Rehabilitation Engineering Research Center for Prosthetics & Orthotics (NURERC)

REPORT ON THE STATE-OF-THE-SCIENCE MEETING IN PROSTHETICS & ORTHOTICS (P&O)

Held at Northwestern University Prosthetics-Orthotics Center on October 13, 2012

NORTHWESTERN UNIVERSITY
FEINBERG SCHOOL OF MEDICINE

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FOREWORD

This report summarizes the findings and recommendations from a State-of-the-Science meeting to critically assess the status of knowledge translation in the field of prosthetics and orthotics (P&O) held on October 13, 2012 at the Northwestern University Prosthetics-Orthotics Center (NUPOC) in Chicago, IL. This meeting was hosted by the Rehabilitation Engineering Research Center (RERC) for P&O, which is funded by the National Institute on Disability and Rehabilitation Research (NIDRR).

Our meeting consisted of four invited presentations that helped to define knowledge translation, explore knowledge translation for development projects, discuss knowledge translation as part of P&O education and training, and consider how to disseminate, track and evaluate new knowledge in P&O. These formal presentations were intended to stimulate discussion among the participants. Further discussion was prompted by a panel on the need for knowledge translation in P&O that included representative perspectives from a manufacturer, researcher, clinician and educator, and small group discussions on finding solutions to knowledge translation in P&O. The meeting was attended by approximately 24 prosthetists, orthotists, user representatives, and research engineers from the community at large and from our own RERC (see Appendix A for a list of participants).

This meeting represents only one mechanism that our RERC used to identify knowledge translation of clinically-relevant P&O research. We began gathering information for this meeting earlier in 2012 when we launched an expanded version of the online survey from our 2006 State-of-the-Science Meeting (the report of which can be found at http://www.nupoc.northwestern.edu/docs/research/RERC/SOS-2006_Report.pdf).

It is our hope that the information gleaned from our SOS related activities will be considered by investigators and clinicians in the field, and will prove useful for guiding knowledge translation activities of clinically-relevant research in the field of P&O.

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ACKNOWLEDGEMENTS

The State-of-the-Science meeting and this report would not have been possible without the efforts of the following people: Dr. R. J. Garrick and Elizabeth Rowe for their administrative and organizational assistance in holding the meeting; 2012 NIDRR-RERC Scholar James Schweitzer who helped analyze the results of the online survey; Erin Boutwell, Angelika Zissimopoulos, Matthew Major, and Oluseeni Komolafe for taking notes during the meeting that facilitated the writing of this report; Larissa Connor for helping draft the report; the faculty and staff of NUPOC for their support of this activity; and all the speakers and attendees who spurred and participated in discussion.

We suggest that this report be cited as follows:
Fatone S (Ed.) (2014) Spreading the Word: Promoting Clinically-Relevant Knowledge in Prosthetics and Orthotics. Report on the State of the Science Meeting in Prosthetics & Orthotics. Rehabilitation Engineering Research Center in Prosthetics and Orthotics, Northwestern University Prosthetics-Orthotics Center, Chicago, IL, October 13, 2012.

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EXECUTIVE SUMMARY

The 2012 Northwestern University Rehabilitation Engineering Research Center (NU-RERC) State-of-the-Science meeting examined Knowledge Translation (KT) in Prosthetics and Orthotics (P&O). Stakeholders, including educators, researchers, clinicians, device-users, and manufacturers, collaborated to identify challenges and solutions to the delivery and effective integration of knowledge in P&O.

The NU-RERC for P&O is funded by the National Institute on Disability and Rehabilitation Research (NIDRR). NIDRR is different from other funding organizations: it is person-focused with an interest in improving quality of life for persons with disabilities. Areas of interest include technology for access and function, and independent living and community. NIDRR RERCs apply advanced technology to solve rehabilitation problems. They are charged with seeking and evaluating the newest technology that benefits rehabilitation.

The NU-RERC for P&O consists of 7 research and 5 development projects as well as training and dissemination activities. NIDRR RERCs are required to hold a State-of-the-Science meeting in the 4th year of their grant cycle. The introduction of evidence-based practice (EBP) has spurred state-of-the science meetings by different groups. For example, the American Academy of Orthotists and Prosthetists (AAOP) have conducted 11 state-of-the-science meetings in the last decade (reports can be found at http://www.oandp.org/jpo/ssc.asp) and the International Society for Prosthetics and Orthotics (ISPO) have held 6 consensus conferences since 1994 (reports can be found at http://www.ispoint.org/consensus-conferences-reports). In 2002, the NU-RERC held a State-of-the-Science meeting that focused primarily on the researcher's perspectives of research needs, while in 2006 we asked practitioners for their perspectives of clinically-relevant research needs. Our 2006 report identified over 100 potential research projects and helped us create the agenda for our 2012 State-of-the-Science meeting. We wanted to explore a theme that did not overlap unnecessarily with these prior meetings but was inspired by them.

Practitioners observe user problems with devices first hand. Historically, practitioners have had an abundance of experience but limited science on which to base their decisions. Hence, decisions often come down to individual experience. Fortunately, the science to support practice continues to grow. The expectation of evidence-based practice (EBP) is that practitioners use the best available science as part of their clinical practice, raising the question of *how best* to communicate the results of available research to prosthetists and orthotists. Similarly, how do we get manufacturers interested in products arising from research development activities?

We report here on our 2012 State-of-the-Science meeting which focused on KT; in other words, how to communicate results to various stakeholders. Our goal was to identify challenges and propose solutions for communicating and applying the knowledge resulting from research and development activities for the maximum benefit of end-users in P&O.

Meeting attendees were asked to consider five questions over the course of the meeting that may help knowledge producers facilitate the application of research:[1,2]

1. What should be disseminated?
2. To whom should it be disseminated?
3. By whom should it be disseminated?
4. How should it be disseminated?
5. With what effect should it be disseminated?

Conclusions/Recommendations:
Discussion yielded a number of solutions for KT specific to the P&O field. The following recommendations were made to P&O investigators who desire to engage and educate a wider variety and more stakeholders in the field.

1. Researchers should consider multiple and alternative pathways for implementing KT besides publishing in scientific journals. Methods for information access and delivery need to be more effective and time efficient. KT content should be delivered in an interactive and multi-sensory manner, such as through the various forms of social media. The Internet could be used as a vehicle to help drive KT to appropriate stakeholders. For example, by facilitating the creation of a KT learning center with tabs that direct stakeholders (i.e., practitioners, P&O users, policy makers, insurers, etc.) to the

appropriate content area. The content of the learning center could be short audio/video presentations (i.e., 10 minutes maximum) on a single-focused topic, enabling participants to fast forward or reverse at their leisure. The KT learning center could issue certificates to participants for every course completed. A major advantage of the online learning center is that the content would be available 24 hours/day and 7 days/week.

2. Implement formal KT activities during the P&O residency. KT activities could be a part of the ongoing education process associated with residency, to continue to reinforce the need for implementing EBP into clinical practice. These activities could include evidence-based practice monthly meetings, journal club, and workshops. Furthermore, schools like NUPOC could create and add blended learning content that could be accessed online even after MPO students graduate.

3. Researchers should communicate KT directly to insurers. Claims are often decided by individuals who are unfamiliar with the P&O field. Case managers need better education and information to make informed decisions.

4. Involve stakeholders earlier in the research and development process. Specifically, we need to improve communication between clinicians/device users and researchers. The research and researchers must be regarded as accessible. Information should flow both ways, with researchers engaging clinicians/device users to help identify problems and influence research directions. Additionally, students and practitioners should be given opportunities to interact with the experts and ask questions about implementing EBP.

5. KT education tends to focus on students, but we shouldn't ignore experienced practitioners. New graduates can help educate experienced practitioners, but additionally, workshops could be created and made available online, targeted at more experience practitioners.

6. The importance of research must continue to be recognized by the P&O field. We need to work with higher-level managers and administrators on KT issues, explaining to them how their practices can be improved by implementation of EBP. Changes in clinical practice should be implemented incrementally. Practice should be SMART—simple, measurable, achievable, realistic and timely.

PRE-MEETING SURVEY RESULTS

Note that these results have been previously published and presented:

- *Schweitzer J, Fatone S (2012) The 2012 and 2006 NUPOC State of the Science Survey Results. Capabilities, 20(3):1-2.*
- *Fatone S, Schweitzer J, Gard S (2013) Perceptions of prosthetics and orthotics research within the prosthetics and orthotics community. 39th Academy Annual Meeting and Scientific Symposium of the American Academy of Orthotists and Prosthetists, February 20-23, Orlando, FL.*

Introduction

The Northwestern University Rehabilitation Engineering Research Center (NU-RERC) for Prosthetics & Orthotics (P&O) is funded by the National Institute on Disability and Rehabilitation Research (NIDRR). All NIDRR RERCs are required to hold a State-of-the-Science meeting in the 4th year of their grant cycle. The 2012 NU-RERC State-of-the-Science meeting held on October 13, 2012 at the Northwestern University Prosthetics-Orthotics Center (NUPOC) in Chicago, IL, examined Knowledge Translation (KT) in Prosthetics and Orthotics (P&O). However, this meeting represented only one mechanism that the NU-RERC used to identify knowledge translation of clinically-relevant P&O research. We began gathering information for this meeting earlier in 2012 when we launched an expanded version of the online survey from our 2006 State-of-the-Science Meeting (the report of which can be found at http://www.nupoc.northwestern.edu/docs/research/RERC/SOS-2006_Report.pdf).

In order to make the available research valuable to practitioners, the direction of present and future research must address the needs of P&O users. Feedback from P&O stakeholders regarding the state of current and future research is one means of assessing the applicability of ongoing research. This feedback can be used to gauge the adequacy of current research, as well as guide future research. Hence, the purpose of the pre-meeting survey was to gauge the opinions of the P&O community regarding the direction of research in the field of P&O over the next 5-10 years. This survey was conducted and analyzed with the intention of contributing to and encouraging discourse regarding clinically-relevant research, and the translation of that research to evidence-based practice (EBP).

Method

The survey contained 46 questions that spanned four different sections: demographics (4 questions), resources (1 question), research (18 questions), and statements that assessed beliefs about research using a 5-point Likert Scale (21 questions) (refer to Appendix B for a copy of the survey). Research questions were largely similar to our previous NU-RERC survey about P&O research conducted prior to our 2006 State-of-the-Science meeting.[3] This allowed for comparison between the cohorts' responses, demonstrating possible changes in the perceptions of research in P&O over time. The level-of-agreement statements were added to the 2012 survey and chosen to represent topics for which there existed research to either support or refute each claim. Thus, these statements were used to assess the extent of knowledge of the evidence as it applied to these statements.

The 2012 survey was available online from January 29 to March 11, 2012 and was advertised on the oandp-l and amp-l list servers. Two follow-up, reminder emails were sent to the oandp-l list server subscribers after the survey was launched, they were sent on February 6, 2012 and March 9, 2012. oandp-l is an email discussion list with subscribers worldwide whose purpose is to enable clinical and research discussions related to P&O. During the time the survey was available, the estimated number of persons subscribed to oandp-l was 5,462. amp-l is a moderated forum intended for discussions among adults with amputation or related issues and is currently hosted by the University of Washington.

Results

2012 Demographics

377 individuals responded to the survey (6.9% of oandp-l subscribers). The response rate spiked after each reminder email was sent. Not all 377 respondents provided a response for every question, and respondent participation varied across the different survey sections. Average participation for each question was 81.3% (about 306 respondents).

The majority of survey respondents were males (71.6%) between 30-59 years of age (67.4%, refer to page S0.14 and Figure 1). There were few respondents older than 69 years (14 respondents) and none younger than 20 years. Certified Prosthetists (19.6%), Certified Orthotists (16.7%), and Certified Prosthetist/Orthotists (30.5%) together comprised 66.8% of respondents' associations with P&O (refer to page S0.15). The cohort's amount of experience in P&O was fairly evenly distributed, with the largest fraction of respondents citing 21-40 years of involvement with the field (34.5%).

