

Innovative Assessment of Collaboration 2014
Welcome, Opening Remarks
Panel 1: Organizations

Alina von Davier, ETS

Good morning. I want to thank all of you for joining us for this one-and-a-half day working meeting. I am Alina von Davier from Educational Testing Service. I am a co-organizer of this event together with my colleagues Pat Kyllonen, who is here, and Mengxiao Zhu, also from ETS who could not be here today, but she has been a strong force behind this work for the past few months. I want to acknowledge the support from Educational Testing Service and from the US Research Army Institute. This event has been motivated actually about a year and a half ago by a meeting that was sponsored at that time by NRC, National Research Council, and the US Research Army Institute where I was a speaker and their format was having different panelists working together on identifying research directions for measuring individuals and groups. And that's where for the first time I had this idea that actually in order for us to learn more about communication, collaboration and how to build assessments for this new construct we need perhaps to learn from each other, to look across disciplines and bring people together to identify and speed up the research around this new construct.

So our first speaker today, will give the opening remarks, is Dr. Jay, Gerald, Goodwin, and he will be talking about the impact and the necessity of considering constructs such as collaboration for assessment. Dr. Jay Goodwin is chief of Foundational Science Research Unit at the US Army Research Institute for Behavioral

and Social Sciences, ARI, and he is the Director of Cognitive Sciences Laboratory at the same Institute. So it is my pleasure to introduce Jay Goodwin.

Jay (Gerald) Goodwin, ARI

All right, good morning, everyone. I'm not going to talk for too long. I'll see if I can actually get us right back on schedule. I just wanted to take a minute and talk a little bit about how we got here. Alina alluded to it just a second ago, which I appreciate very much. But walking backwards actually to the genesis for the NRC study that led to the workshop that she mentioned, you know, I'm responsible right now for the basic research program of ARI, and I had been looking in 2010, early 2011, across all of ARI's responsible areas and trying to figure out what would it take to move some of these areas forward. When I was looking at our personnel testing area, the military has a very, very solid cognitive tests battery that we use for entry into the military service, the Armed Services Vocational Aptitude Battery. It takes an awful lot to generate incremental validity over that and we have been doing that with some of our personality testing, which has been the most recent area for our investment, but I'm trying to look forward another 15, 20 years down the line. What would it take to generate the next ASVAB?

And so in doing so what I very rapidly started to discover when I was talking to some of our personnel testing experts is there are some things that we can't do within our current paradigm very well or at all. Dealing with complex variants, for instance with situational judgment tests or any other types of performance-based tests, you end up with multiple constructs coming into play, you have impure items and we end up with

very messy tests, and it's a deficiency within the underlying psychometric theory that doesn't allow us to deal with that very neatly. Assessment of social and interpersonal skills is another area that often has come up and that's a part of what led to this specific workshop, but it deals with the same kind of issue of having complex variance. Being able to assess multiple constructs simultaneously, most of our psychometric tests, psychometric theory is designed to allow us to measure constructs in serial, one construct at a time. We design items that are ideally suited or ideally would tap into a single construct and we have a pure item assessment. Well, what happens when we have items or performance sets where you have multiple constructs coming into play simultaneously? How do you assign construct scores from performance on that item from someone's responses?

So we were asking these questions internally and I went to the National Research Council and asked them to put together a proposal that would help us look out into the scientific community to see what answers were out there. That led to the current study of which Pat is actually a member of the Consensus Study Committee and part of that was a workshop. The workshop was designed to bring in as many good ideas as we could get from out there, and then the Consensus Study was designed to take all of that input and narrow it down to a set of best recommendations.

At the beginning of the workshop I actually used the slide that, this slide – now I can put that down because that's my one and only slide – to answer why, why are we doing this? Well, part of why is if you think about IRT, which is the dominant measurement paradigm that we're under now, the original work on IRT was done in the late 1950s, early 1960s. If I'm not mistaken a seminal paper for IRT is 1956, 1957. That

moved forward into conceptual demonstrations and how we could use that to generate adaptive tests in the 1960s. Microprocessors and computers actually led to being able to put that into play in real computer-adaptive tests in the 1970s, and in the mid '70s we really started focusing within DOD – and actually I think Pat just this morning alluded to the race for the moon; I think ETS was doing that simultaneously – to put into practice the first computer-adaptive test. That led to a computer-adaptive version of the ASVAB that was developed during that decade of 1975-85 that actually went operational in 1990. Pat, I don't know if DOD won the race to the moon or ETS did.

PK: [Pat Kyllonen] ETS did.

There you go.

PK: [Pat Kyllonen] It was close.

And the Army actually developed a computer-adaptive prescreening version for ASVAB that went operational in '88. We actually have a computer-adaptive personality test that is operational now within DOD called TAPAS, the Tailored Adaptive Personality Assessment System. So within DOD we've gone from the original theoretical work being done in the 1950s to 40 years, 35 years later having the first computer-adaptive test and another 20 years after that having our second major one. So we're looking at this very long time scale for the development of these tests and moving from real serious original theory and theoretical work to the real practical application of that. Since my job is making sure that we're generating the real deep original theory and looking at the time scale, I decided, well, I'd better get busy on this so that we have something in hand to be able to have the next major generation of ASVAB actually operational sometime before I die. I won't make it before I retire most likely, but given that that's only about 20,

25 years away, but if we can have at least the start of the operational development done before I retire I'll be, I'll look at this and think I'm satisfied.

So that was the genesis for the workshop or for the NRC study of which we had a workshop. It was fairly serendipitous that we had Alina as our keynote speaker at the workshop. I had actually, I had scheduled to go up and talk to folks at ETS about four months prior and we got snowed out if I remember correctly, so I ended up talking to everybody on the phone and Alina was one of my phone calls. And I got on the phone, hadn't heard of Alina before, didn't know anything about her, didn't know anything about what she was doing and she said, "Well, you know, this is who I am, and I'm just arriving here at ETS and I'm going to be the Director for the Center for New Psychometrics." And we had a great conversation, and when we were looking, when I was working with the NRC and we were looking for someone to be the keynote speaker I thought, "Hey, there is this woman out there at ETS who's really, you know, what she was talking about was a novel way to approach psychometric theory. I think that's exactly who we want to have as the keynote." She came in and she gave a fabulous talk, and from that, as she just said, she and Mengxiao and Pat came up with an idea that led directly to this.

Now the Army's interest in this effort, this particular workshop, has multiple areas. As you might imagine, first and foremost I am very interested in moving measurement theory forward. The emphasis on assessment of collaboration I think is a very able vehicle for us to do that. Collaboration is a very complex performance involving multiple people, involving social and interpersonal skills, involving the constructs that are very messy for us to assess and to come up with interesting and

very accurate ways to assess. If we can through this effort lay the seeds and the groundwork to move measurement theory forward, and to move the assessment and identify new approaches for assessing social and interpersonal skills and come up with ways to deal with some of these messy constructs, I will have viewed all of this a tremendous success. And my hope is that leaving here, many of you who are actually out there doing the research and of a wide variety of organizations will take some of these ideas back, and hopefully these seeds will start to germinate and help all of us move this discipline forward into the future.

And with that I will retire from the podium and let our next round of speakers – I'm looking forward to hearing from our panels today and tomorrow – let our next round of speakers get up here and talk about the real content of the workshop. Thank you.

Patrick Kyllonen, ETS

Welcome, everyone. This is a very exciting event. So my role will be, on this panel will be to; we're going to start off – I'll steal whoever's chair is open during the time they're talking, yeah, that's fine – so I will introduce the panel members and then each panel member will talk 12 to 15 minutes, so it'll be a fairly brief prepared talk. After that we will go through a set of questions, and then after the set of questions we'll have Q&A from the audience, and we have a microphone and please come up to the microphone to ask questions at the end of it. So it'll be one-third, one-third, one-third. That's the basic game plan here and we'll do that throughout for all of the different, all five panels, and Alina and I will take turns moderating. So let me just begin by introducing our panel members, Eduardo Salas is a Trustee Chair and Pegasus

Professor of Psychology at the University of Central Florida, and he also holds an appointment as Program Director for Human Systems Integration Research Department at University of Central Florida's Institute for Simulation and Training. And he will be the first speaker, but let me just introduce all four panelists. The next speaker will be Leslie DeChurch, who's an Associate Professor of Industrial Organizational Psychology at Georgia Tech, and she is also a recipient of an NSF Career Award to support her research in multi-team systems. And then after Leslie, Noshir Contractor will speak and he is the Jane S. and William J. White Professor of Behavioral Sciences in the McCormick School of Engineering and Applied Science in the School of Communication in the Kellogg School of Management at Northwestern University. He's also Director of the Science of Networks and Communities or the SONIC Research Group at Northwestern University. And then finally Steve Fiore will be speaking. He's Director of the Cognitive Sciences Laboratory and faculty with the University of Central Florida's Cognitive Sciences program in the Department of Philosophy and the Institute for Simulation and Training. So let us begin then with Eduardo Salas.

Eduardo Salas, University of Central Florida

Good morning, everybody. So what I decided to do this morning and maybe to kick it off was to helicopter a little bit, 35,000 feet sort of observations. And I cannot see everybody here, but I'm going to guess that I am the one who has spent the most time looking at team performance measurement. I've been doing this roughly for about 30 years. Actually I started my career with the Navy in 1984 and my job was to develop a team performance laboratory. And the first thing that happened was, after I got in there,

was to ask, “Where are the measures? How do we measure collaboration and teamwork?” And to my surprise, I heard a bunch of people telling me, “We don’t have any. You have to develop it.” And so I was on a journey with me and others, collaborators, for the last 30 years, trying to develop assessment tools to understand collaboration teamwork, team performance.

And so what I thought I would do today is give you my insights, my experience, what works, what doesn’t work. I will not be talking about a specific tool or specific technique or a specific instrument. I will be telling you, and hopefully challenge you and give you some insights again into what works, what doesn’t work, what has been my experience. Some of this comes from research. Some of this comes from my gut after observing teams in all those domains that you see there, to include very recently actually engineering students at the large universities where working with others is a problem. Engineers, don’t want to offend anybody, but the data suggest that engineers are not good at playing with others. And so there are a number of NSF grants out there trying to look at how do you improve collaboration and coordination in college students. So since I have a bout 15 minutes or less, why don’t I just get into these things? Again my intention is just to make you think, challenge you. There’s some bad news, there’s some good news in what I’m about to tell you, and then at the end I will tell you what I think we need to do. Again that’s just my opinion. Let’s see if this works.

