn.org
	www.cs.uoregon.edu/research/tau
	ft.ornl.gov/research/papyrus
	ft.ornl.gov/research/openarc
	rm.org/
	www.cs.uoregon.edu/research/pdt/home.php

Mathematical Libraries Products (16)

xSDK	https://xsdk.info
hypre	http://www.llnl.gov/casc/hypre
FleCSI	http://www.flecsi.org
MFEM	http://mfem.org/
Kokkoskernels	https://github.com/kokkos/kokkos-kernels/
Trilinos	https://github.com/trilinos/Trilinos
SUNDIALS	https://computation.llnl.gov/projects/sundials
PETSc/TAO	http://www.mcs.anl.gov/petsc
libEnsemble	https://github.com/Libensemble/libensemble
STRUMPACK	http://portal.nersc.gov/project/sparse/strumpack/
SuperLU	http://crd-legacy.lbl.gov/~xiaoye/SuperLU/
ForTrilinos	https://trilinos.github.io/ForTrilinos/
SLATE	http://icl.utk.edu/slate/
MAGMA-sparse	https://bitbucket.org/icl/magma
DTK	https://github.com/ORNL-CEES/DataTransferKit
Tasmanian	http://tasmanian.ornl.gov/

etc…

Resources mentioned during IPAM tutorial

- xSDK https://xsdk.info
- E4S https://e4s.io
- Strategies for Working Remotely https://www.exascaleproject.org/strategies-for-working-remotely/
- HPC Best Practices Webinar https://ideas-productivity.org/events/hpc-best-practices-webinars/
- BSSw Tutorials https://bssw-tutorial.github.io/
- Better Scientific Software site https://bssw.io
- Productivity Sustainability Improvement Planning (PSIP) https://github.com/bssw-psip

Follow IDEAS and BSSw

- IDEAS Productivity mailing list: http://eepurl.com/cQCyJ5
  - Announcements of IDEAS-organized events
    - Best Practices for HPC Software Developers webinar series
    - Strategies for Working Remotely panel series
    - Software-focused events at major scientific meetings (e.g., SIAM, ISC, SC, etc.)
  - Typically 2-3 messages per month
- BSSw Digest: https://bssw.io/pages/receive-our-email-digest
  - Updates on BSSw content
    - New blog posts, events, and resources
    - BSSw Fellowship
  - Typically 1-2 messages per month
  - Also: RSS feed: https://bssw.io/items.rss

Resources

- Bluewaters webinar series: Scientific Software Ecosystems series
- Fussell, C. & Goodyear, C. W. (2017). One mission: How leaders build a team of teams, Penguin Random House LLC: NY.
- Hansen, M. T. (2018). Great at work: How top performers do less, work better, and achieve more. New York, NY: Simon & Schuster.
- McChrystal, S., Collins, T., Silverman, D., Fussell, C. (2015). Team of teams: New rules of engagement for a complex world. Penguin Random House LLC: NY.
- McNulty, E.J. (2015). Leading in an increasingly VUCA world. Strategy+ Business.
- Mui, C. (2016). Lead Like a Humble Gardener. Forbes.
- Raybourn E.M., Moulton J.D., Hungerford A. (2019) Scaling Productivity and Innovation on the Path to Exascale with a “Team of Teams” Approach. In: Nah FH., Siau K. (eds) HCI in Business, Government and Organizations. Information Systems and Analytics. HCII 2019. Lecture Notes in Computer Science, vol 11589. Springer, Cham.
- Walker, J. (2018) The DoD office you’ve never heard of—and why that’s about to change. Defense News.
- Webinar series: Best Practices for HPC Software Developers

Where the objectives met?

We've concluded! Can you now describe

- **What** are Scientific [research] software teams
  - *What are the challenges?*
  - *What characteristics make teams effective?*
  - *What are the cultural dynamics that influence our communication?*
- **How** to develop engaged and productive (in-person, hybrid, and virtual) teams
  - *How do we build team cultures?*
  - *What are best practices for team communication?*
- **When** you have become Teams of Teams: networks of code collaborations
  - *What are common organizational configurations?*
  - *How do we scale from a small team to a larger team, or team of teams?*
  - *What do the characteristics of a team of teams?*
- **Where** you can find resources for forming and sustaining scientific software (code) communities
  - *Where can I find training resources?*
  - *What lightweight tools may help with productivity?*

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Citation

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Share your stories.

Thank you for your participation!

So your code will see the future.

https://bssw.io/contributes/new

Upgrading Team Practices

https://bssw.io/psip/