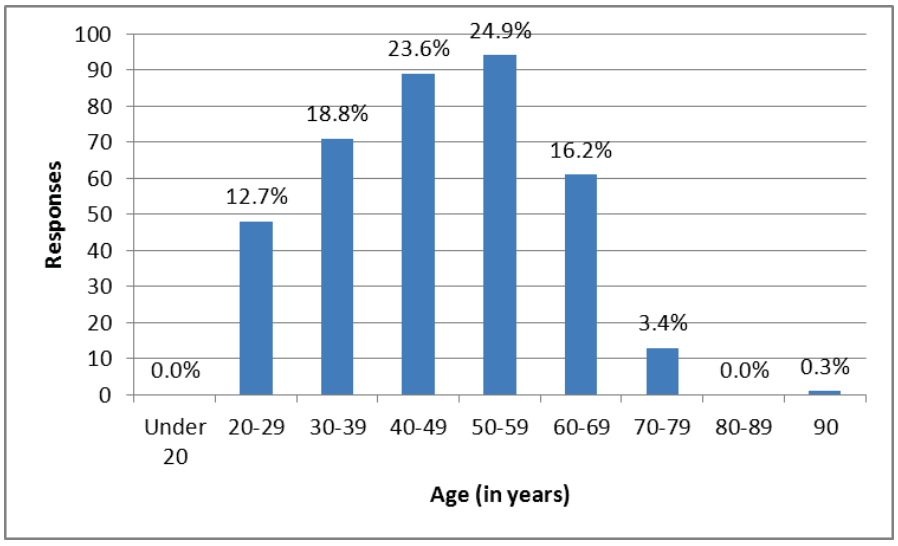

Figure 1: Age distribution of 2012 survey respondents.

P&O Resources (refer to page S0.16)

The largest number of respondents felt that clinical colleagues at hand were the most important resource for guiding their role in P&O (100 responses). Other top categories were continuing education, national professional organizations, and academic journals.

Research

More than half of the respondents from both cohorts indicated that they did not conduct or participate in research. Understandably, prosthetists and orthotists participated in more research in their respective disciplines than in the alternate discipline (refer to page S0.18).

The majority of respondents believed research was important (93.4%, refer to page S0.19) and more than half thought that research was lacking (62.1%, refer to page S0.20). In contrast, less than half of the respondents perceived that research emphasis was lacking in P&O (45.0%, refer to page S0.21).

Only a slight majority of respondents believed that research funding was inadequate and prevented further research from being conducted (53.7%, refer to page S0.23). However, more than 75% of the cohort indicated that they could identify areas that necessitated more research, yet they lacked the ability or resources to conduct that research (refer to page S0.24).

When identifying the top 5 areas where research should be directed, outcome measures were identified as the most important area for future research in both P&O (refer to page S0.26). Respondents identified *"shape acquisition procedures," "creating new patient assessment tools or guides,"* and *"assessment of assembled devices"* as the most important topics for research related to prosthetic processes. Prosthetic processes refer to the methods and tools that are utilized during the fabrication and fitting of a prosthesis. Similarly, respondents displayed an interest in outcome measures as an avenue for research on orthotic processes. The cohort recognized *"understanding of how current orthotic technology affects user performance"* as the most important category for investigation in orthotic processes. *"Creating new patient assessment tools or guides"* was recognized as the second most important area for continuing research. The topic selected as third most important was *"practice management in orthotics."*

Respondents were given the opportunity to communicate what they interpreted as the three most important questions to be addressed by research in P&O over the next five to ten years. This open-ended format provided freedom for respondents to

share those ideas that had not been identified in previous questions. The most common topics in response to this question for prosthetics were:

- Improve comfort of the socket and interface
- Increase sensory feedback
- Create ways to hold the P&O industry more accountable
- Outcome measurements - ways for prosthetists/orthotists to objectively assess the effectiveness of their treatment
- Osseointegration
- Powered microprocessor controlled units
- Strategies for regulating and maintaining consistency in residual limb volume management
- Interface materials that address excess moisture problems in individuals who sweat profusely
- Gait assessment strategies

The most common responses for orthotics were:

- Outcome Measures - efficacy of P&O services, EBP
- Cost-Benefit analysis of P&O services/technologies
- Development of low cost alternatives
- Development of materials for P&O applications
- Development of light weight components
- Development of fabrication processes: ease and quality
- Long term and real world functional analyses, application of motion analysis to P&O

The cohort's responses to the level of agreement statements listed in Table 1 are illustrated on page S0.28.

Table 1 Statements referenced in the chart on page S0.28.

Number	Statements
1	It is easier to fit a body-powered upper-limb prosthesis than an electronic system.
2	Alignment procedures for lower limb prostheses are standardized and validated.
3	Lower-limb orthoses are heavy.
4	Ankle-foot orthoses improve gait biomechanics.
5	Bench and static alignment are unrelated to the outcome of dynamic alignment.
6	Current prosthetic technologies can provide abilities and functions that surpass those of able-bodied persons.
7	Electronic upper-limb prostheses provide better function than body-powered prostheses.
8	Lower-limb orthoses are cumbersome.
9	Walking with microprocessor-controlled knees requires less energy expenditure than non-microprocessor-controlled knees.
10	Persons with partial foot amputation have a better quality of life than persons with transtibial amputation.
11	Prosthetic arms and hands exist that function and feel just like real ones.
12	Shock-absorbing pylons reduce impact forces during level walking.
13	The application of inelastic shoulder straps allows a thermoplastic thoraco-lumbo-sacral orthosis to control vertebral levels as superior as T4.
14	The cost of a prosthesis/orthosis generally correlates with the function it provides the user.
15	Thermoplastic thoraco-lumbo-sacral orthoses control the spine two vertebral levels inferior to the superior trimline and two vertebral levels superior to the inferior trimline.
16	To wear a lower-limb orthosis, you always have to buy bigger shoes.
17	Varying the length of bilateral running prostheses can increase performance beyond that of able-bodied runners.
18	Lower-limb prostheses are heavy.
19	Ankle-foot orthoses improve balance and stability.
20	Persons with partial foot amputation use less energy to walk than persons with transtibial amputation.
21	Because ankle-foot orthoses are routinely prescribed we do not need any more research about how they affect function.

Discussion

This survey provides useful insight into current perceptions of P&O research. These results become even more informative when compared to responses gathered from an analogous survey that was administered in 2006. The equivalence of the questions and congruence between the cohorts with regards to age and association with P&O permits comparison, allowing us to explore possible changes in the perceptions of research over the past five years.

The 2006 survey was available online from November 21 to December 30, 2005. This survey was advertised on oandp-l and the Clinical Gait Analysis list server. There were 3,300 oandp-l subscribers during this period and 224 individuals responded to the survey. The subscriber-respondent participation rate was almost identical to that of 2012 (6.8% in 2006 vs 6.9% in 2012).

Similar to the 2012 cohort, the majority of the respondents from 2006 fell within the 30-59 year age bracket (78%). Also in correspondence with 2012, more than half of the respondents identified themselves as Certified Prosthetists, Certified Orthotists, or dual certified practitioners (66.8% in 2012 vs 60% in 2006, refer to page S0.14).

The proportion of respondents who believed that research was important remained relatively constant over time (93.4% in 2012 vs 98.2% in 2006, refer to page S0.20). However, the percentage of respondents that believed that research was lacking decreased to 62.1% from 79.9% in 2006 (refer to page S0.20). Also, the fraction of the cohort who perceived that a lack of funding prevented more research from being conducted decreased to (53.7% in 2012 vs 74.6% in 2006, refer to page S0.23). These responses suggest that respondents perceived an improvement in the focus of research and the funds available to perform research. The number of respondents who did not participate in research increased over time (68% in 2012 vs 54% in 2006, refer to page S0.18). Of the different associations with P&O that respondents cited, researchers and engineers would logically be the most likely to conduct research. However, the fraction of the 2012 cohort that identified themselves as researchers or engineers was only 12.6% of the total respondents. Since the majority of both cohorts were prosthetists and orthotists, it is perhaps not surprising that most of the respondents did not engage in research. Furthermore, more than 75% of both cohorts indicated that they could identify areas that necessitated research, however they lacked the ability or resources to carry out that research (refer to page S0.21). The responses to these statements suggest that, although funding is perceived to be more accessible, respondents still thought that there were factors that impeded the conduct of research.

Based on the resources the respondents indicated as most important for guiding their role in P&O (refer to page S0.16) it appeared that the majority of respondents do not initially seek academic journals as a source of information. A 2007 survey administered by Whiteside et al.[4] aimed at describing the current practice of ABC Certified Prosthetists and Orthotists reported that prosthetists and orthotists spent the least amount of time in practice on *"promotion of competency and enhancement of professional practice."* Research was one of the topics that fell into this broader category (others were continuing education, training, and organizational affiliations). Orthotists and prosthetists dedicated 8.0% and 8.4% of their time to these tasks and ranked their frequency of participation in product development, research clinical trials, and outcome studies as a 1.6 for orthotics and 1.7 for prosthetics. The numbers correspond to the rankings respondents gave for the amount of time they spent doing each task 1=Never or rarely, 2=Occasionally). This is additional evidence suggesting that prosthetists and orthotists seldom participate in or conduct research.

Yet, in the 2012 survey, of the respondents who indicated they were prosthetic and orthotic students 55.6% specified they had conducted or participated in research. This is a higher fraction than the Certified Prosthetists and Orthotists. As a result of the master's degree becoming a requirement for P&O education, a greater number of new practitioners may become more involved in research. Geil[5] suggests, *"A gulf exists between the perceived research needs and the clinically applicable research that is being produced."* These incoming practitioners may help to narrow the gulf between practitioner and researcher that Geil describes. In the Whiteside et al.[4] survey less than 1.0% of prosthetists and orthotists had earned a master's in P&O in 2007. This further demonstrates that low research participation rates have the potential to be altered with increased participation in the masters programs, if the programs integrate an effective research component.

In 2012, 40.0% of certified practitioners thought that the research emphasis was inadequate, which was slightly less than respondents as a whole (45.0%). Ideally, prosthetists and orthotists have the most knowledge regarding the clinical value of current research according to their patients' needs. In effect, prosthetists and orthotists would seem to be the most reliable source for evaluating the emphasis of current research. However, Stevens[6] questions practitioners' ability to digest and apply research from journals when he states, *"The ability of the average practitioner to conduct literature searches and*

critically read and evaluate original journal articles may be less than ideal." Similarly, based on the resources the 2012 cohort indicated as most important for guiding their role in P&O (refer to page S0.16) it appears that the majority of respondents do not initially seek academic journals as a source of information. Further investigation, as to why a seemingly important resource for information may be largely unused among P&O practitioners is needed.

In attempting to provide relevant information for EBP, gaining the opinions of clinicians and other individuals associated with P&O with regard to future research is necessary to build a working framework for prospective research. When evaluating what the 2012 cohort regarded as the most important questions to be addressed in P&O in the next 5-10 years, their responses represented a broad range of categories within P&O research. Yet, their answers can be grouped into more general themes, illustrating a clearer picture of where respondents envision research progressing. In general, the responses for prosthetics can be placed into the categories: outcome measurements, performance enhancement, and comfort development. For orthotics, categories representative of the 2012 cohort's responses included outcome measurements, low cost production, and material development. These more comprehensive categories give a better indication of the main areas respondents believe future research should be directed in orthotics.

Similar to the responses for questions to be addressed in P&O over the next 5-10 years a large amount of overlap was present in the topics the cohorts identified as important for future research between the two surveys. The similarity in the responses could possibly mean that the respondents perceive the topics identified as important in 2006 as still inadequately explored, requiring further research. It is also significant that for P&O, outcome measures were recognized as most important for impending research in both survey cohorts. This may illustrate that currently, respondents perceive device-user evaluation methods as more important than the technology advancement of specific componentry. This is further exemplified because many of the categories acknowledged as most important for research associated with P&O processes were also related to outcome measures. The cohort's responses demonstrate a change in the perception of where research should be dedicated. The focus of research shifted from advancement of devices and componentry to assessment of these systems for different patient pathologies.

The likely catalysts behind these changes are the imminent regulations which could potentially be enforced by insurance companies. Insurance companies are beginning to push towards parameters that would require practitioners to support the validity of their interventions with objective evidence. Practitioners' difficulties related to earning reimbursement, have displayed a need for research regarding processes that objectively demonstrate the effectiveness of their care. These measures will allow practitioners to prove the adequacy of their care, in effect getting reimbursed for the services they provide. However, the focus of these measures is not merely reimbursement. The goal is to provide patients with quality care, and outcome measures are a tool that can objectively exhibit the high level of care a practitioner provides. Ultimately, the development of outcome measures for use in P&O will reach far beyond simple reimbursement and will allow for the assessment of treatment and an indication of progress.