So we started this again in the ‘80s and ‘90s. Actually in the mid-‘90s we put together, which are very similar to this, very much focused on team performance assessment, which yield that book that you see there. We brought for three days just like this a bunch of experts and different multidisciplinary to tell us what do we know

about teamwork assessment. So we've been doing this for a long time. And then the other book on making decisions under stress, which was this large project funded in the late '80s into the mid-'90s to try to understand team decision making under stress in command and control teams and a big investment that we did there was looking at measurement, so that book also publishes a lot of insights and tools, things about measurement. Since then my job in the last five, six years has been to translate what we know about measurement. Here are some examples of tools that we have put out there and I'll tell you a bit more about this. But there's a large body of knowledge out there in the measurement aspect of it. However it's not very well organized. We have been discussing with colleagues over the years and I hope that at the end of this symposium we can begin the road of organizing this in some fashion or another and I'm going to offer an organizing framework.

So to remind us what are we dealing with here, it's collaboration, it's dynamic, episodic, multilevel, elusive, task dependent. The task matters a lot in what teams do. I'm a believer that teams don't perform. It's individuals that perform, and when you aggregate that, that's when you get the sense of what the team is doing. And it's influenced by many factors, just like I think Jay alluded to earlier. And just to give you an idea, this is the nature of the beast. This is just a framework that helps organize all the variables that impact team performance, team performance assessment. So it's messy, just like Jay said, and continues to be messy. There's new techniques coming out that are helping, but I believe that there's more research that needs to be done. So let's go directly to the observations. I'm going to have ten of these, very quickly.

So the first one is context matters. There's no silver bullet here. And there's not a month that goes by where I get two or three phone calls with somebody asking me either in healthcare, in aviation, in industry, in the oil industry and financial industry, "Can you send me the measurement protocol to help me with my team performance problems?" And I usually say, "I don't have the measurement tool, but I can send you a measurement tool or I can point out you to a methodology on how to develop this." In my opinion – we can debate this – all of the instruments need to be adapted to the context. The good news is that I think; somebody asked me not too long ago, "What's the percentage of adaptation, if you will?" So if you define your construct well, what you want to assess, that's 80 percent of it, and then the 20 percent has to be adapted to the context, very specific domain. So again my first observation after 30 years, if you call me, "Send me the tool," I will not be able to do that. There might be some of you who think that they have the tool, but I don't necessarily think that's the case.

My experience the best thing is to triangulate. Self-report, peer assessments and observations have been the three approaches that help. This is a no-brainer. If you can do this in research, that's what you do. In practice it's very difficult. Usually it's basically self-report and I'll say more about that. It takes a team to evaluate a team. In my experience it takes more than one observer to really, that knows well what collaboration is all about. And you cannot escape observation. There are a lot of; although there are some unobtrusive measures coming up that I think are very promising, still at the end of the day you need to observe what team members, five minutes, okay. Size matters. Believe it or not the size of the team makes a difference in terms of how, who and what, so the smaller the team the better. I've learned over the years that psychometric experts

can only assess between four and five constructs and our tendency is to try to evaluate 20, 18. I've seen scales that try to assess 12, 15 constructs. It's impossible for psychometrics to do that because I think everything correlates, so I think that.

It's best to capture attitudes, the ABCs is what we call them, attitudes, behaviors and conditions. Conditions remain a challenge. Like I said there are a number of unobtrusive approaches that I think some of these guys might be discussing, and there are some low-level metrics like heart rate and EEG that look promising, but at least you ought to do that. The matter. The more specific you are the better. A lot of people want generic tools, and then when they use the generic tools they find it to be useless, especially for development. So behavioral markers matter and they need to be contextualized.

This is kind of an editorial. It's all about the constructs. I mean there's now an obsession with methodological tools or statistical techniques that in my mind it's necessary but not sufficient to assess collaboration. So we need to always be reminding ourselves it's about the constructs. It's about collaboration. A measurement of teamwork is not one-stop shopping. It's dynamic phenomena, so teams do different things at different times. Big challenge. How do you capture that? How do you assess that? And again this is an obtrusive measure [rapid, Spanish-accented speech]

Number nine, what is good for science is not necessarily good for practice. I do a lot of practical consulting, if you will, and in research we have the advantage that we can do all kinds of things like translate and do self-report, all kinds of things. In practice people in a corporate world, in places like that, they just want something that's simple, easy to use, that is relevant and is diagnostic. I think we can do the simple, we can

do the easy, you know, the ease of use, but the relevant diagnostic is the big challenge. At the end that's why I think these need to re-conceptualize(?).

And let me end with what I think is what we need to do, and again I pose this as a challenge to all of us. I think we need to go back to basics. We have ignored the basics of what team performance measurement or measurement in general is. And let me offer this. At the end of the day this is what we need to know, what you're going to measure, why are you going to measure it, when you're going to measure it, where and how. And I think that what is needed here, and we need to organize a lot this body of knowledge out there and begin to say, "If you're going to measure situation awareness, mutual performance monitoring, whatever construct you have, then we can begin to feel this taxonomy. I think there's enough out there to begin to do that. Would it be perfect? No, but it will be enough guidance. This is a principle that I think this field needs to organize all this area. I think that's it. Thank you.

Leslie DeChurch, Georgia Tech

Perfect. Okay, good morning, everybody. So now that Eduardo has simplified this problem for us significantly, we're going to get a little more complex even still. So the title of our panel today is "Organizations" and many of us are teams researchers, and so this is an interesting problem space where we're essentially using teams and principles of teams to try to understand a phenomenon that's actually a few orders of magnitude more complex than teamwork, which is that of collaboration. And so another way that I could frame this talk, which I originally called "Confluent and Countervailing Forces Within and Between Teams," is collaboration in multi-team systems. And I think taking

account of this multi-team perspective adds something to our ability to understand and assess collaboration in real world organizations.

So I'll start with an example, which is the Human Genome Project. This kind of illustrates the nature of a complex collaborative problem. This was originally sculpted to be a 15-year massive scientific undertaking originally led out by the Department of Energy and the National Institute of Health, and at any given time in the Human Genome Project there were researchers from 18 countries and 200 different PIs working in their labs, and there was a tremendous amount of orchestration in order to sequence the genome, both within all of these different laboratories, but also between the laboratories. And so this was kind of a massive undertaking of collaboration. We can say what we will about how effective it was, but they finished the project in less than the originally-planned 15 years.

So this is to kind of get our heads into the nature of what we're talking about when we talk about collaboration in organizations, that it's often not; what organizations don't look like is these kind of neatly-bounded sets of teams that stand alone, work on a task and individuals are interdependent. Right? So if we're trying to hit that target, we're missing one of the big boundaries of collaboration which is that individuals are still the focal unit, but they have to work across multiple teams as well as within teams.

And so here's a nice quote about this, Walter Isaacson's new book. He talks about, he's reflecting on the different biographies that he's written about people like Steve Jobs and Albert Einstein and he says, "Well, we sort of are misleading. When you look at the grand innovations of our time," having written about people like Steve Jobs he realized how important the complex teamwork around him was to these ultimate

successes, that the kind of markers that we look at and say, “This is a signal of collaborative success,” that these involve a lot of different teamwork and a lot of tensions. The story of Darwin’s discovery was fantastic because it was actually he would have never published the book if he wasn’t about to be scooped. Right? And so this was a very interesting case where when we all talk about collaboration there are these complex dynamics of oftentimes competition between different groups that is fueling the activity within a particular group.

And so the lens I use to describe these kind of complex collaborative dynamics is multi-team systems, which we define as a unit of analysis that’s larger than a team, but smaller than an organization. This gives us a lens and a boundary to be able to study this phenomenon. So we define them as two or more teams who work interdependently pursuing both proximal team goals and also distal multi-team goals. And we’ve written a lot about multi-team systems. The kind I’m going to focus on today are the ones you would find in science working on the Human Genome Project, or the ones you’d find in organizations where the goal is to develop new products or perhaps the ones today working on solving the problem of innovative assessment of collaboration.

And so we start with the team’s literature. Eduardo’s done a fantastic overview of this. We have a fairly sophisticated science of what makes individual teams work. Furthermore we have some nice meta-analyses that have been conducted over the last 15, 20 years on everything from the classic team cohesion, the importance of people identifying and attaching themselves to the team, feeling motivated by the team, having healthy perceptions of conflict levels, being able to manage conflict in a product way, having, exhibiting positive interaction process, sharing unique information, having a

shared mental model and an understanding of how to distribute knowledge and expertise throughout the team.

So we have some kind of core constructs, and these constructs are all properties of teams or processes of teams and that's an important distinction. So properties are things like affect, motivation, cognition. Essentially they're the core functions of what it means to be human. Right? I think, I feel. And they're extrapolated up to a higher level of analysis and they crystalize into patterns in the team. We can contrast those with the other things that we do as humans which is we behave and we act, and in teams those take the forms of interactions. In multi-team systems they take the form of interactions often between the members of different groups or teams.

And so when we asked the question, "What are multi-team systems and what makes them work?" we sort of started off about 15 years ago with this problem of complex collaboration and we built it from the ground up. So we said, "Okay, these are systems of teams. Let's start with what we know about teams and let's try to generalize one level up." And so we essentially have three lines of thinking. So the early work I'm calling it, which is circa 2005, if we look at sort of the narrative question that was being asked in the field it was, "What predicts MTS effectiveness?" So we know that there are these complex collaborations. They're in the military, they're in science. What makes them work? And we started looking for predictors.

And you had an awful lot of empirical studies that started coming out. I won't say an awful lot because this work was hard to do, many of the reasons surrounding measurement, but this work was single level and it would be of the general form of between-team coordination predicts multi-team performance after you control for within-

team coordination. And so there were many what I'll call confluence studies where we found that things that went on within teams needed to be augmented by interaction processes and collaborative dynamics between teams.