The responses to the agreement statements can be used to evaluate the cohort's understanding and awareness of scientifically established knowledge in P&O. The responses to the statement *"Shock-absorbing pylons reduce impact forces during level walking,"* illustrated that the majority of respondents thought that shock absorbing pylons (SAP) did reduce impact forces (18.0%- Strongly Agree. 46.3%- Somewhat Agree refer to page S0.29). In contrast, currently available research demonstrates that there is little data to suggest that SAPs significantly decrease ground reaction forces.[7,8] For this statement it appears that the respondents were unaware of the literature regarding this topic, and thus had a misconception of the function of SAPs. When evaluating specifically the responses by prosthetists, the majority still believed that SAPs reduced impact forces during walking (23.4%-Strongly Agree, 55.0%-Somewhat Agree refer to page S0.29). These responses further support a disconnect between research and practitioners. At some point the dissemination of knowledge from researcher to clinician appears to have stalled.

Another exemplar statement, *"Persons with partial foot amputation use less energy to walk than persons with transtibial amputation,"* elicited a majority of Neutral/No opinion responses, however more individuals agreed with the statement than disagreed (37.9%-Neutral/No opinion, Strongly Agree/Somewhat Agree- 35.5% refer to page S0.29). Conversely, research demonstrates that although, generally energy expenditure increases as the level of amputation moves proximally along the limb, partial foot amputations in which the metatarsals are lost, may no longer be metabolically cost-effective.[9] Similar to the previous statement the cohort either misinterpreted or was unaware of research regarding level of amputation and energy expenditure. When evaluating only the responses of prosthetists, the majority also selected Neutral/No opinion (36.0%-

Neutral/No opinion, refer to page S0.29). Although the responses of prosthetists and cohort alike, may not follow what research findings suggest, there are many factors that can affect the energy expenditure at a certain level of limb amputation. Thus, Neutral/No opinion is not an unreasonable response.

The cohort's responses to these statements may suggest that they do not frequently read research articles in P&O, don't have access to these publications, or have difficulty translating the information available in the research articles to clinical practice.

Conclusion

This survey has provided interesting insights into the research perceptions of stakeholders associated with prosthetics and orthotics. It is clear that the "gulf" between practitioner and researcher that Geil[5] alludes to exists. This is apparent when looking at the responses to many of the level-of-agreement statements which were contrary to research concerning the topics. It is also evident when observing the 2012 data that the higher instance of research participation by P&O students indicate a trend towards a greater level of importance on the research component of P&O education. Amongst the most important information gleaned from these surveys is that respondents perceive future research regarding outcome measures as most important.

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Comments:

Terry Supan clarified that the reason we should focus on outcomes measures is due to the emphasis on quantifying care. Ingrid Masterton responded that the challenge is how to define what to measure in a rehabilitation context. She asked whether NIDRR has mandates related to models or theoretical constructs that should be used across the board. Stefania Fatone responded that the different areas of NIDRR's portfolio make it difficult to have a unified framework, but the International Classification of Functioning (ICF) is gaining momentum in the research arena. NIDRR has always had an interest in the participation domain, which is harder to measure than impairment levels and so there is no definitive framework. The ICF considers that at every point in the life cycle, limitation of functioning can be experienced. Personal and environmental factors affect how the impairment influences one's life. Gerry Harris concurred. Ingrid Masterton encouraged, that we use the ICF as a language.

Stefania Fatone stated that NIDRR considers outputs and outcomes of work that it funds: outputs are what comes out of research, while outcomes are the impact on the field.

Walter Afable suggested that we should focus on evidence based practice but be careful that we don't overstate that. Technically, we have a responsibility to report patient satisfaction. Trends in outcomes are important, e.g. reducing audit risk, but we are still not there in terms of good tools that demonstrate function.

Stefania Fatone suggested that missing from the discussion is how outcomes influence reimbursement. Outcomes offer a pathway for justifying reimbursement but will not guarantee reimbursement. We can only demonstrate using outcomes that what is being done is meaningful. This requires case by case judicious use of outcome tools by clinician – the burden is on the clinician to pick the correct outcome that demonstrates care. Yeongchi Wu observed, *"If there is no outcome, there will be no income."* But Steve Gard cautioned that this might offer a limited view: the goal is to provide the best care. The bottom line though is that the need for outcomes are impacting practitioners.

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SOS Pre-meeting Survey Summary

Stefania Fatone

October 13, 2012

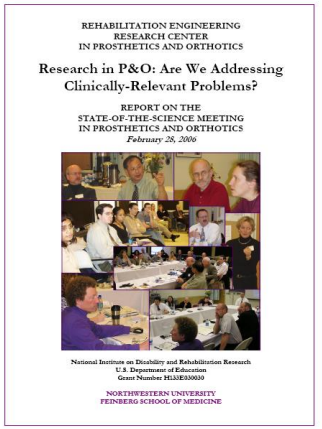
Objectives

- To survey the opinions of the P&O community regarding the direction of research in the field of P&O over the next 5-10 years.
- Compare the results to the 2006 SOS pre-meeting survey to gain insight into changes in the perception of P&O research that may have occurred during the intervening years.

Survey Structure

46 questions in four different sections:

1. demographics (4 questions)
2. resources (1 question)
3. research (18 questions)



4. statements that assessed beliefs about various topics using a 5-point Likert Scale (21 questions)

RERC SOS Pre-meeting Survey

Demographics

Age:

- ◯ Under 20
- ◯ 20-29
- ◯ 30-39
- ◯ 40-49
- ◯ 50-59
- ◯ 60-69
- ◯ 70-79
- ◯ 80-89
- ◯ 90+

Gender:

- ◯ Female
- ◯ Male

Please indicate your association with the field of Prosthetics and Orthotics (may select more than one):

- ☐ Consumer
- ☐ Educator
- ☐ Engineer
- ☐ Family member or personal companion of consumer
- ☐ Orthotist
- ☐ Pedorthotist
- ☐ Physician
- ☐ Prosthetic/Orthotic Resident
- ☐ Prosthetic/Orthotic Student
- ☐ Prosthetist
- ☐ Researcher
- ☐ Therapist

Other (please specify)

Years of experience in the field of Prosthetics and Orthotics:

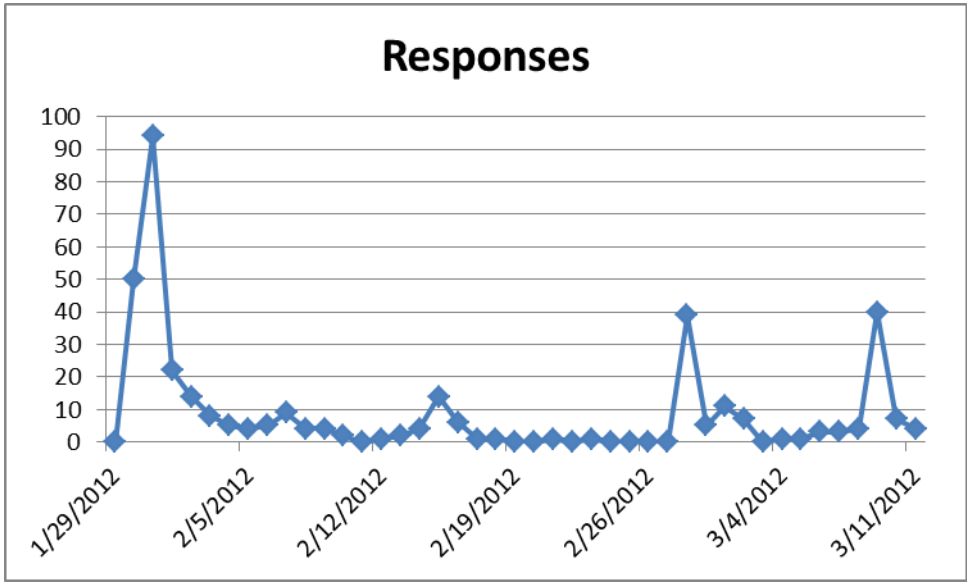
- ◯ 0-5
- ◯ 6-10
- ◯ 11-20
- ◯ 21-40
- ◯ 41+

Survey

Launched 1/29/12 → Closed 3/11/12

oandp-l and *amp-l*

Two reminder emails



Respondents

	2012	2006
Respondents	377	224
oandp-l subscribers	5,462	3,300
% of subscribers responding to survey	6.9%	6.8%

Respondents

	2012	2006
Respondents	377	224
% age 30-59 years	67%	78%
% identifying as CP, CO, CPO	67%	60%

Respondents

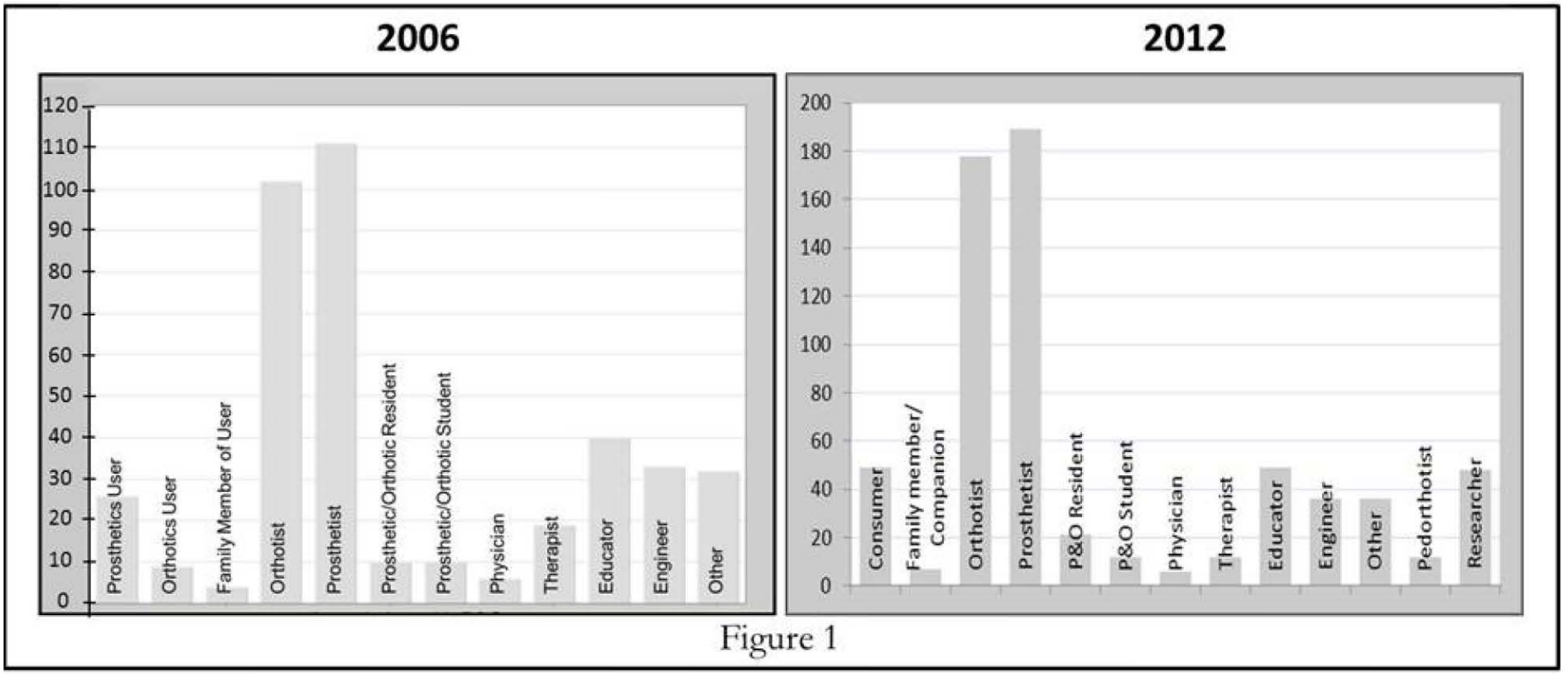


Figure 1

Resources

- Academic journals
- Clinical colleagues at hand
- Continuing education
- Employer resources
- Family members or personal companions
- Local clinical experts
- Local professional organizations
- Manufacturer publications
- National advocacy organizations
- National clinical experts
- National professional organizations
- Popular press
- Prosthesis and Orthosis users
- Prosthetic and Orthotic magazines
- Regional clinical experts

Included most often in the top 5	%
Continuing education	63
Academic journals	60
Clinical colleagues at hand	55
Prosthetic and Orthotic users	39
National professional organizations Prosthetic and Orthotic Magazines	46

In order of importance, please rank the top 5 resources you use to guide you in your role in Prosthetics and Orthotics (number 1 through 5 with 1 being the most important):

Top 5 number 1 (# of responses)	
Clinical colleagues at hand	100
Academic journals	70
Continuing education	65
Prosthetic and Orthotic users	38
Local clinical experts	18

Top for each rank (# of respondents)	
1. Clinical colleagues at hand	100
2. Continuing education	72
3. Continuing education	46
4. National professional organizations	40
5. Academic journals	38

Resources

Other (*mentioned more than once)
Third party payor requirements
L-Codes
Word of mouth
Internet*
Listserv*
National meetings
Mentors from residencies
Observations from other fields
Non-P&O journals
Sales representatives
International conferences
International colleagues

P&O Research

% yes	2012	2006
Do you conduct or participate in research?	32	46

The average percentage of time they dedicated to research was 15%.

P&O Research

% yes	2012	2006
Do you conduct or participate in research?	32	46
Is research important?	93.4	98.2

Proportion of respondents who thought that research was important was largely unchanged.

P&O Research

% yes	2012	2006
Do you conduct or participate in research?	32	46
Is research important?	93.4	98.2
Is the amount of research lacking?	62.1	79.9

Proportion of respondents who believed that the *amount* of P&O research was lacking decreased.

P&O Research

% yes	2012	2006
Do you conduct or participate in research?	32	46
Is research important?	93.4	98.2
Is the amount of research lacking?	62.1	79.9
Is the emphasis of research lacking?	45.0	61.2

Proportion of respondents who thought that the *emphasis* of P&O research was lacking decreased.

P&O Research

- Taken together, these results suggest that the amount and emphasis of research focused on P&O is perceived to have improved over the last five years.

P&O Research

% yes	2012	2006
Does insufficient funding prevent P&O research?	53.7	74.6

Perceptions of available research funding improved.

P&O Research

% yes	2012	2006
Does insufficient funding prevent P&O research?	53.7	74.6
Can you identify areas where further research is needed but lack the ability/resources to carry out the work?	75.8	78.1

P&O Research Funding

- Although funding may not be viewed as limiting P&O research in general, other factors seem to be constraining the amount of research conducted by CP/CO/CPOs.

P&O Research Direction

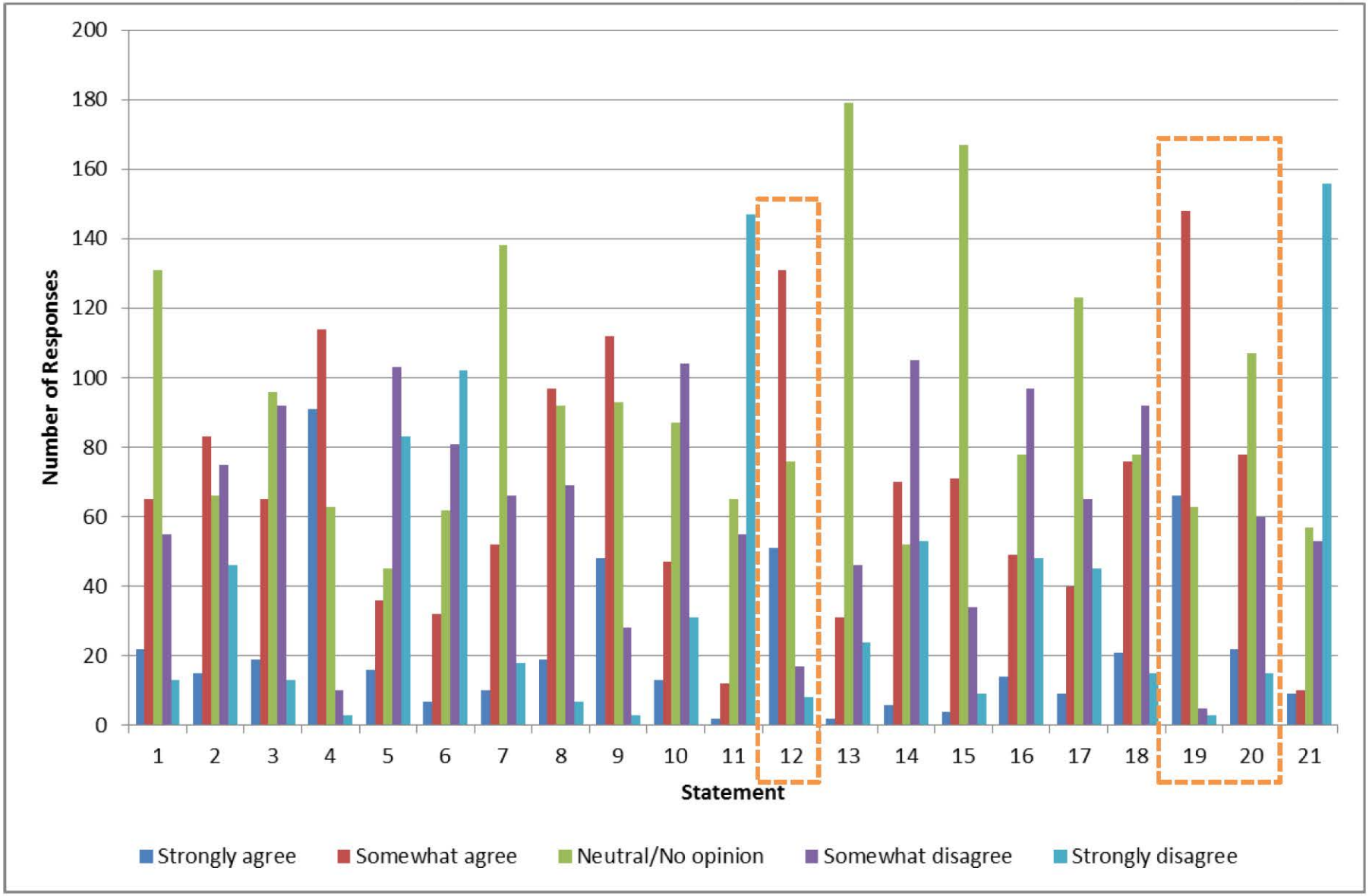
Top five areas where research should be directed in P&O	2012		2006	
	Prosthetics	Orthotics	Prosthetics	Orthotics
1.	Outcome Measures	Outcome Measures	Outcome Measures	Outcome measures
2.	Outcome Measures	Ankle-Foot Orthoses	Socket/ Interface	Ankle-Foot Orthoses
3.	Socket/ Interface	Fabrication	Socket/ Interface	Fabrication
4.	Materials	Materials	Control of Prosthesis	Materials
5.	Control of Prosthesis	Knee Joints/ Powered Components	Suspension	Materials

Statements

RERC SOS Pre-meeting Survey

Based on your experience and knowledge of Orthotics and Prosthetics, please indicate your level of agreement with each of the statements below:

	Strongly Agree	Somewhat Agree	Neutral / No Opinion	Somewhat Disagree	Strongly Disagree
It is easier to fit a body-powered upper-limb prosthesis than an electronic system.	◯	◯	◯	◯	◯
Shock-absorbing pylons reduce impact during level walking.	◯	◯	◯	◯	◯
Lower-limb orthoses are heavy.	◯	◯	◯	◯	◯
Ankle-foot orthoses improve gait biomechanics.	◯	◯	◯	◯	◯
Bench and static alignment are unrelated to the outcome of dynamic alignment.	◯	◯	◯	◯	◯
Persons with partial foot amputation have a better quality of life than persons with transtibial amputation.	◯	◯	◯	◯	◯
Electronic upper-limb prostheses provide better function than body-powered prostheses.	◯	◯	◯	◯	◯
Lower-limb orthoses are cumbersome.	◯	◯	◯	◯	◯

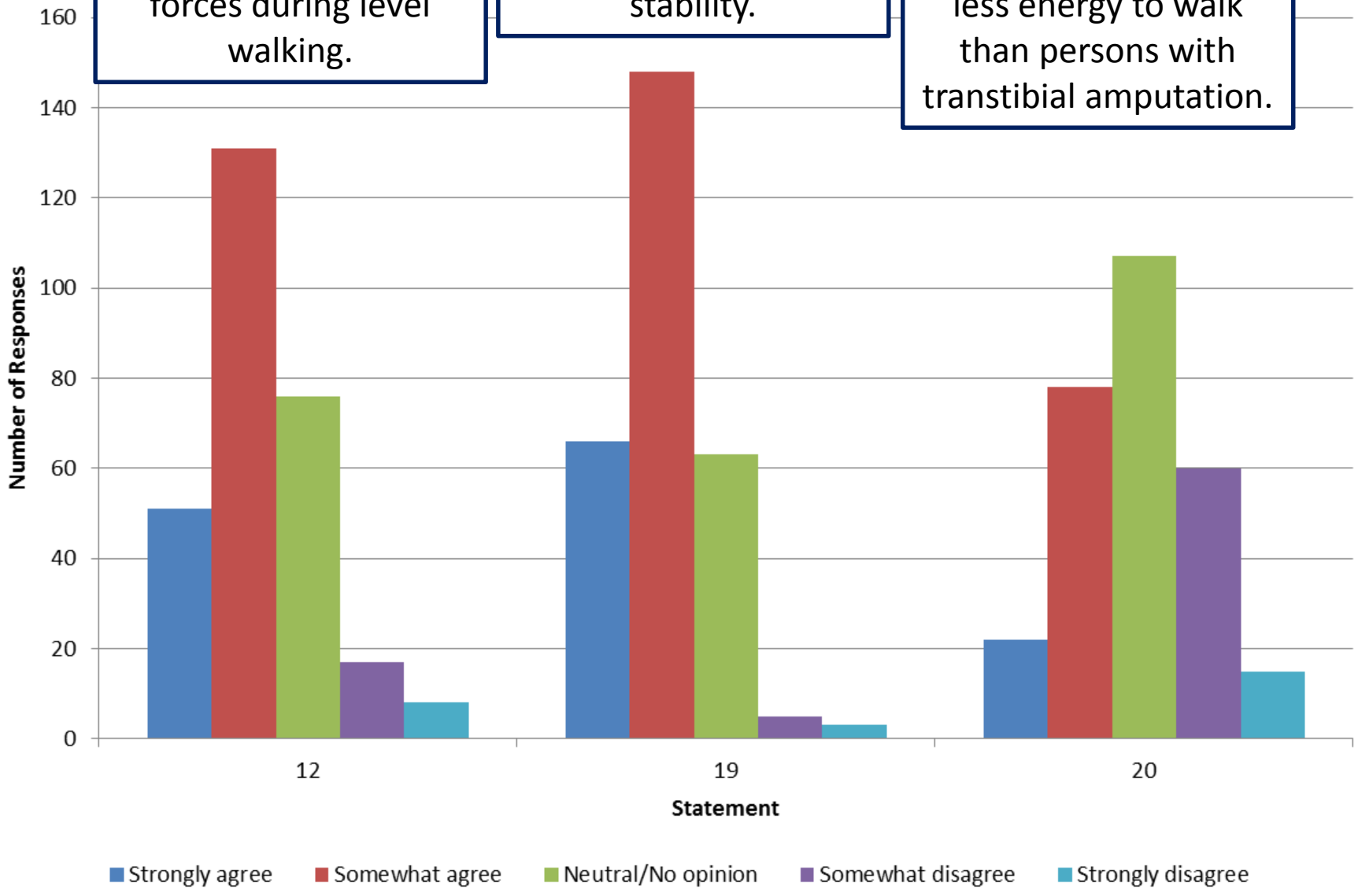

200
180
160
140
120
100
80
60
40
20
0
Number of Responses
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
Statement
Strongly agree
Somewhat agree
Neutral/No opinion
Somewhat disagree
Strongly disagree

S0.28

Shock-absorbing pylons reduce impact forces during level walking.

Ankle-foot orthoses improve balance and stability.

Persons with partial foot amputation use less energy to walk than persons with transtibial amputation.



Shock-absorbing pylons reduce impact forces during level walking.

Ankle-foot orthoses improve balance and stability.

Persons with partial foot amputation use less energy to walk than persons with transtibial amputation.

- Majority of respondents thought shock absorbing pylons did reduce impact forces during level walking
- When evaluating specifically the responses by prosthetists the majority still believed that shock absorbing pylons reduce impact forces during level walking (23.4%-Strongly Agree, 55.0%-Somewhat Agree)
- However, studies suggest that shock absorbing pylons do not significantly decrease impact forces during level walking (Gard & Konz 2003; Adderson et al 2009)

Shock-absorbing pylons reduce impact forces during level walking.

Ankle-foot orthoses improve balance and stability.

Persons with partial foot amputation use less energy to walk than persons with transtibial amputation.

- Majority of respondents thought ankle-foot orthoses did improve balance and stability
- Studies suggest that ankle-foot orthosis effects on balance are dependent on their design with rigid improving static balance and more flexible designs better for dynamic balance conditions (Ramstrand & Ramstrand 2010).

Shock-absorbing pylons reduce impact forces during level walking.

Ankle-foot orthoses improve balance and stability.

Persons with partial foot amputation use less energy to walk than persons with transtibial amputation.