Then there was a new paradigm that started emerging around 2010 and this paradigm asked a slightly different question. It said, "What predicts team versus multi-team performance?" And so there was this growing observation that some of the things that we did to build collaboration that made teams effective had unintended harmful consequences when those teams had to operate as systems. And so this really got the attention of MTS researchers and we started investigating some of these unintended consequences. However, if you look at those empirical studies, they all are still single level. They're not multi-level investigations. So the examine-and-affect size like planning and performance at the MTS level and they say, "Well, in the prior research we already know that this has a beneficial effect at the team level and now here's our finding that it has this different effect at the multi-team level," but that's still missing part of the piece.

And so what I'm going to talk mostly about today is a new paradigm circa 2014 which recasts this question as, "What predicts team and MTS effectiveness?" and that's the question we need to be thinking about when we're talking about measuring and assessing collaboration. And this inherently is about the optimization of collaboration across different entities and it entails; you can't test it without looking at cross-level effects of different processes and states that emerge both within and between teams. And so here's the model we've developed to conceptualize this notion of confluent and countervailing forces in multi-team systems, and essentially we can think about this in terms of our basic predictor criteria and relationships where predictors are teamwork

processes and states and criteria are either markers of things like team viability or team functioning, do people want to remain within this group, or also things like performance and effectiveness.

And so essentially if we think about these kind of characteristic relationships, one in four are the relationships we started off asking. So four is the whole team's literature. Right? The ones that I showed you all these meta-analyses. Relationship depicted on line one was the early work on multi-team systems. This countervailing research is looking at things like relationship one and three together. Right? Now what I'm proposing by this countervailing perspective is that the relationships we really need to think of in terms of an optimization perspective are the combination of relationships one and two, right, which tell you about the effects of a process and state at multiple levels of analysis. And this is about having divergent consequences where in an organization you're interested in maximizing both. We want well-functioning teams that play nicely and well-functioning systems. So when we have these kind of relationships where relationship one and two exhibit the opposite form, so we do something for example to build cohesion, but it has this negative consequence at the system level, we have to find out how to optimize those if we're trying to predict collaboration. The same thing with three and four. Relationships three and four represent another type of countervailing force where to the extent that three and four have opposite consequences at different levels of analysis, we can't optimize without focusing on both of those together.

And so the notion formally of countervailing forces are combinations of teamwork processes and properties that operate differently at different levels of analysis. A countervailing first occurs when a process or an emergent state has both positive and

negative effects and here's a table outlining four types which I'll go through some examples. If we look on the left-hand side of the table we can see the level of origin. so the idea is this collaborative process or state comes about and takes on meaning at either the team level or the system level.

Across the top we look at the consequences, so what are the consequences to the team and what are the consequences to the system? And this lays out four different types, and we can see this essentially by looking at these are all combinations of one and two, so type three and type four countervailance are examples of this conjoint analysis of relationships one and two, and I'll give an example here with team cohesion. So this is a team-level property. We're looking at predictor C in the top graphic and the idea is that cohesion is very beneficial locally to teams, but cohesion builds an insular boundary and suppresses some of the interaction that goes on between teams or the trust and willingness to share information openly.

Conflict is another one. So conflict actually may have consequences locally, if we think about the consequences of a team that's embroiled in relationship conflict, negative. We generally think we want that to be avoided. But we also have this nice effect where conflict may actually soften the team and make the boundary permeable to new ideas. So a team that's not, that's got some internal disagreement is more open to the uptake of novel perspectives and new ideas than a team that's not. So something that's harmful that we thought, "Oh, if we want to build good teams we should try to eliminate conflict," we actually find the opposite when we take this multi-team perspective. There can be unintended benefits.

I'll go through two other kind of examples here and I just want to show you an illustration of this in some real data. This is a study where, one of my uber-talented PhD students has led, looking at, demonstrating these countervailing forces with team communication networks. And so this is her conceptual model looking at MTS functioning, and so the predictors are now team internal communications, so the density of the communication network with a team, and the boundary-spanning density. So to what extent are teams in a multi-team system forming boundary-spanning ties to other teams? If you read these literatures separately they both say maximize. Right? If you read the boundary-spanning literature, we know how important structural holes are. If you read the team's literature, we know teams need dense internal networks. These literatures don't look at both outcomes simultaneously.

And so we'll skip to the conclusions here. We see that indeed these literatures are both true when we consider the single-level effects. However when we look at the cross-level effects, we see that boundary spanning has this negative quadratic relationship with team identification. So up until a certain point boundary spanning is indeed beneficial. Past a threshold it starts weakening the team identification to where you lose that internal coherence.

And let me skip to the end. So implications for assessing collaboration, sort of three conclusions. One, collaboration involves processes and states linking not only individuals within teams, but also teams within larger systems. Second, these team processes and states exhibit countervailing effects. We often don't see them because the literatures at these different levels of analysis have previously remained separate and disconnected, not testing cross-level effects. And third, assessment needs to

predict collaborative processes and states that have been optimized across multiple levels, and I'm out of time. Thank you.

Noshir Contractor, Northwestern University

I want to thank again the organizers, Alina and Patrick and Mengxiao for organizing this event and, of course, also to Jay and his team for helping to co-sponsor this event, so this is quite an exciting opportunity. I'm going to talk a little bit that I'm going to piggyback in some ways fortunately on the fact that Leslie has already introduced the notion of multi-team systems, and the picture talk – I don't know whether I'm going to get through all my slides – but the big picture that I wanted to focus on is that very often when we think of dynamics, the ways in which we think of dynamics are shaped by the kinds of methods that we think of. Until pretty recently dynamics was thought of in network terms at least. You look at a network at one point in time, and you look at a network at a network at the second point in time and the third point in time, and then you look longitudinally at how these networks at each point in time shape subsequent points of time.

However technology has now made it possible where we don't need to look at networks at snapshots of times, but in fact look at each relational even as it happens. So when we look at time-stamped data in teams, you know when A talked with B, or A sent a message to C, and so on and so forth. So what that did was once we had time-stamped data our first instinct was to take this time-stamped data and too bucket it into days or weeks or months and then look at it longitudinally, which we realized was a silly thing to do because we were losing all the resolution in the dynamics of the data.

And so what I want to talk about today is about how theorizing about dynamics in groups and teams has changed dramatically because of the kind of data we have access to and in fact prompted the development of new methodologies, in particular relational event network methodologies that I'm going to talk about today briefly. Not so much the methodology but how it gives us new types of insights about the impacts of how links form within teams, and one of the generative mechanisms that generate intra-team, inter-team communication, and then how do these mechanisms impact the performance of the team? So I'm going to talk a little bit about the form versus the perform, what forms may not be necessarily what performs. And we'll see some instances of how that plays out quite nicely when you're looking at the sequence of relational events within networks.

So we think of this now as sequential structural signatures where you can look at the structural signature not as one point in time but as a link going from A to B followed by say a link going from B to C and so on, and we look at certain signatures and see if there are certain patterns, dynamic patterns that are associated with greater performance for example within organizations. So we refer to these signatures as sequential structural signatures.

So this is an example. On the left what you see is a photograph of A, B and C and you say you've got this data. You know that if A talks to C and C talks to B, there's a greater likelihood that you'll also see a link from A to B. But in sort of looking at it as a photograph, if you look at it as a movie, then your time-stamping it and saying if there is a link from A to C followed by a link from C to B, then there will be a link from A to B. That's an example of a sequential structural signature in that particular ordering. So

relational events are any behavior that are directed from one individual to another, and the most common one of course is the message, spoken or typed. And we can think of essentially a relational event as defined by at least three factors and those three are the sender, the receiver, the event time and maybe a fourth one which is the event type. So any particular relational event, it will have a sender I, a receiver J, a timestamp of when it happened and potentially the type of event. Was it spoken, was it written, for example, would be an example of that.

So this would be an example of an event sequence. There's an event at E1, which is a link from A to B at time 1, sorry, a link from B to C at time 2, and then a link from A to C at time 3. So this is the example of how that data looks like. I'm not going to go into the methodology. I'm happy to talk to you offline. I have a whole set of slides here that I have hidden, but this particular session was focusing more on theory than methods and so I'm going to focus on what we can learn from these approaches and then leave you with a teaser if you want to learn more about these methodologies.

So this is a relational event network model and the basic idea is that to analyze the likelihood of a particular sequence we look at the probability of each event, as well as the probability that no other event happened in the time, and so in that sense it's kind of like event history analysis. Some of you are familiar with hazard functions and survival functions and so that's the ilk, except that now this is network data so it has the problems of violating assumptions of independence of the observations. Okay, something stopped working. Okay, there we go.

So let's look at the generators of the intra-team communication. So here we are simply saying, "What generates communications within teams? And then we'll look

separately at what generates it between teams.” Within teams we can say that if people belong to the same team, by virtue of the fact that they share a common membership they will increase their likelihood, so that’s why there’s a greater likelihood of communication between I and J because they belong to the square team and between U and B because they belong to the circle team. You can have another one that says that inter-team communication, that is the amount you communicate with your team, is being driven by what you communicate outside your team. So in this case if A talks to someone in another team, D, to what extent is that likely to then result in other members in A’s team coming and talking to him or her? So that’s the arrows going there and we call that representation. The alternative is that when A talks to someone outside the team, D, to what extent does A then feel propelled to come and talk to people inside the team and we call that gatekeeping. A third one is now we focus on inter-team communication. What is driving communication between A and someone outside? Well, it could be because of the fact that if A has been talking to his teammates or her teammates B and C, that’s what’s going to propel A to go talk to D. Or the alternative, which is gatekeeping, which is that if A is talking to B and C in her own team, that’s going to make A now more attractive as somebody that someone from the outside wants to come and talk to, and so in that case A is playing a gatekeeping role.

And finally the last one is contagion. If A finds that her teammate B is talking to people on another team, then how does that influence A’s likelihood of herself talking to somebody from that other team? In other words, cutting out the indirect and going directly to the person from the other team. And then finally to what extent is the fact that U talked to I in another team and then will continue to talk to I, so just keeps repeating it

because they've already built up this inter-team relationship, or not only would they talk to that same person but they may talk to other people within the same team and that's generalized share(?). So once you build up a connection with another team, you keep wanting to do that.