- Majority of responses were neutral/no opinion
- More individuals agreed with the statement than disagreed
- However, the energy expenditure of partial foot amputees is still largely unknown (Dillon et al. 2007)

Final Thoughts

- Our 2012 pre-meeting survey suggests that research needs have not changed greatly since 2006 when the NU-RERC held its last SOS meeting.
- However, our survey results also indicate that research findings are not always effectively reaching the P&O community. Hence, the focus of our meeting on knowledge translation.

SESSION 1: KNOWLEDGE TRANSLATION ACROSS RERC ACTIVITIES

Speaker: **Jennifer Flagg, MBA**
NIDRR Disability Rehabilitation Research Program (DRRP) KT4TT

Summary:
NIDRR's goal is to improve life for people with disabilities by generating policies and products that contribute toward the independence and participation of all people with disabilities. Knowledge Translation (KT) is a useful tool to get from outputs to outcomes however stakeholders need to be involved throughout the process.

What exactly is KT? The definition was recently changed: KT is a process that ensures new knowledge and products gained through research and development will ultimately be used to improve the lives of individuals with disabilities and further their participation in society.

It is important to distinguish between Knowledge Dissemination Utilization (KDU) and KT. KDU is an end of grant activity; a linear, mechanical process of information transfer that focuses on "pushing" knowledge out into use. KT is an integrated activity; an interactive, nonlinear process dependent on the beliefs, values, circumstances and needs of intended users. KT needs and anticipated barriers shape research, development, and dissemination activities. KT is built around interactions among various stakeholders such as researchers, clinicians, users, etc., and involves collaboration with people as individuals, even beyond surveys.

A 2007 National Center for the Dissemination of Disability Research (NCDDR) survey reported that the target audience for KT includes researchers, clinicians, and people with disabilities. Strategies for disseminating KT included presentations (95.5%), scholarly articles (91.9%), reports (74.8%), training sessions (71.7%), and websites (68.5%). Current methods for measuring impact include participant counts, material requests, citation searches, participation surveys, and interviews; however these methods may not accurately reflect who is using information in practice. Barriers for disseminating KT included limited funding and planning time. Other survey comments included that some saw KT as an end of grant activity and some believed *"…dissemination and/or utilization activities would take away from this project's primary work and focus."*

Knowledge exists in different states: (1) scientific (discovery), (2) engineering (invention), and (3) industrial (production). Multiple stages within these states allow for different types of outputs (refer to chart on page S1.18). There are different strategies of knowledge communication for these different states: (1) research activity generating discovery outputs utilizes KT, (2) development activity generating invention outputs utilizes technology transfer (TT), and (3) production activity generating innovation outputs utilizes commercial transaction, all of which ultimately lead to marketplace outcomes and impacts (refer to flow chart on page S1.19). When it comes to KT for discovery outputs, traditionally knowledge creation activities occur first, then needs identification, and finally solutions are developed (refer to flow chart on page S1.20). Opportunities for KT include assessing needs with input from stakeholders, performing preliminary assessment with input from stakeholders, identifying expertise needs and assembling a transdisciplinary research team, initiating key co-development practices, and testing refined beta prototypes with consumers in the field. A TT planning template is shown on page S1.22 and a KT planning template on page S1.23. Other resources include the NCDDR KT Library and KT training programs such as the Scientist KT Training and KT Professional Certificate.

Key Points:
(1) **Involve Knowledge Users** when identifying research topics, questions, and hypotheses as well as when designing and implementing study methods.
(2) **Pay attention to context.**
(3) **Tailor dissemination strategies.**
(4) **Use planning tools.**

Knowledge Translation
KT4TT
Technology Transfer

Knowledge Translation Across RERC Activities

Jennifer L Flagg, MBA
Center on KT4TT
University at Buffalo

Presentation Outline

- KT- What is it and why does it matter?
- What is currently being done by RERC's?
- What else can be done?

NIDRR's Goal: Impacts

Outcomes

Knowledge Translation
KT4TT
Technology Transfer

How do we get there?

Outputs

KT

Stakeholders

Outcomes

Impacts

What is KT?

All of NIDRR's centers and projects will carry out KT.

- *KT is a process of ensuring that new knowledge and products gained through research and development will ultimately be used to improve the lives of individuals with disabilities and further their participation in society.* *(2010-2014 proposed LRP)*

What is KT?

- KT takes place in a complex system
- Interactions vary in intensity, complexity and level of engagement
- Focus on the needs of the knowledge users

- Key Components:
  - Involve relevant stakeholders in design and conduct
  - Assess and disseminate
  - Translating findings into usable information

KT versus KDU?

- KDU
  - End of grant activity
  - Linear, mechanical process of information transfer
  - Focus on “pushing” knowledge out into use

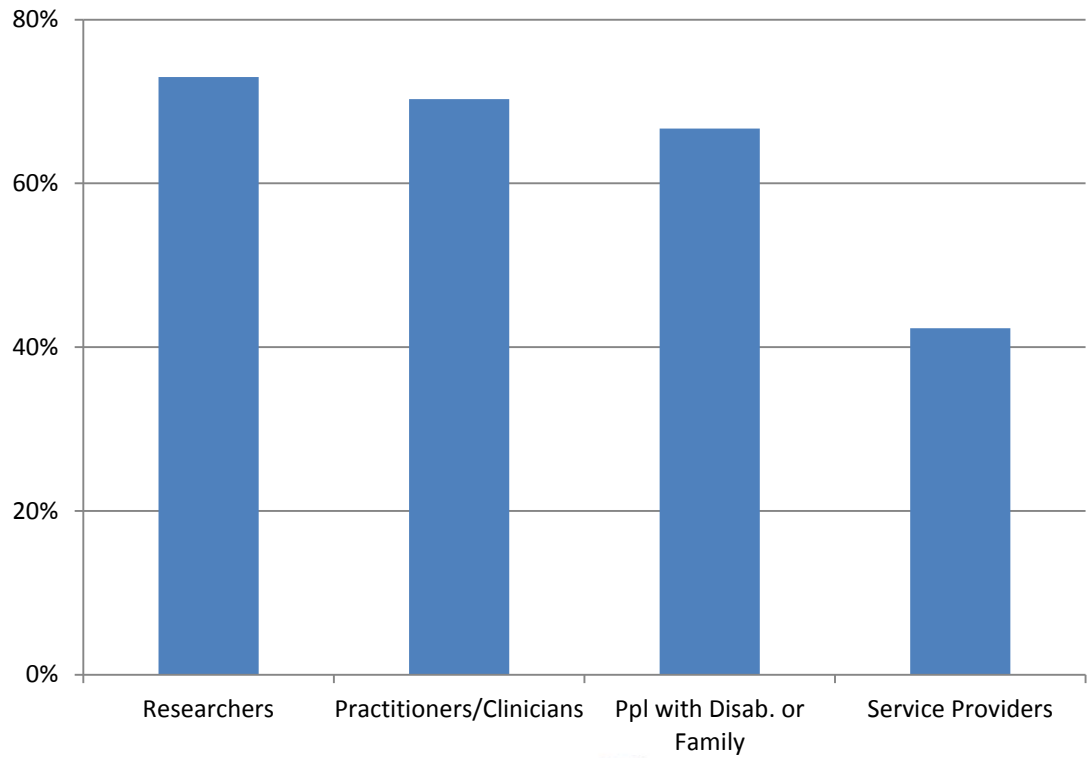
- KT
  - Integrated activity
  - Interactive, nonlinear process
    - Dependent on the beliefs, values, circumstances, and needs of intended users
  - Needs and anticipated barriers shape research, development, and dissemination activities

Relationships

What is Currently Being Done?

Knowledge Translation
KT4TT
Technology Transfer

Target Audiences



Dissemination and Research Utilization Strategies

- Present papers or lectures (95.5%)
- Scholarly articles (91.9%)
- Annual/final reports (74.8%)
- Trainings (71.7%)
- Websites/pages (68.5%)

Measuring Impact

- Participant counts (72.2%)
- Material requests/distributions (56.7%/52.6%)
- Citation searches (51.5%)
- Participant surveys (40.2%)
- Interviews (24.7%)

Barriers to Reaching Target Audience

- Limited funding
- Limited planning time

- Comments
  - Saw KT as an end of grant activity
  - "…dissemination and/or utilization activities would take away from this project's primary work and focus."

What Else Can Be Done?

Three Different Methods yield Knowledge Outputs in 3 Different States

Scientific Research Method ▶

Conceptual Discovery

Engineering Development Method ▶

Prototype Invention

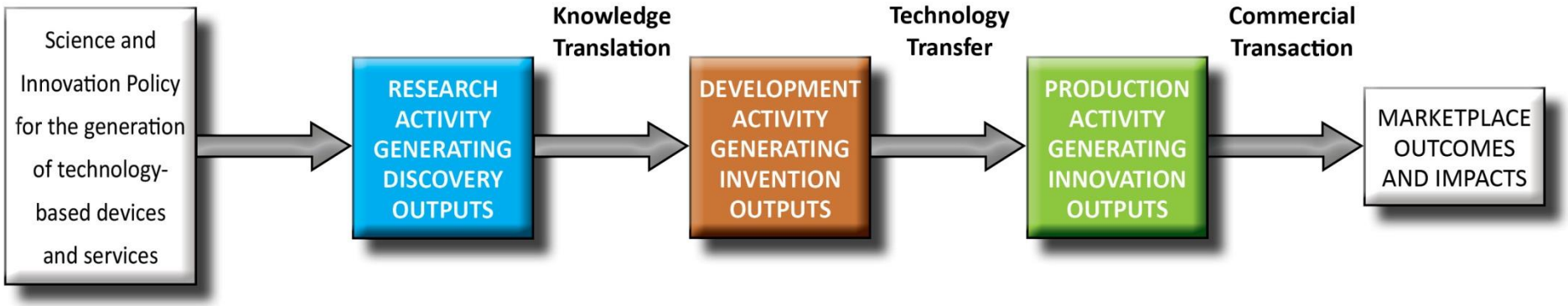
Industrial Production Method ▶

Commercial Product

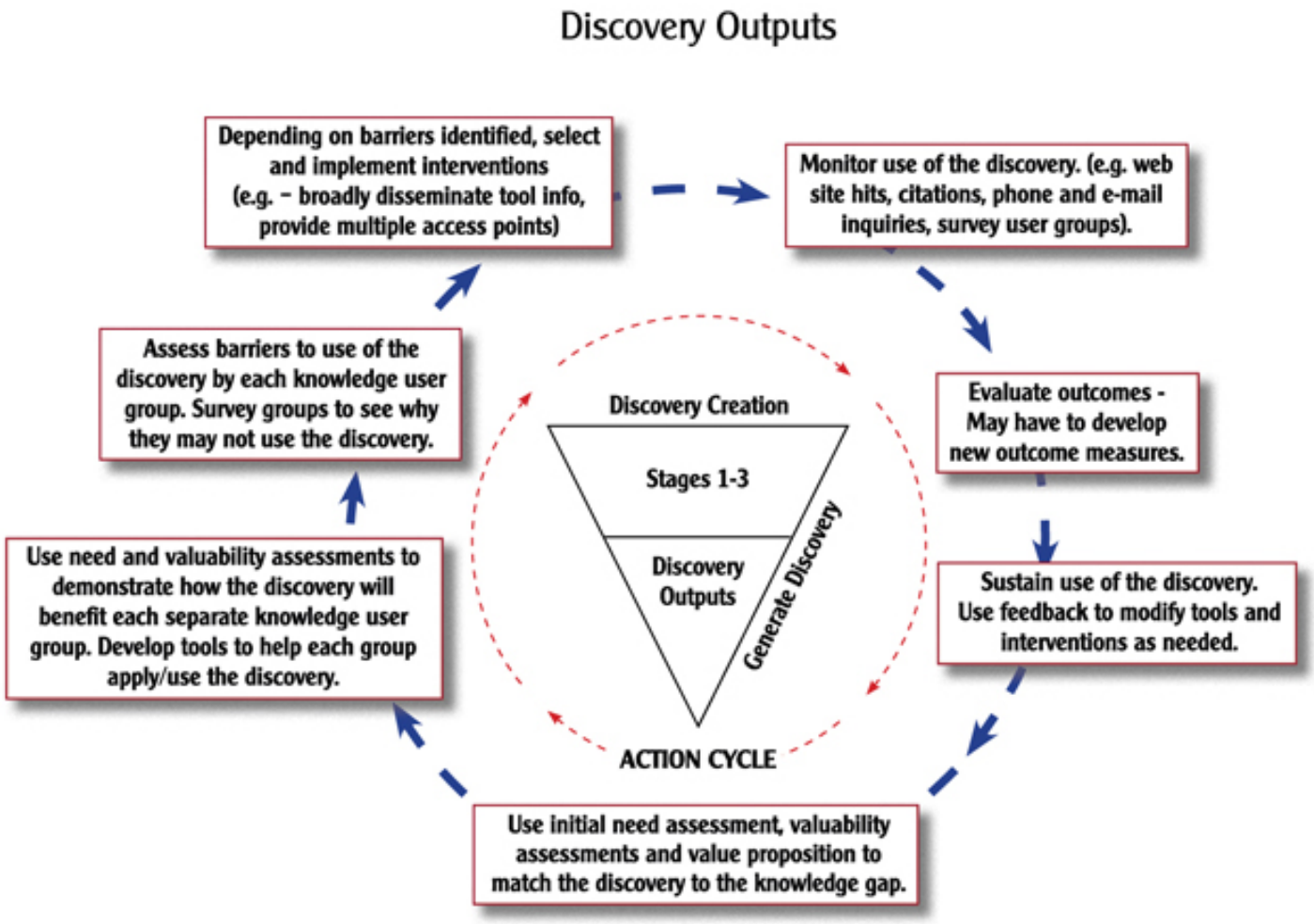
Need to Knowledge (NtK) Model for Technological Innovations

Phases	Stages and Gates
Discovery (Research)	Stage 1: Define Problem & Solution
	👍 👎 ?
	Stage 2: Scoping
	👍 👎 ?
	Stage 3: Conduct Research and Generate Discoveries → Discovery Output!
Invention (Development)	*Communicate Discovery State Knowledge* 👍 👎 ?
	Stage 4: Build Business Case and Plan for Development
	👍 👎 ?
	Stage 5: Implement Development Plan
	👍 👎 ?
	Stage 6: Testing and Validation → Invention Output!
Innovation (Production)	*Communicate Invention State Knowledge* 👍 👎 ?
	Stage 7: Plan and Prepare for Production
	👍 👎 ?
	Stage 8: Launch Device or Service → Innovation Output!
	Communicate Innovation State Knowledge 👍 👎 ?
	Stage 9: Life-Cycle Review / Terminate? 👍 👎 ?

Knowledge Communication – 3 Strategies for 3 States



KT for Discovery Outputs



Opportunities for KT

- 1.1 Assess needs with input from stakeholders.
- 2.2 Perform preliminary valuability assessments with input from stakeholders.
- 3.1 Identify expertise needs and assemble transdisciplinary research team.
- 4.6 Initiate key co-development practices.
- 6.3 Test refined beta prototype with consumers in field.

Knowledge Translation
KT4TT
Technology Transfer

Practical Tool
TT Planning Template

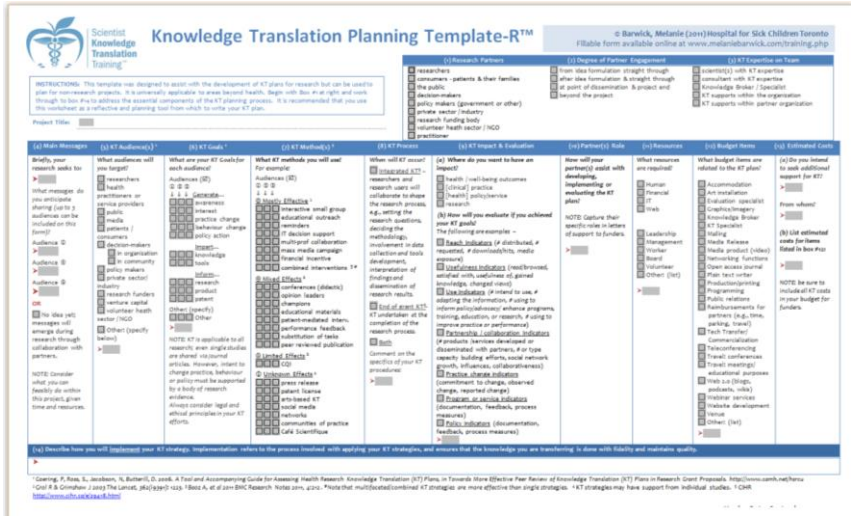
http://kt4tt.buffalo.edu/knowledgebase

Stages and Gates	Steps	Plans/Progress
Stage 1: Define Problem and Solution	1.1. Opportunity for KT: Assess needs for device or service with input from relevant stakeholders from the six knowledge user (KU) groups. 1.2. Identify a problem (need). Identify audience for solution. Identify context for both. 1.3. Propose plausible solution (goal) to problem in the form of a device or service. 1.4. Determine scope of project (role); output as conceptual discovery, prototype invention or device/service innovation? 1.5. Consider path to market.	.
Gate 1: Idea Screen. PI decides to either terminate or move forward with project to develop solution to problem.		
Stage 2: Scoping (Initial screen to validate innovativeness and value to target markets)	2.1. Define innovation opportunity.	
	2.2. Opportunity for KT: expanding on previously identified needs, perform preliminary valuability assessments (business, market and technical) on device/ service with input from stakeholders in the six KU groups. 2.3. Identify potential barriers.	
Gate 2: Second Screen. PI must decide if envisioned project output and eventual device/service outcomes are still considered innovative in the light of results from assessments. PI decides if generation of new knowledge is required. If no, PI decides if project should move directly to invention phase or terminate. If yes, should they pursue external funding to conduct remainder of discovery phase?		
Stage 3: Conduct Research and Generate Research-Based Findings (Create/find relevant knowledge)	3.1. Opportunity for KT: Identify expertise needs and assemble transdisciplinary research team (I.e. methodologist, statistician, etc.) 3.2. Identify specific knowledge gaps- purpose of research phase. 3.3. Select appropriate research design and develop	

Practical Tool
KT Planning Template

Available at: http://www.melaniebarwick.com/training.php

- Consider:
  - Research partners
  - Level of partner engagement
  - KT expertise on team
  - Messages
  - Audiences
  - KT goals
  - KT methods & processes
  - Intended impact & evaluation
  - Role of partners
  - Resources & budget → Estimated costs
  - Implementation Plan



Resources

- NCDDR KT Library
  - http://www.ncddr.org/ktinfocenter/

- KT Training Programs
  - Scientist KT Training
  - Knowledge Translation Professional Certificate

Key Take Aways

- Involve Knowledge Users:
  - Identifying research topics, questions and hypotheses
  - Designing and implementing study methods
- Pay attention to context
- Tailor dissemination strategies
  - Critical information, formats and channels
- Use planning tools

Questions

ACKNOWLEDGEMENT

This is a presentation of the Center on Knowledge Translation for Technology Transfer, which is funded by the National Institute on Disability and Rehabilitation Research, U.S. Department of Education, under grant #H133A080050.

SESSION 2: KNOWLEDGE TRANSLATION AND THE DEVELOPMENT OF INNOVATED PRODUCTS

Speaker: **David Tiemeier, PhD**
NU Innovation and New Ventures Office (NU-INVO)

Summary:
The mission of the Northwestern University Innovation and New Ventures Office (NU-INVO) is to: (1) catalyze the translation of basic knowledge into innovative products and services, (2) connect investigators across disciplines, (3) connect investigators to external partners, and (4) champion cross-campus coordination.

Where does it start? "Creative collisions" lead to new paths of research which in turn lead to expanding knowledge and innovative products to meet previously unmet needs. NU-INVO works with researchers at the "event" of invention to navigate the commercial and social impact trajectory.

A particular challenge is crossing the gap from concept/invention to commercial development. Building value is critical to the success of concept products and inventions. If this is not accomplished, active marketing and licensing is a great challenge and is often rendered useless. One can build value by recognizing the content of knowledge and how this will manifest into a product that will entice the industry to take on the project for commercial development. At NU-INVO, there are people who help (1) identify and shape innovations, (2) add value through prototypes/proof-of concept, and (3) launch industry initiatives by promoting consistency via cross-campus coordination and by managing differences in corporate agreements. The Chicago Innovation Mentors group is another resource for guidance on invention development and start-ups.

It is important to recognize that in addition to the end patient, the industry partner is also a customer. These partners should be involved in the development process at some stage to help shape the research and overall "story." However, it should be noted that intellectual property must be secured before you embark on the commercial trajectory. This often involves developing and publishing a patent. Take care to avoid premature and public disclosure of your ideas.