So we collected data from about 660 individuals in 33 multi-acting(?) systems, and they are 20-person MTSs. These are very large multi-team systems, teams of teams, five people in each team and four teams, and they were given responsibilities to protect a convey of humanitarian aid going through four different regions within an area that had insurgent activity and IEDs. I'm not going to spend too much time in the details out here other than to say we gave them access to use SKYPE to talk to anyone that they wanted. And so the results that we have here, which is what I want to focus on for the rest of the time here, is to say, "What did we find?" So we'll first start with the signatures of team communication. Then we'll do the signatures of first intra-team, then inter-team. That's the form part of it. And then we'll look at the extent to which these intra and inter-team affected the performance of the team and that should give me all I have time for here in any case.

So the first one is we find significant that team membership does lead to intra-team communication. This was not at all a surprise. It means that you're more likely to talk; if in the past you've talked to somebody on your own team, you're more likely to continue talking to that person in the future within your own team and that's a significant finding there. The second one is we also found a negative effect for representation, which means that if people, if you were talking to people in other teams, that was not likely to be followed by people from your own team coming and talking to you. See

that's a negative finding. In other words just because you talk to people on the outside doesn't mean people in your team will come and talk to you. We'll come back to that because it's kind of an interesting nugget to interpret it.

When it comes to inter-team communication we found that between team communication, that is we are predicting whether you talk to somebody from another team and that's going to be based on inertia. In the past if you've already talked to somebody from another team, then tomorrow you're more likely to keep talking to that same person from another team. That's the first one there, that between team personal significance. And the second one was also significant, though by a smaller magnitude, which says that if I talk to someone in this team, then tomorrow I'm sufficiently more likely to talk to another person on that same other team, and so that's the more generalized inertia.

So what did we find in summary? We found that in most MTSs internal communication is based on team membership and avoiding intra-team representation. That is when you talk to people from the outside, people in your own team are not going to come and try to seek that information from you. And that between-team communication was basically driven by inertia. If you talk to somebody in another team at this moment you're more likely to talk to them again at the very next moment. Likewise if you talk to someone from another team at this moment you're also more likely to talk to some other teammate of that person at the next moment.

The next thing we wanted to do was to look at performance, so to what extent now could you take these structural signatures that we see forming and try to map them on whether they are helping the team perform better or perform worse. And so here

what we did was we had two measures of performance at the team level and one measure of performance at the multi-team system level. At the team level the measure of the first measure of performance was how safe were you to keep your own quadrant in that area, your own region? So that has two measures because in order to keep it safe you need to detect if there was IEDs or insurgent activity, and the second measure is you need to be able to neutralize those IEDs or insurgent activities. At the MTS level, the multi-team system level, the measure of performance was more global, and that is you had to safely take your convoy from one area to another. It doesn't matter whether it was just cleaning up a lot of areas within your own area, but how you managed to take the convoy across the entire four areas without getting hit or damaged and making the most progress on it, so that was the number of grid spaces they moved and it was corrected for damage.

So what did we find? We found again that groups where people were more likely to engage in communication within their team was going to improve their own team performance. So here now are the dependent variable, here are two measures of team performance. We'll come to MTSs later on. And the team performance, how successful were they to identify, how successful were they to neutralize? And what we find here is that if they talk more to members in their own team, they're not more likely to identify new targets, but they're certainly more likely to be able to neutralize those targets. The second significant finding there is intra-team representation which says that if people who talked from the outside, if you talk to people on the outside and then people in your team came and spoke with you, then you are in fact more likely to be successful in identifying as well as successful in neutralizing it. Now notice that this was one of those

things where it was less likely to occur. Inter-team representation was not very likely to occur, but when it does occur it increases the performance quite significantly. Intra-team gatekeeping was also significant, which meant that if you talk to people from the outside that in fact after that if you came in and disseminated that information on the inside, you're also more likely to successfully identify as well as neutralize your targets.

So in terms of; now the last measure of team performance was – I'm sorry – in terms of team performance based on your communication with others, if you kept talking to the same people, if you talked to talk to people in another team based upon the fact that you previously talked to another member on the team, the inter-team contagion, that helped you identify new people, new targets because you could cut to the chase and go directly to outsiders to get information. And also if you continue to talk to talk to people on the other team, the same people, you were successful in identifying new targets, but not so successful in neutralizing the new targets. So your inter-team communication helped you detect problems, but didn't help you actually neutralize them, etcetera.

So in summary then we have within-team communication was generated based on team membership, representation and gatekeeping, and between-team communication was generated by contagion as well as personal inertia. So the last thing then, and then I'm overtime here, but I'm going to take just another minute to wrap this up, is what predicts MTS performance? So far we looked at team performance. Now we're looking at performance at the multi-team system. Here again we find that; so I should have mentioned one thing on the previous slide that I didn't and that is when you look at these numbers here – oops, where is it? – I want you to pay attention to the

R squares. This is phenomenal. You're explaining 59 and 53 percent of the ability for a team to be able to identify and neutralize targets by looking at the sequential structure of signatures. This is something that I think is quite promising as a theoretical framework for understanding performance within these contexts. Back again to MTS performance, here too we have good variance, explain a little less, about 31 percent of the variance. But here it says again if you belong to people, if you talk to people on your own team that helps with the overall MTS performance. But if you engage in behavior where you talk to someone from another team and then come back and the people from your own team are coming to you, that's going to have a negative impact on the overall system performance, but a positive impact if you are the one who reaches out to them. So the nugget here is if you are talking to other people from outside, don't wait for your own team to come and talk to you to get information. You should be the one pushing that information out to them if you want the overall MTS to do better.

And then finally again inertia continues to be a negative impact, and that is if you talk to people in another team, the same people again and again, you have a tendency to do that, to form that, but when you do that you're actually hurting the overall MTS performance. So again I'm just going to summarize here. Within-team team communication generators with team membership, representation harms the MTS, gatekeeping benefits the MTS, personal inertia and generalized inertia harms the overall performance of the MTS. So the takeaway here is that we have a form versus perform paradox and that is most MTSs form internal communication based on team membership, which helps the team and the MTS. They avoid intra-team representation, which benefits the team and harms the MTS. So in a sense this is similar to Leslie's

notion of the countervailing forces where something happens and it helps the team, but it harms the MTS, and likewise with inter-team communication you have similar situations where something benefits the team, but harms the MTS in a different context, etcetera. So I'm going to just stop with that and hope that this new methodology will allow us to think more creatively and theorize more creatively about the ways in which we can study dynamics and its impact on performance. Thank you.

PK: [Patrick Kyllonen] Thank you, Noshir. So our last speaker for the panel will be Stephen Fiore from the University of Central Florida.

Stephen Fiore, University of Central Florida

Thank you, everybody. When we structured this panel we decided to start broad and go into detail and then end broad, and Eduardo talked about the 35,000-foot view, and I'm going to take us to the 50,000-foot view, probably because I like looking down on Eduardo. But I wanted to provide some insights about what's been happening in the study of interaction and the study of collaboration over the past few years that I find particularly intriguing. So I wanted to go from neurons to networks as kind of a play on words and alliteration because there's been some exciting work going on, but because they told me I only have 12 minutes, I'm going to give you vertigo because I'm going to move really rapidly between these levels of analysis.

So I want to talk about what's been happening to kind of set the stage and go from, as I said, this more micro level to a more macro level and then identify what I think is necessary for the study of collaboration to help move us forward with regard to understanding new ways, new methods and new measurement techniques. So as

you've heard so far, and as you're about to hear more over the course of the next day and a half, there's been a tremendous amount of new methods and new technologies involved in the study of collaboration, the study of interaction, but there's also been the development, and an important development, of new concepts and new methods. And importantly we're looking not just within levels of analysis, but across levels of analysis. So what I want to talk about now is thinking about research that crosses levels and crosses disciplinary approaches for studying collaboration, and what I'm going to reach for at the end is a push for interdisciplinary teams that are going to be able to work together to utilize these new technologies to study teams and to synthesize these methods and theories in new ways that we can understand collaboration like we never have before.

So now I'm going to get into some detail, what I think are some really interesting studies that have been happening at the more micro level. So this was one of many that have been happening with regard to what's called social neuroscience. So this is the field that developed about a decade ago when neuroscientists were getting sophisticated enough to start looking at social cognitive properties instead of just cognitive properties, and this is one of many studies where they looked at how people, how interaction was affecting neuroscientific properties in the context of EEG activation and the context for this was guitar duos. So these were people who were actually playing guitar in a duo and they were looking at synchrony and EEG activation. They were looking at prefrontal cortex activation because they speculated that theory of mind areas were going to be activated due to the need to monitor the other member of the duo, and what was interesting is they were looking at coordination and leader and

follower assignments in the duos. And what they found here in looking at the EEG activation was that the oscillations will vary dependent upon these leader-follower assignments, and they found that there was particularly(?) within brain phase locking and between brain phase coherence that was indicative of the amount of amount of coordination demands associated with the particular duo that they were playing. So what they argued was that these kinds of phase locking and phase coherence was actually facilitating the coordination within the duo. So this is one of many examples that have been looking at this kind of tightly-coupled interaction using neuroscientific techniques.

There's also been some interesting work looking at neuropeptides, and this was a study that looked at oxytocin and how it influenced trust and cooperation. So oxytocin I reckon, I understand is kind of a controversial area of research, but I think it's an interesting and promising area of research and there's been a number of different groups who are interested in this. And they were looking at a classic social psychology problem, the prisoner's dilemma, and what they did was they implemented oxytocin or a placebo through aerosol and they wanted to see the degree to which this neuropeptide altered the form of collaboration. And the interesting effect that they found was it did change motivation within the group, but what was most interesting was that oxytocin influenced what they referred to as a defense-motivated competitive desire that was manifested when they were trying to predict vulnerable in-group members. So more specifically it didn't alter the nature of the competition and how they interacted with the team to which they were opposed. What it did was it altered the behavior when they saw vulnerable in-group membership. So if there was a member within their group who

they saw as vulnerable, the oxytocin actually inflated their activity and inflated their defensive kind of capabilities. So evolutionary psychologists obviously got very excited about this because they saw this as an indication that this was a particular kind of neuropeptide that has developed to help us protect each other when we engage in cooperative and collaborative behaviors. So again just a couple of examples of what's been happening at this more micro level.