Knowledge Translation and the Development of Innovative Products

David C. Tiemeier, Ph.D.
Senior Director, INVO
October 13, 2012

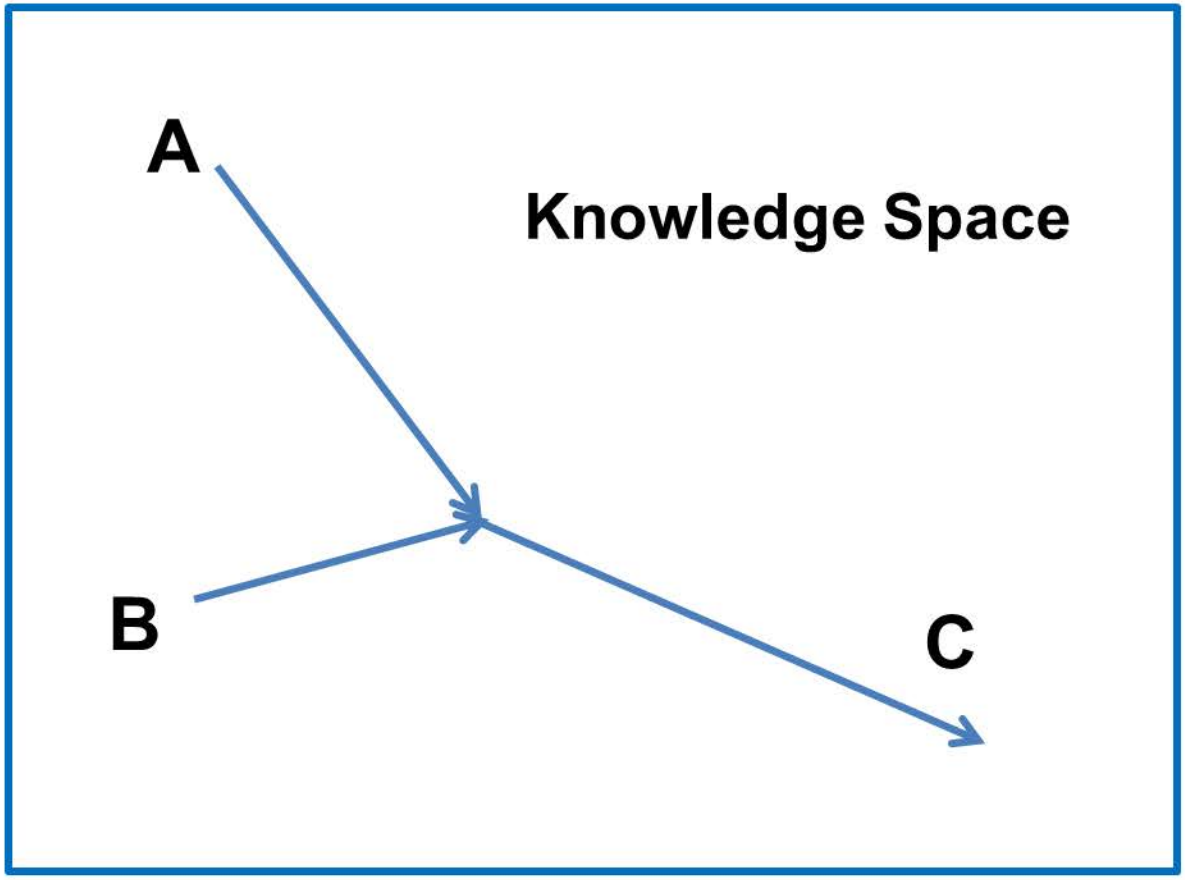
INVO's Mission

Alicia Loffler, Ph.D.
Executive Director
Associate VP, Research

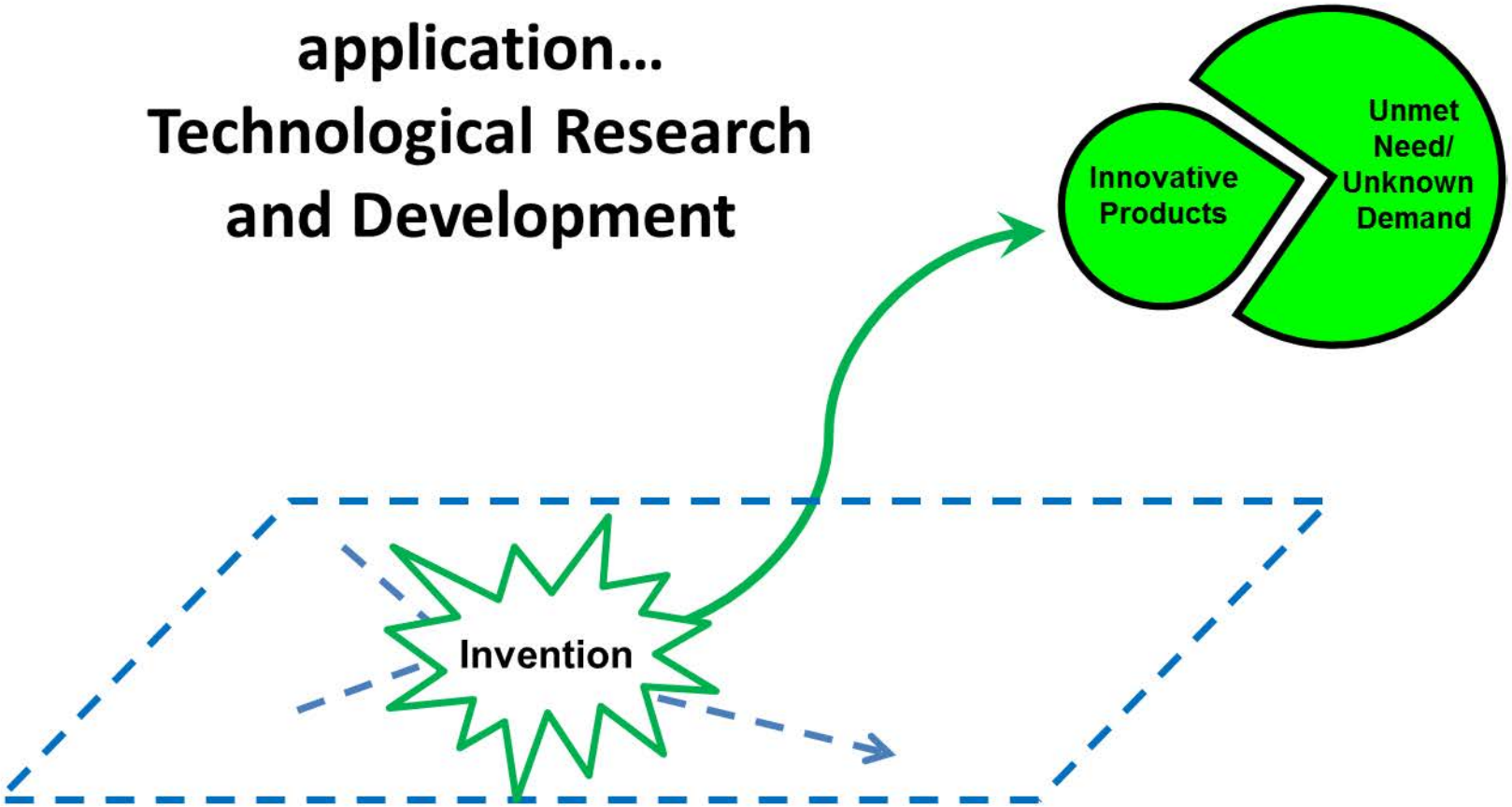
- Catalyze the translation of basic knowledge coming out of individual projects into innovative products and services
- Connect investigators across disciplines
- Connect investigators to external partners, experts, and money
- Champion cross-campus coordination and implementation of best practices

Where does it start?

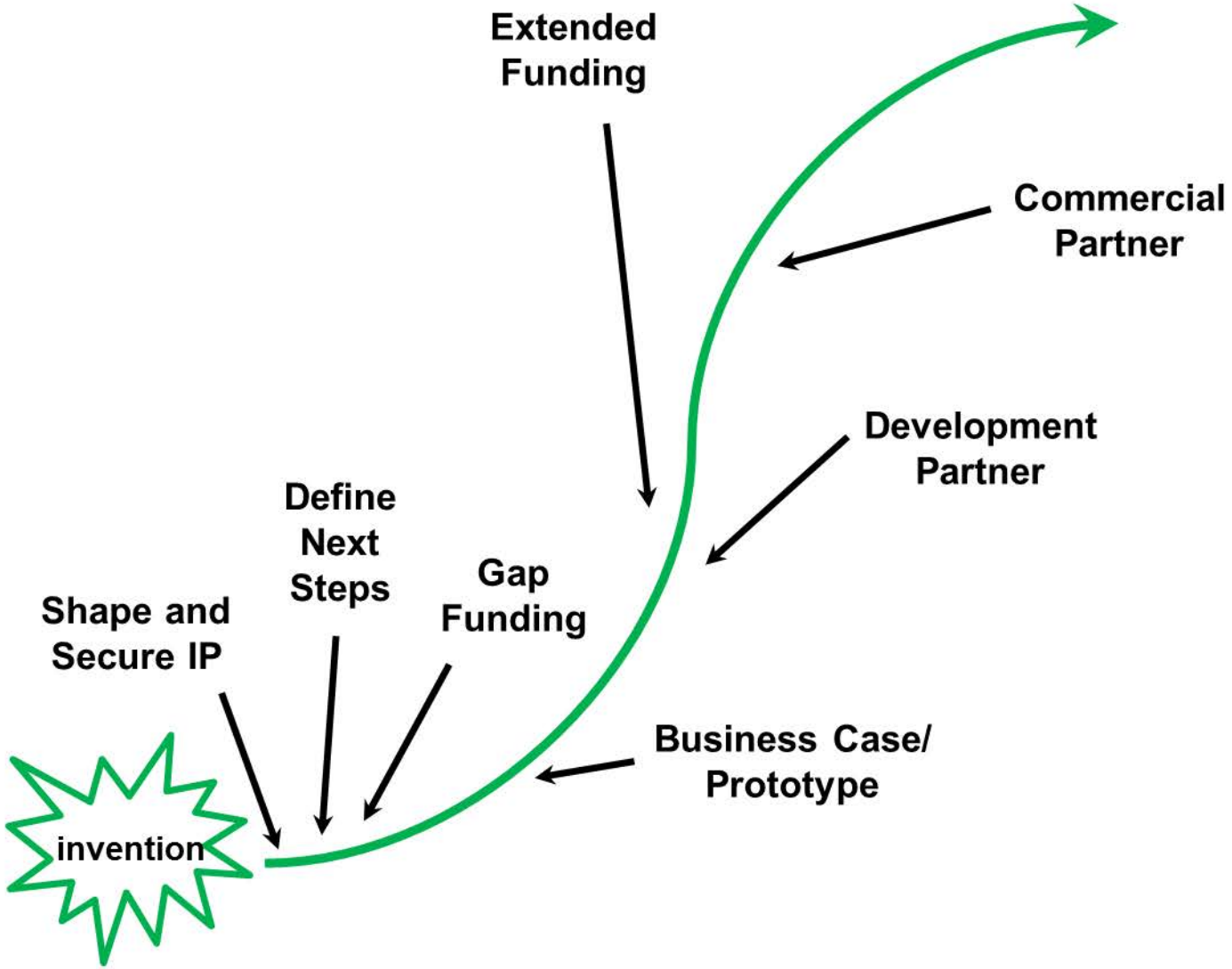
Creative collisions lead to new directions



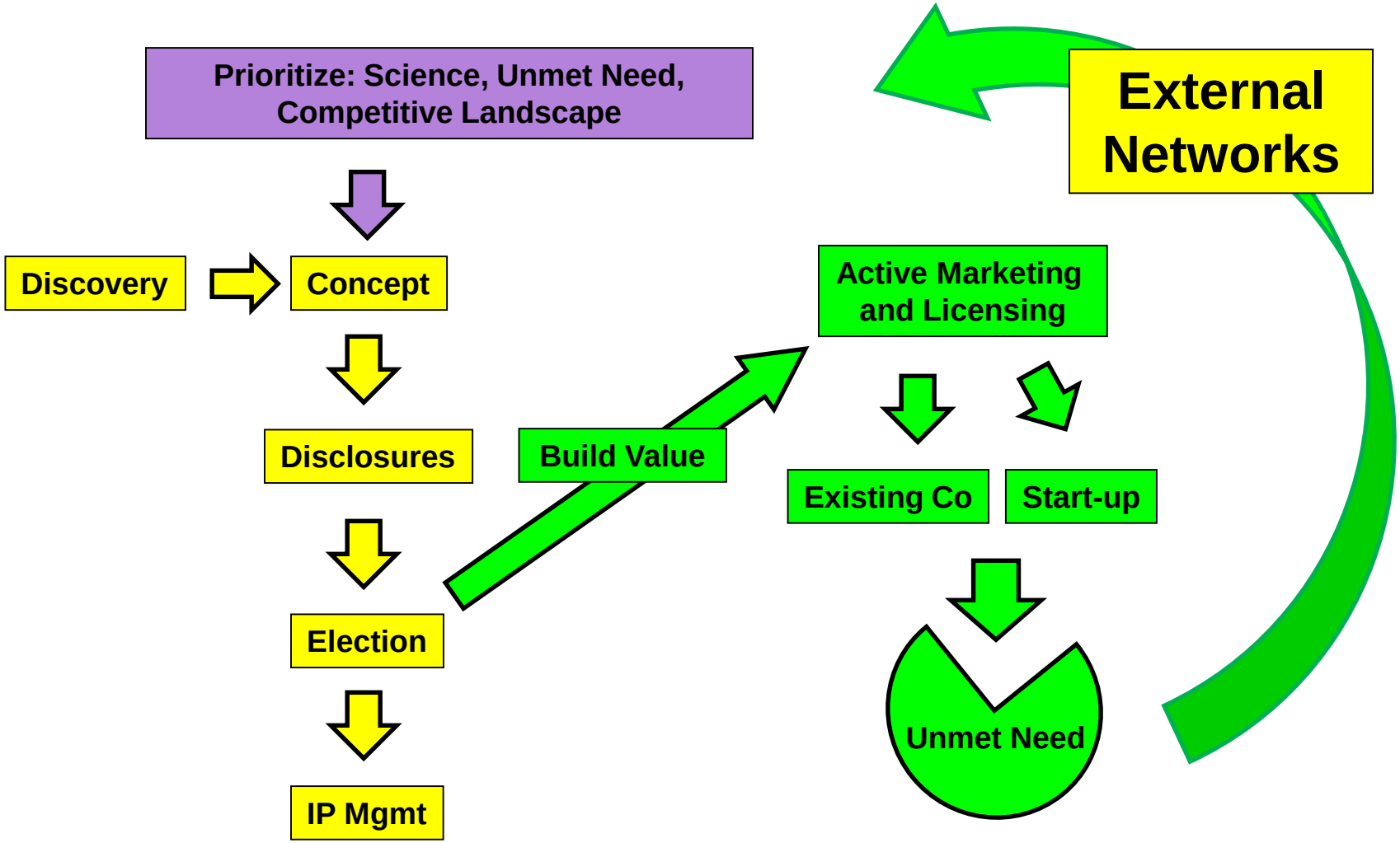
"Market" perspective pulls basic research toward an application… Technological Research and Development