Some exciting work that I think has been happening more at the traditional group level. This is kind of, you can think of it as a kind of neo behaviorism, so where they're studying specifically observations of behaviors and more at the non-verbal level. So this was looking at what they refer to as sensory and motor communication and this was movement patterns within the context of orchestras. So some of you may remember Richard Hackman's classic work on teams in the context of orchestras. This was something similar in that they wanted to look at leadership, but what they did was they instrumented – no pun intended – members of the orchestra with these techniques, these passive markers for kinematic data capture and they used infrared optical systems where they could track the movement of the violinist and the conductor's wand. So these are new technologies that have become much more inexpensive and you may be familiar with this kind of kinematic data capture if you've seen point light studies. So this is a really important, interesting area of work where they've been able to show that this is a nice way to capture behavior by looking at simply movements of points of light. And what they looked at here was the context of the relationship between the conductor's wand and the elbow movements of the violinist. And what they were able to show is that there was a causal relationship in the leadership dynamics between the

conductor's want that was specifically related to expert judgments of the aesthetic quality of the music. So the conductor actually modulated the inter-musician interaction and what they found was when there was a tighter coupling between the instructor, between the conductor and the musicians, performance was better than when there was a tighter coupling between musicians themselves. So they looked at the musicians' interactions and the interaction between the conductor and the musicians and they found the aesthetic quality of the music was superior when the musicians were led by the conductor as opposed to following each other.

So now at the more macro, or I'm sorry another meso-level study, this was looking at team productivity, another important area of research and collaboration, but this was instrumenting teams in the wild so they could study creativity in organizations. And what they did was they used an electronic experience sampling method, and this was using the sociometric badges that have become very popular over the past few years, and they were looking at the nature of the interaction, the quantity of the interaction, the amount of body movements associated with these interactions and relating that to creativity. And what they did is they had people report the productivity on the job, and they had experts rate the creativity of that productivity, and they found that days that were rated as more creative by experts actually showed higher levels of daily movement and higher levels of face-to-face interaction with the team members. And I think this is kind of intriguing, and so obviously interaction with team members is an important component of creativity because it can spawn new ideas. But also just the fact that there is more activity itself that facilitated creativity is interesting because there has been work looking at individuals and showing simply how movement facilitates

creativity. And it can be any kind of movement. It can be taking a walk, it can be going outside and looking at nature, but movement has been shown to be facilitating creativity and I thought this was a nice illustration taking that to a collaborative level, showing that movement and interaction with team members facilitated creativity.

Now at the more macro level this was a study that did a kind of network analysis similar to what you just heard, but it was more at the behavioral level and looking at complex behavioral coordination in international soccer leagues. And in this study they looked at over 300,000 passes of professional soccer players and they wanted to study the centrality, the network intensity of these soccer players to see if they could be predictive of performance. So network intensity in this study was measured by the passing rate within the teams and network centrality was measured by the degree to which they focused on a particular player or they distributed the passes amongst players. And what they found was that the interactions were indicative of team performance such that the more passes engaged by members of the team the higher the performance, and the more centralized those passes were the worse the performance. So the punchline here was in this kind of dynamic coupling in a really complex time-stressed environment it is better to pass a lot, but to be variable with whom you're passing because that is going to increase performance and scores.

So this next study that I want to study to talk about at the network level used massively multiplayer online roleplaying games, so this is another hot area of research. Honestly I've never played one of these things. I think they're taking us closer to the matrix than we should be, but I recognize their value as a research tool. So they were looking at performance in teamwork and success in this environment and what I liked

about this was they not only looked at the endgame parameters, but they also looked at the network parameters, and more importantly they looked at several months of collaboration of around 7,000 players. And because I'm running out of time just the punchline here was that using the chat windows as an indication of the social network content, that was just as predictive of winners in the games as using the typical parameters. So you could look at things like the amount of power that they acquired, the kind of cooperation within the teams and the military strength of the team, but basically the social network analysis looking at the chat windows was just as predictive of the endgame play.

So with regard to this point about studying collaboration across levels, what I wanted to illustrate here is the various number of disciplines from neuroscience, neurophysiology to computer science, to psychology, to social computational sciences, the very context associated with studying collaboration and these new innovative methods for studying collaborations. And the point here is that if we want to build better theory along with these new technologies we need to leverage this kind of complementarity and develop the kinds of interdisciplinary teams where you can work together and draw upon each other's expertise.

So to wrap things up I want to look at this from a much broader perspective and look at some of the contextual factors that I think are necessary to engage in this kind of complementary research. So first there's this idea of interdependencies. So I gave you kind of a broad brush of all of this research, but what I didn't talk about was the very forms of interdependencies within these teams. So within team research one of my favorite papers that articulated this notion was Saavedra et al back in 1993 where they

articulated the different forms of interdependencies that that can emerge within teams. And they talked about the more simple level of interdependencies, pooled interdependence all the way up to intensive interdependence where a lot of give and take was need for the teams to work effectively. So this is one robust construct that I think that needs to be integrated with these kinds of multilevel analysis from neurons to networks to get a better handle of what might be happening.

Another thing that we need to consider when looking across these levels is this concept of virtuality. So Brad Kirkman and John Matthew did a nice job articulating what we mean by virtuality. Leslie DeChurch and her colleagues did a nice meta-analysis of virtuality. And this is important because the nature of collaboration is changing. So they looked at low virtuality and high virtuality contexts and were able to find different kinds of performance predictors based upon the amount of collocation within the teams, the richness of the team, tools that were being used for collaboration. So I think that this is an important construct that needs to be integrated with regard to study in this collaboration across levels.

And finally there's this idea of scale. So the size of the team has been mentioned a lot in the prior talks and I think we're going to hear about that more, but I think scale is probably one of the most important factors that we need to better understand when it comes to collaboration. So initially we had this idea of team, so Eduardo and his colleagues came up with this definition that's been used a lot, two or more individuals who must interact and adapt to achieve specified shared and valued objectives, and Leslie and her colleagues have run with this idea of multi-team systems to try to capture the notion of teams of teams interacting. And the point I think that needs to be

recognized here is one of what's referred to as reification. Before we had the multi-team system construct all we thought about were teams and organizations. We kind of ignored what was going on in between these levels of analysis. But when this multi-team systems concept was developed, it helped us get our head around this more complex form of interaction that was going on in between within the organizations, and I think there's a very useful development here with regard to helping us understand collaboration across levels.

So with that said I think that we can integrate these kind of robust factors of scale, virtuality and interdependence in such a way that we can think about looking from neurons to networks and take these context-related factors to get a better understanding. And I put this together because as I said these are really robust constructs, and in the back left-hand corner you have low virtuality, you have high interdependence and you have a small team, and that's where the majority of team research has taken place. That is a high degree of interdependence, collocation and a small team. And what we're talking about now is moving across these various levels of these phenomenon in such a way that we need to think about how we can specifically manipulate. So this is essentially a notional meta-analysis that needs to first populated and then conducted, because my point here is there's a lot of empty areas of this three-dimensional space that I've identified, and over the next decade or so I think we're going to be seeing this space populated with more studies, and when that happens we're going to be able to start to get a better handle of the factors that arise at the neuronal level and the network level to help us better understand collaboration. And I'm way out of time so I'm going to end it there and say if you want to learn more about

group research you can come to the Interdisciplinary Network for Group Research Conference this July in Pittsburgh because you're going to be hearing all kinds of research along these lines. Thank you.

Panel Discussion and Q&A

PK: = Pat Kyllonen
JG: = Jay (Gerald) Goodwin
ES: = Eduardo Salas
LD: = Leslie DeChurch
NC: = Noshir Contractor
SF: = Stephen Fiore
R: = Other Speakers

PK: Well, that was a very exciting and very impressive set of opening presentations and I'm sure that that gets a lot of ideas going on what questions that we might ask in the following session. But before that we want to begin by doing something different. We're going to ask panel members to address certain questions that have been prepared in advance and you can see them here. And so let's just begin with the first one. And the issue is there is a measurement community out there and that's the people who develop tests in education, in organizations, in the military, in different contexts. And those tests are used for selection purposes in some cases. They're used for monitoring the development of employees and students over time. They're used for promotions in organizations. They're used for placement in college and other kind of situations. The question is from the research you've done that we've just heard about are there some take-home messages? Are there some lessons we've learned from that research that might be of use in something that the measurement community should be aware of? Different ideas on what we should do in terms of measuring individuals and

groups and so forth in these various contexts. Anyone want to speak up on that?

Eduardo, sure.

ES: So again going back to my experience, which it's what I came here to share, is we need to learn more from the measurement community and the measurement community needs to learn more about what collaboration is all about. So if we come together, we will win. That's the first thought I had at that. And so the question is, I mean in these four presentations you've seen many challenges, many different views of looking at this. So we're still struggling with defining collaboration and teamwork. We know that we need a psychometrically-robust assessment. The question is how do we come together and that's why I want to emphasize this again, that I think what we need is some sort of organizing framework that tells us where we are today and the best thing I can think of right now is let's go to basics. What are the constructs that we know are important in collaboration? When do we measure? How do we measure? Why do we measure? And underneath all of that is the measurement community needs to be at the forefront of some of that. So that's my first thought on that.

But there's no question that at least from my experience in practice, I mean the communities out there that are doing team-based assessment and performance, they need better tools, and the tools need to be robust, diagnostic, useful, but also at the same time easy to use.

PK: Right, absolutely. Thank you very much. Noshir?

NC: Sure. I was struck by the point that I'm going to focus on most is the second and the third and that is the conceptual understanding of collaboration. One of

the things that's happened with new technologies is that we are now seeing and we've been heralding things like Wikipedia, and you can think about a Wikipedia page, and there are a bunch of people who work on it, and if you've ever done that you know there is a lot of interaction that occurs amongst these people. They have a separate page where they comment to each other, etcetera. The question I put before you is, is that a collaboration? Because there the team is not defined a priori [a priority?]. People come and go. This is an ongoing website. I mean a Wikipedia page gets edited, and unedited, and reversed, and so on and so forth all the time.

And so one of the challenges, I had a former student of mine who is now a postdoc at Northeastern, Brian Keegan, and he did his dissertation looking at teams that are contributing to Wikipedia pages in the aftermath of a disaster, and comparing those to historical Wikipedia pages and looking at the dynamics of, the network dynamics that explain this. And one of the questions that he legitimately asked is, "Well, is that really a team that's working on it and is that a collaboration?" And Brian has persuaded me that, yes, that is a form of collaboration, but we don't have good ways of thinking of how to define that collaboration and what does it mean to be part of a semipermeable, amorphous team that is constantly changing in that sense? So I think that that's something; as we think about the measurement we should also be mindful of the fact that the ways in which we conceptualize collaboration have broadened considerably.

PK: Thank you. Leslie?

LD: Yeah, so I want to go back to the first question on why would the measurement be interested? So first of all we're a pathetic case of measurement. I think in some ways there's a couple aspects of this problem of collaboration that are

challenging to the measurement community and of course challenging to us. One is that we're trying to measure constructs that are moving targets. So unlike developing measures of traits or very stable constructs, the team's research might measure constructs as if they're not changing, but that's a measurement problem. So in essence team processes and properties and collaborative dynamics are just that. They're dynamics, and yet we don't have the measurement sophistication. Noshir presented an example of how we're trying to go there. But I think the dynamic nature of the constructs presents both a challenge to the measurement community, also an opportunity. And I think the second is that they're multilevel and that the collaboration is something that lives in the individual and their interactions with one another, so I think that's another, a second point. And also that right now the theory is sort of way ahead of the measurement in this area, so we sort of have more theoretical apparatus than we can operationalize. But I think with advances in measurement techniques and levels of resolution, that's able to push the theory and I think the paper with Noshir using relational event networks is an example of that, that once we can start to conceptualize how team, you know, what are the underlying motors that drive and shape teamwork process. We couldn't even think of that as a construct until we had access to data to look at that, so I think that's important.

And the other one is that there's just plain old interesting data streams. So now that people are having their team and collaborative activities in places like Wikipedia, but also through other kind of digital data streams, they're leaving behind lots of high-resolution information about their functioning and coherence. So it's a case in point where we can do a lot better than kind of self-report and observer ratings and arduous

coding, and so there's kind of an opportunity particularly right now to understand how to turn and harvest these into good valid measures.

PK: Thank you. Steve?

SF: Well, I think we need to measure collaboration because the world is becoming more collaborative. And if you look at what organizations are requesting, they want not just people who are good at their job. What they want is people who are good at collaboration. And taking the lead from the title of this organization that put together the workshop, the Educational Testing Service, you've been assessing individuals for decades now and what we need to understand better is how to assess teams. And the reason we need to understand how to assess teams is we need to push teamwork down into the K-through-12 kind of environment, because if we want to better educate the masses we need to teach them how to behave in a collaborative way and how to engage in complex taskwork in such a way that they become good team members. So we need obviously to figure out better ways of measuring teamwork and we're not going to be able to do that if we only focus on what we call the taskwork. So basically taking the heuristic from the team training literature where they differentiated between taskwork and teamwork as to what needs to be trained, I'd say that the assessment community has done a great job measuring what we would call taskwork. Now they need how to figure out how to do such a good job in measuring teamwork.

PK: Great, thank you. And let me just take one more crack at a version of question one and that is imagine ten years from now we have, the Army has, ETS has, other organizations, SHL has a test that measures a person's teamwork, team

capability. What would that look like? What would that be? What would that? Or is there; does that make any sense?

ES: Well, if you're talking about like team collective orientation? So there is a lot of interest out there in my experience in coming, in diagnosing individuals who are going to be team oriented, collective oriented as opposed to egocentric. So this is a situation test, have been tested here and there in different communities, a lot of interest in the industries that I touch, healthcare, aviation, actually some in the military, oil industry. They're all interested in the composition aspect of it. That is, "Before I bring this individual in to do some collaborative task, will he or she have the disposition to do it?" So I think will be very useful. But I tell you in my experience in healthcare, for example, they're thinking by 2018, 2019 that potential medical students in addition to taking the MCAT to get in, they're going to have to take a Situational Judgment Test to see if they're correct oriented. So more industries eventually will get that direction. So do we need them? Yes.

But let me say something as probably I said at the beginning, and I'm probably the one who spend most time looking at this, measurement comes and goes. Measurement interest comes and goes. Measurement, no offense to anybody, is not a sexy thing, so it's very difficult to sustain funding for this kind of work. Very difficult. I tried it. Jay has tried it. Others have tried it. In 30 years this goes ways. Nobody that I know funds in a sustainable way measurement approaches, techniques, measurement research. They fund things, you know, a construct, multi-team systems, something new, and then we, the researchers, will get that funding. They have to do something about measurement and it gets piecemeal. That's why I think But nobody that I know of,

and correct me if I'm wrong, I don't know what agency can sustain assessing, I'm sorry funding the kind of work that in measurement is needed to make significant progress. So that's what we; it's all piecemeal. That's why I'm saying we need to go back to basics. I mean I've been there, and hopefully will things change and maybe Jay has now the power to continue this in other industries, but it just comes and goes. We've been through this road many, many times. A little progress here, a little progress here, and I'm cautionary optimistic that there's a lot of good work being known, you know, which we're going to hear the next day and a half. But let's be realistic. This is a tough area to sustain resources in a mandate, if you will, to get things

PK: Thank you. Noshir?

NC: I was going to touch on an issue related to measurement that in my own mind I think I need to disambiguate. One is the measurement of collaboration as it's happening, so it's the kind of stuff that, the relational event network stuff that I was showing as an example of the behavior of collaboration. But then there's also the measurement of a person's aptitude for collaboration. So, for example, several years ago the ABET, the Accreditation Board for Engineering, around the country had sent out a survey to employers and said, "What do you think that engineers need the most? And they were expecting people to come back with partial differential equations of finite element, etcetera, and they said the biggest thing they needed was communication. And that was about two decades ago, and of course engineering schools then said, "Can we put those into the syllabi? But that means if they have to do communication that they can't do something else," and then the industry backed off and said, "No, no, no, they need to be technically skilled. It would be nice if they can communicate, but we

can do without it if it means that they're not going to be able to do other engineering things."

Now I think the point I was trying to make here is that we have actually seen a fundamental change in universities still have general education requirements for communication, but I think where we are now is that we need to think more about collaborative fluency rather than just communication ability, and collaborative fluency is not something that is measured very well. Now it might be measured behavior of collaboration in order to assess an individual's collaborative fluency, but those are two separate measurement issues that are clearly related to each other and I think both of those are desperately in need at this point.

PK: Thank you. And I wonder if we could talk about a slightly different issue which is an organization might be interested in whether the teams in that organization are working effectively. And so organizations spend lots of money, fifty, \$70 billion a year on training. Some of that is team training. And then organizations want to know whether those teams are effective in a kind of a Kirkpatrick type training sort of framework. Can you imagine a system of measurement of team effectiveness that would feed back to the organization's training system and promise to evaluate effectively whether the teams are effective sometime in the future?

LD: Absolutely. So I think this distinction that Noshir draws is really important of separating the two measurement challenges. One is the assessment of collaboration, which is this challenge, versus the first one you raised of we measure individuals as a way to predict their ability to contribute to teams. This I think, this one of measuring collaboration I think is the easier one to solve. So you can imagine with real-time data

on interactions that as we get more sophisticated just being able to represent or operationalize how well functioning a team or a collaborative system of teams is, is sort of the easier target to hit. I think being able to predict a priori what you measure in an individual given that any select for any battery or test that's going to assess individuals has to account for the fact that individuals' traits and expression of traits are conditioned on other individuals. Right? So if you imagine a personality test, you take a big-five indicator, and then it tells you your standing and there are some norms. Here's you on extroversion, and here's the rest of the world and here's where you are. And you might have some differences in different situations, but in general this is your natural where you operate. Any way that we assess individuals' propensity for collaboration or any similar construct is going to essentially have to give them; imagine what the scored report looks like. It's if you are in a team of this size with this kind of interdependency and people with these collaborative propensities, this is what your performance is. But if you're in a team of this size, and this kind of interdependence, and this level of specialization and people with this kind of, this is what it is. Right? So it's all these, to me it's all these conditionings of thinking about individuals' characteristics and how they get expressed is a function of the task and the nature of interdependencies, how specialized people are, but the characteristics of the other people in their social propensities. So to me that's the harder one. I think this measuring and operationalizing and collaboration is the somewhat easier challenge.

PK: And that reminds me of Lee Cronbach's APA address where he talked about the interactions between aptitude and treatment such that we entered into a hall of mirrors that never ended and that creates challenges. Steve, would you like to?

SF: Sure. A few years ago the National Research Council had a Committee on 21st Century Skills and part of that involved interpersonal skills. And when I was presenting on interpersonal skills and the need to measure what we are now referring to as collaboration in this workshop, I argued for the creation of what I labeled “inactive fidelity.” And what I meant by that was the degree to which there was actually an interacting other that was present, because as Leslie and Noshir briefly described typically when these kinds of assessments are made it’s in the kind of rigged environment of the Situational Judgment Test, where you’re interacting with, in a scenario or maybe with an agent or an avatar. But the reality is that collaboration is difficult and problems often arise, and if these problems didn’t arise then collaboration would be easy. And because of that we need to assess the degree to which people are comfortable with uncomfortable situations and can engage in these kinds of real interactions. So the challenge I see is developing assessments that have this kind of inactive fidelity. That is they are actually more valid with regard to the ecological context that you’re really trying to assess for. So that’s point one.

Point two is I have a problem with the term collaboration because I think it’s too vague. And a few years ago I did kind of an etymological analysis of some of these concepts, and what I found was that these terms collaboration, and cooperation and coordination that are being used somewhat synonymously in the literature really have some different origins. So collaboration and cooperation really are derived from two concepts that is working and together. Coordination though was what I saw as the more intriguing and the more important concept when it comes to teams and teamwork. So coordination was derived from three concepts that have to do with arrangement

together and order. So when we think about coordination I think that's the more complex forms for interactions that we need to consider as opposed to just this simple concept of working together. So I'd say we need to learn how to measure coordination within teams and not just the simple aspect of collaboration which just means loosely to work together.

AS: I'd like to say I'm not so sure I agree with what Leslie just said. Sorry, Leslie. So I think the collaboration aspect of it, it's still the biggest challenge and I think we can develop a heuristic eventually that will allow us to get to those conditions, if you have high interdependence, if you have this. I think that's a lot closer. None of these will be perfect. Let's be realistic. No measurement tool out there will be perfect for all we're talking about, but I think because of all the things that we're talking about, the dynamic nature, episodic, how it's defined, etcetera, that assessing of collaboration or teamwork, whatever term Steve wants to use, that's the top part. The more static, if you will, you know, interdependence, whether you have a propensity or not, I think that's more manageable. So that's what my gut tells me because there's more work going in that area that is more robust than the one on the collaboration side.

PK: So I think we've already been talking about this, but that leads us to questions two and three. And I think all of you already have given a response, but the real issue is, is there a construct of collaboration in a kind of a psychological construct perspective or is it so multifaceted that it's; I mean I'm starting to get the impression that it's so multifaceted that it might not be a construct. But is there a higher-order construct of collaboration which means collaborative skill, collaborative processes, collaborative activities, collaborative something or other, or is that just a too abstract a level of

discourse with respect to psychological constructs? Anyone? Is there something called collaborative skill?

LD: So I'm going to guess that we all agree on this one that it's a concept and it's not a construct, that there are so many constructs that are subsumed under this, but we'll see if others. But I think that's what the silence is, it's definitely not a construct.

ES: Yeah, to me it's an umbrella. There are a handful of factors under it and it could be coordination, communication, conflict, commission. Steve is going to love this, where I'm headed. Recently I invoked the seven Cs of teamwork, so and I don't involve collaboration, but I think it's a good umbrella, but there that there are constructs there.

SF: Yeah, I think that characterization reminds me of the problem that the military faced for years trying to assess what they called situation awareness, and lots of measures were developed and then some people came in and said, "Well, situation awareness is really the end state and what you should be measuring is situation assessment, that is the processes engaged to lead to situation awareness." So collaboration is really an end state, but it's an evolving state, but there are all kinds of processes involved that are necessary to get you there.

NC: Another part of this, the fact that it's a concept but not a construct, goes back to Eduardo's initial opening remarks where he talked about context mattering, and I think one way to think about collaboration is to think about the different contexts in which it happens. And so, example, to go back to the one I mentioned previously, the context in which collaboration happens on Wikipedia and the dynamics associated with that are going to be fundamentally different from the kinds of collaboration that might happen with entitling the teams in the military for example.

ES: I'll give you another insight in my own practice. So I invoke the term collaboration a lot when I go to industry because that's what they understand, that's what they want, that's how they conceptualize what they want the individuals in their organization to do and then I educate. I explain underneath there are several facets of that. So let's not ... the term because if you want to create a test for industry to assess, they're going to say, "We want something that's around collaboration skills." So there are two sides to this. From a science perspective, yeah, it is an umbrella, but in industry my experience at least is they embrace it, they know, they think they know what it is, they want that and they need help, period.

SF: Yeah, I want to add to that and play off of that. A number of years ago someone challenged us to embrace the complexity associated with some of the research and I'd like to say we need to embrace the context associated with this kind of research, because the technologies, you're asking about technologies, I think the technologies are allowing us to study context in ways that we have never done before. And I tried to put up that three-dimensional space as a way to make some sense of the context. So Noshir's example of Wikipedia, I think that's a way to look at this virtuality context, the interdependence context and the scale context. So that is something that has low interdependence, high or low virtuality and a very large scale. So these are lots of people who are distributed and are essentially engaged in more kind of a pooled interdependency. So I think if we get smarter about what we mean by context and use technology to study varied contexts, we're going to be able to get a better understanding of collaboration.

PK: Thanks. So going to the last question then, the question really has to do with the tests versus the technology. And I remember back a couple decades ago, and computers were still first being used as testing devices and so we all thought that was very revolutionary. It would open up the field and we'd be able to measure something besides verbal ability, and math ability and reasoning ability. Today we're still measuring verbal ability, math ability and reasoning ability, but there is some kind of sense in which new technology enables us to measure things that we haven't been able to measure before. And so I wonder if you could comment on maybe what the technology allows us to do in the way of measuring collaboration, collaborative skill and so forth that we might not have been able to measure before.

ES: Let me talk about that and then somebody else. So to me this is about simulation. The power of simulation is to assess, the ability to assess individuals or teams in context. So I go to industries now where they say, "We want to assess individuals in a simulation that the simulation assesses, scores and decides whether to hire the individual without human intervention." So they're looking for skills. One of them is collaborative skills and so on. So there are many industries out there that hire thousands and thousands of people in one, in a 20-minute simulation. Again they want to assess, score and decide whether the person fits the organization on that. So this is a big challenge for assessment because, and essentially the scenario then becomes your test and the items is the triggers in the scenario, the specific events that you put in the scenario for the individual to interact. So I think that ten years from now many industries out there only use simulation to assess all the things that we're talking about without somebody observing maybe. How good it's going to be to be determined, but I think

that's where at least the push in industry. This is the Amazons, the Googles, the people that hire hundreds of people, the FedExes. That's what they want, simulation that assesses scores and hires the individual without somebody talking to them.

PK: Very good. Anyone else talk about technology and assessment?

SF: Well, what came to mind when you posed the question was Abraham Maslow's, "When the only tool you have is a hammer, everything looks like a nail," and I think that is a danger here particularly from a disciplinary standpoint. So I purposely did the neurons and networks to illustrate that. Depending upon your disciplinary predisposition you're going to define, operationalize and measure at the level of analysis that is of interest to you. So you're looking at things like neural synchrony and saying that that is collaboration, you're looking at this kind of behavioral coordination and saying that that's collaboration, and you're looking at the network centrality and the network distribution and saying that that's indicative of collaboration. So just we need to be mindful that the tool we use is giving us the answer we're seeking.

NC: I think one of the interesting opportunities that we have here is using the tool. One of the challenges obviously of always collecting data or [on?] instrumenting systems is that there is a burden put on the respondent. And otherwise there is an inordinate burden put on the researcher to then be able to take that data and code it, and the amount of data that we collect and the amount of data that we actually end up coding and using, there's a huge gap between that because the data is not in a form that is easy to use. Today because of digital trace and digital capabilities, etcetera, I think one of the nice opportunities here is to help develop tools that both enable the

collaboration and at the same time provide us easily-accessible data about how these teams are collaborating and interacting, etcetera.

And one, and an example of that is a project that several of us have been involved in, in developing something called a dream team builder, My Dream Team Builder. So Leslie is involved in this as well. The idea that how many of us would say, “Wow, it will be really good if we could have a technology that would allow us to find the right people with whom you want to collaborate in a team.” How do we do it right now? Not very well. Part of the reason why is because we don’t know all the skill sets as well what the personality matches are, etcetera. So I use this as an example that we need to think creatively of developing tools that will serve the community, and in their using it, because now they have a reason to use it, in their using it we’re now getting collateral data that allows us to understand the dynamics of how teams get assembled and the impact of that assembly process on the subsequent collaboration and then on the subsequent performance of the teams.

So I think that there is a real opportunity that is part of that instrumentation. We think hard about what we can do that would actually help the end community and at the same time create a win-win situation for researchers and for the community being researched.

PK: Thank you. So at this time we will open up the floor for questions. If you have any questions on any of the specifics in the presentations or some of these more general thematic issues, please feel free to come up and grab a microphone. There are two, one in the back, one in the front here, and go ahead.

R: Hi. Good morning. Thank you. I'm Joe Lopreiato from the Uniformed Services University of the Health Sciences, so my interest is in the functioning of healthcare teams. So I have a question for Noshir, building on what Eduardo and Stephen had said. So, Noshir, you talked about looking at sequences of events in a task or a goal and looking for patterns. So building on what Eduardo said about let's be practical here and simple and what Stephen talked about in terms of measuring movements, do you believe looking at patterns is a better measure of performance in teams or between teams than trying to analyze the vast amount of individual data we have?

NC: Well, I might be just a little biased on this answer, but, yes, I will take the opportunity to say I think that the people who are interested in doing network science, and I would consider myself within that community, have long been criticized of looking, of discarding the individual data, the attribute data that you get from individuals and trying to explain everything in terms of structure. I am not of that ilk. I think that there is a value in being able to combine looking at what we can get from attribute data and then looking to see if structure can explain more. A very well-known networks researcher who's passed on, Eric Rogers, said that networks use it as a way to explain additional variance. He called it the turbo charger that allows you to explain more variance. So to answer your question I think if there are things that can be explained by looking at individual data level absolutely we should do that. If beyond that we are able to get greater insights by looking at this relational-level data and looking at those patterns across, over time, then I think that we should definitely not rule that out and see if that

provides us additional, both in terms of predictive power, but also in terms of explanatory power.

ES: I'd like to add something on that because this is again going back to basics. So what is the purpose of measurement? That's what you need to ask first. And if the purpose is developmental training, then patterns may be good or may not be good as an indicator. So the purpose of measurement drives the kind of data you want to collect.

PK: We have another question.

R: I actually have three questions, so I'm going to go through them quickly and you guys can parse them out how you like. Noshir mentioned a term that he called collaborative fluency which really gets at the individual capabilities that enable them to collaborate with others. What are those capabilities? So you gave an overarching label. What's it made up of? Eduardo talked about collective orientation, but that's an attitude. There's obviously some skills and abilities that build in there. What are those things? Number two, Steve touched on and actually Noshir touched on a couple of them as well, different ways that we're assessing collaboration. Noshir talked about communication patterns. Steve touched on some bio-behavioral issues and synchrony issues as well as other forms of activity, synchronous activity. Has anyone looked at combinations of those different sources of data or types of data to see if they're actually overlapping or if they give us unique contributions for understanding collaboration? And the last one has been highlighted by where Eduardo had talked some about context being so important. We've been equating digital collaboration with face-to-face collaboration in some ways. Eduardo brought up the idea of simulated collaboration as

a way to assess these things with the assumption that they are all coequal to some extent or another and I'd like to hear comments from the panelists about the extent to which they think these three things are coequal.

PK: So the first one was on collaborative fluencies and collective orientation, Noshir.

NC: So I think that that, I was putting it more there as a placeholder for research agenda rather than saying that we know the answer to this because I think we need to think about what that means both in terms of measuring collaborative fluency and then in terms of what explains collaborative fluency. So I think that both of those are in the spirit of creating a research agenda is where I put that. I mean I've talked about that and frankly my current dean, Barbara O'Keefe, has been using that phrase even longer than I have. So it has been around. People recognize it. There is something to it. I know that from a communications standpoint there are people who have looked at; there's a whole field, a constructivist approach to communication which looks at something called message design logic. And the idea is that people who are effective in communicating have very well-established and fairly cognitively-complex strategies by which they express themselves to different audiences. So collaborative fluency comes from that same sort of idea, but it requires more about how you co-labor with someone as opposed to communicate with someone and I think those are things that we need to think about. So I think it's a research agenda item that is quite timely.

PK: The next one was; oh, I'm sorry.

ES: I'll just comment as a kind of editorial, not against any of the things, but I think we need to stop inventing new concepts [constructs?] in this area and I'll tell you

why. You know, from a practical level, so I'm doing a thorough review, a meta-analysis for NASA on team cohesion. That's the construct they've zeroed in. You know, "If we go to Mars we're going to send a team and team cohesion is a big thing." So I just can tell you there are 37 definitions of team cohesion out there, 52 measures, 52 ways of measuring team cohesion. And so here we go collective intelligence, collective fluency, collaboration, coordination, cooperation. I mean we have a problem inventing all these things. Not that it doesn't help we're thinking about things, but I think from a practical level we'll go in a path that it will be impossible to recommend. Like we're trying to recommend to NASA, okay, which definition you should use and which, and how you it when you have 37 definitions and 52 ways of measuring out there.

NC: So let me ask you what current concept do you think overlaps with collaborative fluency?

ES: Collective orientation a little bit.

NC: Is that a predictive of?

ES: Is it a what?

NC: The question is, is collective orientation a predictor of collaborative fluency or is it in fact the same as collaborative fluency?

ES: Collective orientation predicts your propensity to be a good team player. That's it. So I mean I'm not saying, I'm not disagreeing. It's just that I mean this is in psychology we have this problem. Like situational awareness was one now. So I'm just throwing out there for us to think about do we need to keep invoking new constructs? And my sense is yes because that's how we get research funded. Again, [laughter] So I mean, but I think we have to think about these things because [shout from back of

room.] Anyway, I think you get the point. I mean if not ten years from now we'll be having the same workshop and talk about the things. I mean team cohesion has been around for 50 years. When I began to look at this literature, I said, "Wow, 50 years of team cohesion and look where we are."

SF: Well, I don't think we should stop inventing concepts. I'll go back to the multi-team systems idea, because as I mentioned I think this is an important and useful demonstration of reification. Before that was invented we didn't have a way to wrap our heads around this different level of coordination between individuals, teams and organizational levels, so this was a new level that had been identified. It was always there, but we had to come up with the concept to figure out what was going on and operationalize it in such a way that we could measure it.

LD: And I think Amy Edmondson has this new book called *Teaming*, right, so teaming is a verb, and it's an example of this kind of reification. And what I like about her conceptualization of flipping it to a verb is it characterizes what we're trying to get at I think Noshir, correct me if I'm wrong, in this collaborative fluency, which is more than a trait of, "I like working in teams," right, which is what the kind of team value scales all get at and it really gets at the notion of being able to switch. So there's some mental acuity of can I read the norms of this group, and then quickly switch and work with group and read new norms? Can I change mental models? Can I diagnose how my skills fit with the skills of the group? Can I recognize the leadership structure and see how I play into it? Can I diagnose who has what expectations? So I think that she's kind of; I don't think it's this construct, but I think she's introduced this concept which lays the foundation for thinking about this construct that sort of needs to be developed that lays out how you get from individual abilities to the ability to work well in teams.

PK: I just want to get through Jay's other two questions before going, but first if we could have a very quick answer. The second question was about combinations, communication patterns and combinations and Steve or Noshir?

SF: Sure. I think that some of the people in social neuroscience have been looking at things like communication coherence and neural coherence, so they've shown this kind of fey(?) synchrony at the linguistic level and the neural level. I've seen similar things with affect and emotion. So there are some interesting combinations going on that are using traditional metrics along with the new metrics.

NC: I think it shows that Jay is doing a good job of trying to help set the research agenda because this again is something that is not done very often. We've been now doing a little bit where we've been using the text analytics. Notice that the presentation I made was just about the actual structure of who said what rather than what was said. And I know that we'll be hearing more about that in this event here itself, but the opportunity of combining text alignment, etcetera, along with the structural, so in other words content in addition to contact, is another example of the juxtaposition of different ideas. I think what is interesting is we have these data now. We have analytics. We still haven't thought creatively about theories that allow us to combine these in ways that make sense.

PK: And then finally the question of context. Eduardo, did you want to?

ES: Yes. But I forgot. What was it? I'm sorry.

PK: The context question was.

R: We've talked about digital collaboration, face-to-face collaboration and you brought up the idea of simulated collaboration, and to some extent we're weighting these as if the extent to which someone is facile in digital collaboration implies that they will also be very good at face-to-face collaboration, and I'm curious to hear from you guys to the extent to which you think digital collaboration, face-to-face collaboration and simulated collaboration are coequal.

ES: So the way I usually answer that is saying it's the concept that Steve brought up, which to me is the key to all of this, which is the nature of task interdependency. So the dependency among those three, then there's a lot of things that you can generalize, but if the interdependency vary between virtual things versus face-to-face, then you have a problem. So to me the interdependency construct drives a lot of what could be generalized two teams or not.

SF: I heard a different question. It sounded more like an issue of the appropriateness of transfer and generalization, so that's what I was trying to say with regard to the point about inactive fidelity. So I think to the degree to which the assessment instrument is valid in this context of inactive fidelity where there is an interacting other, that is you're interacting with a real person where you can get the kind of emotional issues that arise from collaboration, then that's a valid test of transfer. Otherwise you're going to run into the same problem you do with transfer and assessment.

NC: I think there is room for different ways of thinking about how we want to create taxonomies, if you may, off context, and I think Eduardo gave an example based on Steve's notion of interdependence. Another one that Scott Poole and myself introduced in a chapter in the multi-teams systems book that Leslie and her colleagues coedited recently was looking at it in terms of what the goals of the effort is. So we distinguished between teams and MTSs that are focused more on exploring ideas, so exploration as opposed to exploitation, which is exploiting existing resources, or in some cases the goals of the team are just to bond together, to come together to build trust and in other cases it may be swarming, where the goals of the team are to very rapidly be able to respond to something. So there are a variety of different ways in which you could think about defining context based on the goals of what this collaboration is trying to do as well.

PK: Thank you. Next question please.

R: Yes, I'm Judith Torney-Purta, recently retired from the University of Maryland and doing some consulting. One thing was not mentioned at all which I think has implications both for individual-level considerations and for context and that's gender. Women are well known for being more cooperative, collaborative, looking at situations in that way, approaching the situation. And I wonder about this task, for example, which had you avoiding attacks or attacking other people. I think there's some evidence that when the task has this sort of competitive, aggressive, even militaristic sort of aim to it that there may be different ways in which males and females respond to that task. And so I think this is something that needs to be considered both, especially on the individual level, but also on the context level. I think there is a fair amount of evidence that teams in which women are equally represented look rather different from teams where there's one or two women who are in a minority and the rest of the team is male. And I don't think this can simply be ignored, and I didn't hear about it this morning.

LD: So one fun finding in this area, if you know the collective intelligence work of Anita Wooley and her group where they've looked at different factors of groups, where they look at all different configurations of groups, and they do all different kinds of tasks and they sort of look at what are the kind of subset of predictors. And one of their big three is the percentage of the team that's female, but they find that effect goes up and up and up, but you accept that all-female teams are the worst, so you have to have the token male. And so but it's kind of, it at least opens an interesting dialogue I think in this area, that there are gender effects and it's not just about balance, but there are certain aspects of the task that affect this, but that in general the percentage of women causes in itself interesting other dynamics.

PK: Thank you. Next question. Thank you very much for the question. Thank you.

R: William Lorie from Questar Assessment. I thought that one thing that was missing in the discussion which certain has to have a big impact if you're assessing collaboration is what I think is the most salient thing about an organization and it's their power structure, the hierarchies that exist within the organization. When I think of multi-team systems, I

think of departments, and certainly there are some organizations where collaboration between teams is easier, is less mediated by managers, supervisors, etcetera. So what is the role of hierarchy of the organization in this effort to assess collaboration is my question?

PK: Status hierarchies in multi-team systems, it's a great question.

LD: Yeah, I think I'll take it. I don't want to hog the microphone, but I think that's a really fascinating question. And so we've been doing some work looking at leadership networks in sustaining multi-team systems and we find this, to use the term Noshir presented on the form-perform paradox. It speaks to this point of hierarchy, that you tend to see hierarchies form, but in cases where your goal structure, for example, is designed around exploring different ideas, unearthing new perspectives, integrating, that actually the hierarchy is counterproductive. And so I think leadership is one case where you really see that form-perform paradox in terms of what's likely to come about because of order and efficiency, but depending on the nature of the task that may not be productive and furthermore it may change as tasks are dynamic. Right? So at certain points groups need the hierarchy, but then at other points they need to be able to get out of it, right, flatten and take in a new idea from someone else. That's a great question.

SF: Yeah, I think I hear a couple of things conflated in there though. I wasn't sure if you were talking about the ambient culture in which teams are embedded, that is the things like the power structure that may be inherent in an organization versus the contextual factor of how power structure may be embedded in the team itself. So for both of those I think they are relevant contextual factors. So in leadership in teams they have looked at the network forms of leadership to which Leslie is referring. There's also notions of shared leadership or just your traditional single leadership structures within a team. So again that's a contextual factor that I think needs to play into this kind of research.

ES: Yes, very quickly one of the; I alluded a minute ago or so about the seven Cs of teamwork and one of the Cs I invoke is called conditions and that is about the conditions that are set in the organization to support collaboration, teamwork, whatever term you want to use.

And I'm now a believer that you can have the best team in the world, you can have the best leader in the world in your team, but if the conditions are not aligning to support collaboration teamwork you will never get the behavior that you want. So conditions do matter from the macro perspective and influence a team. The question is what do we do with that from a perspective, but, yeah.

NC: I think one last very quick point and that is let's not make, and this may or not have been implied by your question. It's not just a one direction one where these power structures impact collaboration because collaborations in turn impact power structures as well, so it's a evolving system in that respect.

PK: I'm sorry we are at the end, and what I'd request that the questioners do is maybe think of an opportunity to bring up that question in the next panel, unless you want to of course talk about it with the panel members during lunch is another option, but again my apologies. Anyway, thank you very much. It's been an excellent session to start off. And now lunch will be; Liz will announce what the lunch plans are.

END OF PRESENTATION