Commercial and Social Impact Trajectory



Early “market” input critical to success



Promoting Innovation, Adding Value

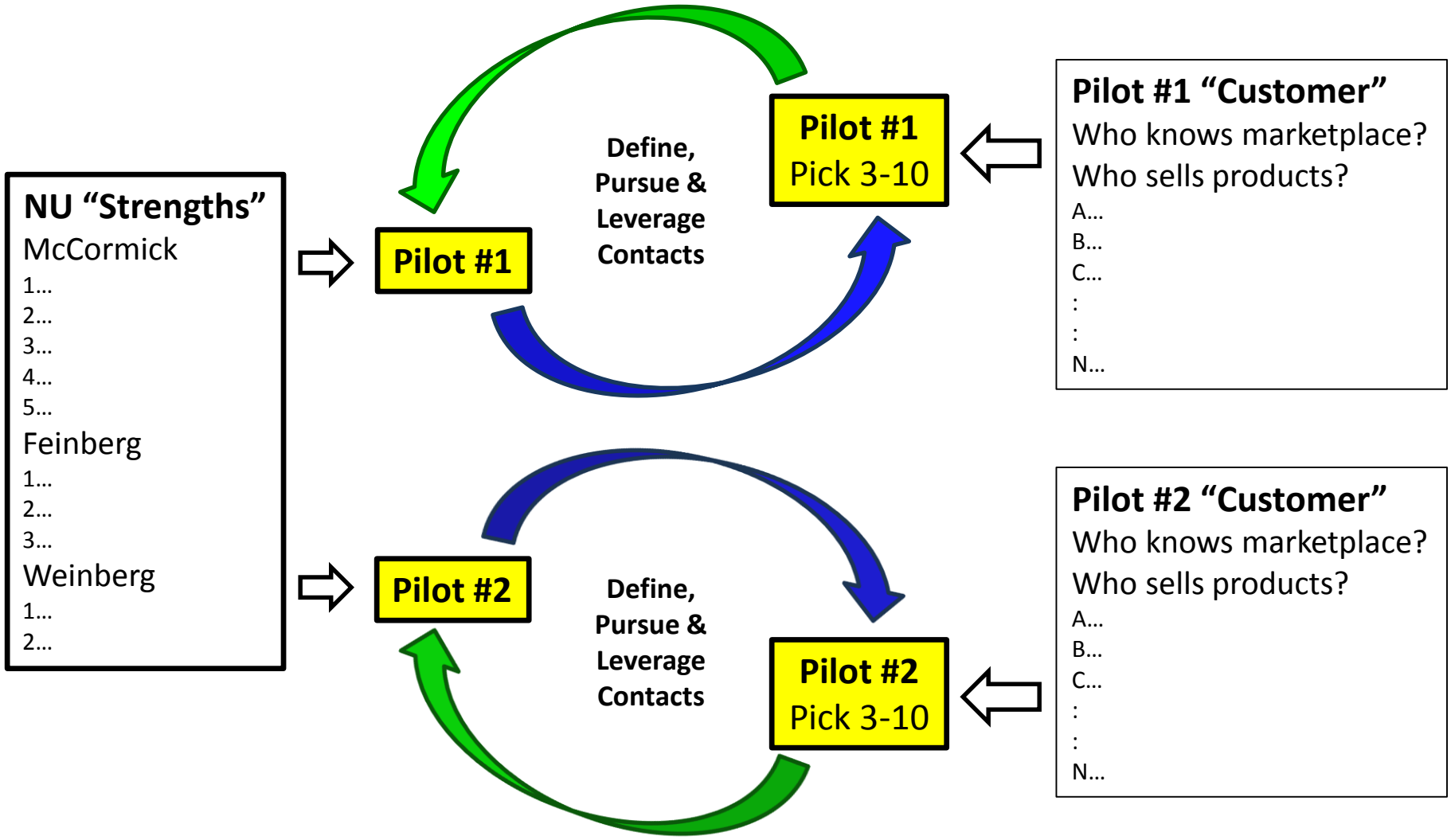
- Identify and help shape innovations: EIRs
  - Mike Janse, MBA: focused on McCormick

- Add value through Prototypes/Proof-of-Concept
  - Invention/Portfolio Management

    Maryam Saleh, Ph.D.: focused on devices

  - Access gap and non-dilutive start-up funding
- Launching Industry Initiative
  - Cross-campus coordination, consistency
  - Managing differences in corporate agreements
- Mentor entrepreneurs: Chicago Innovation Mentors

Industry Networking Pilot Projects



SESSION 3: KNOWLEDGE TRANSLATION IN P&O EDUCATION AND TRAINING

Speaker: **Denise Drane, PhD**
NU Searle Center for Teaching Excellence

Summary:
The objectives of this presentation were to discuss (1) factors that influence KT, (2) factors that can be modified by education and training, (3) and how we can construct learning environments to enhance KT.

Factors that influence KT include:

(1) Work context
(2) User characteristics (refer to page S3.6)
    a. Academic preparation in evidence based practice (EBP)
    b. EBP self-efficacy
    c. There is a divide between research and practice
    d. Literature and research findings are useful in daily practice
    e. Research participation
    f. Clinical instructor
(3) Accessibility of information
(4) Attitudes and beliefs about research, such as:
    a. Only scientists can understand science because it evolves through processes that differ from other intellectual activities.
    b. Science can only be accessed by scientists who may be slow to share their secrets with mortals.
    c. Researchers are not concerned with application and are less helpful than practicing clinicians.
    d. Research is separate from practice and outside the realm of helping improve techniques.
    e. Research is not important because it focuses on groups rather than individual cases.
(5) Social context of research and learning
    a. Learning has a social context
    b. Communities of practice
    c. Clinicians and researchers are generally separate communities

So, how can we create learning environments that enhance KT? This starts with promoting critical thinking. In other words, teaching students how to think rather than what to think. Bloom's Revised Taxonomy is a classification of levels of intellectual behavior important to learning. The six levels are remembering, understanding, applying, analyzing, evaluating, and creating (refer to page S3.13). To create learning environments that enhance KT, focus needs to be on higher level skills such as analyzing, evaluating, and creating (refer to page S3.14). This involves avoiding "cookbook" approaches and using inquiry-based approaches to teaching.

Another method for creating learning environments that enhance KT is to develop Communities of Practice that link researchers and clinicians. This can be accomplished by introducing students to the research community early in their education, even as early as the undergraduate level, through the practice of writing a research proposal. Building these relationships between researchers and future users is key to promoting exchange, synthesis, and ethically sound application of knowledge.

Knowledge Translation in P&O Education and Training

October 13th, 2012

Denise Drane PhD MPH
Associate Director
Searle Center for Teaching Excellence
Northwestern University

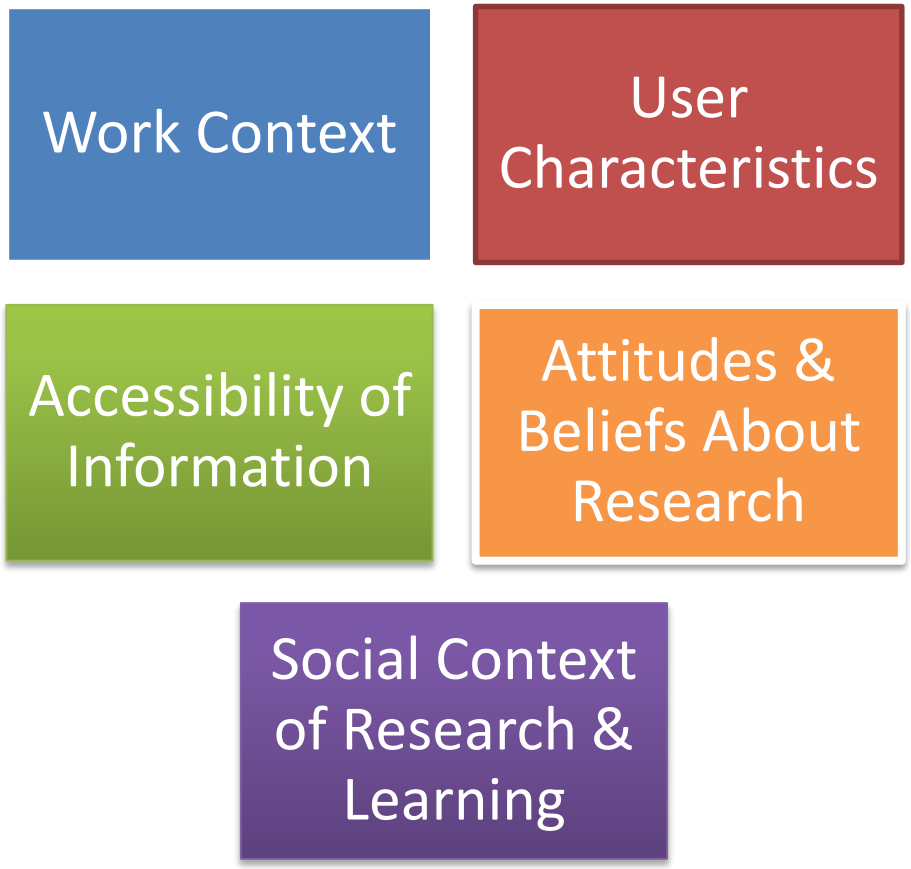
Outline

What factors influence knowledge translation?

Which ones can be modified by education and training?

How can we construct learning environments to enhance knowledge translation?

Factors Influencing Knowledge Translation



Factors Influencing Knowledge Translation

Characteristics of Research Users

Characteristic	Odds ratio (95% CI)
Academic preparation in evidence based practice (EPB)	**4.0 (1.3-12.7)**
EBP self efficacy	**3.9 (2.1-7.4)**
There is a divide between research & practice	**0.3 (0.1-0.9)**
Literature and research findings are useful in daily practice	**12.6 (1.5-103.2)**
Research participation	**5.3 (2.2-13.9)**
Clinical Instructor	1.4 (0.6-3.5)

Salbach et al, 2010; physical therapists n=270

Attitudes & Beliefs About Research

- Only scientists can understand science because it evolves through processes that differ from other intellectual activities

- Science can be accessed only by scientists who may be "slow to share their secrets with mortals."

Black (1975)

Attitudes & Beliefs About Research cont.

- Researchers not concerned with application, and less helpful with people than practicing clinicians.

- Research is separate from practice and outside the realm of helping techniques

Casselman (1972); social workers

Attitudes & Beliefs About Research cont.

- Researchers not important because of its focus on groups rather than individual cases

Laskey (1972); rehab counselors

Social Context of Research & Learning

Learning has a social context

Communities of practice

Clinicians and researchers are generally separate communities

How can we create learning environments to enhance knowledge translation?

Promote Critical Thinking

"We should be teaching students *how* to think. Instead, we are teaching them *what* to think."

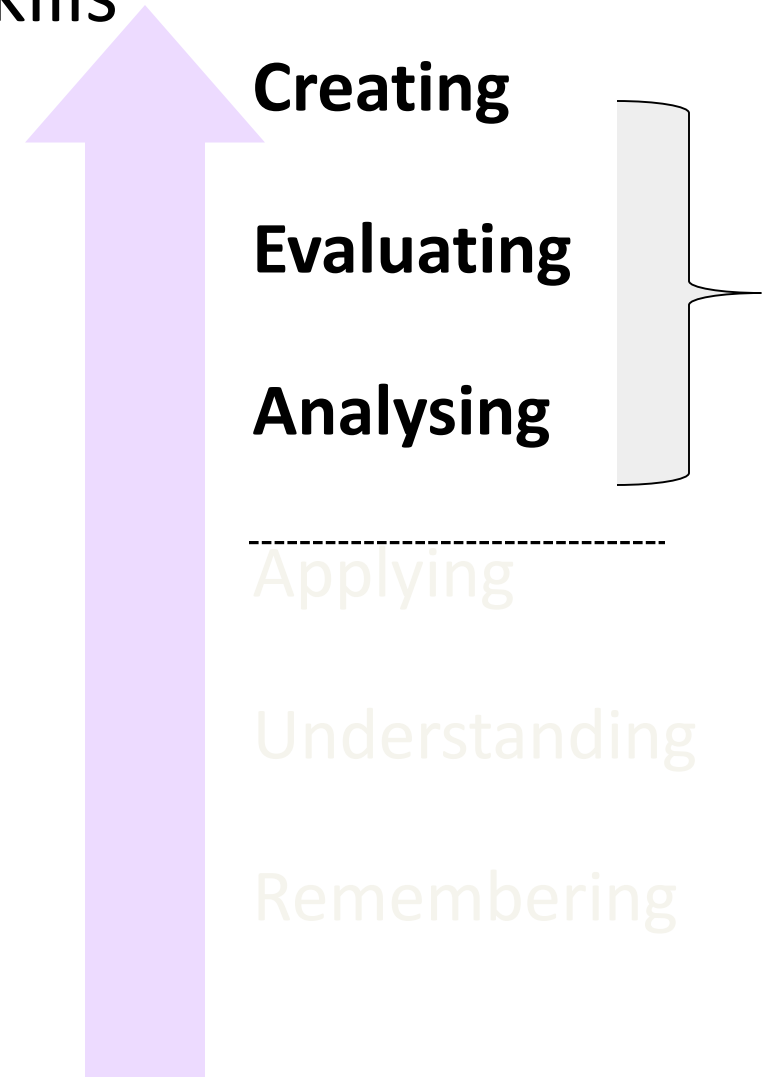
— Clement and Lochhead, 1980,
Cognitive Process Instrution

Bloom's Revised Taxonomy

Creating	**Generating new ideas, products, or ways of viewing things** Designing, constructing, planning, producing, inventing
Evaluating	**Judging based on criteria** Experimenting, checking, hypothesizing, critiquing, justifying
Analyzing	**Breaking information into parts to explore relationships** Comparing, organizing, deconstructing, interrogating, finding
Applying	**Using information in another familiar situation** Implementing, carrying out, using, executing
Understanding	**Explaining ideas or concepts** Interpreting, summarizing, paraphrasing, classifying, explaining
Remembering	**Recalling information** Recognising, listing, describing, retrieving, naming, finding

Anderson & Krathwohl, 2001

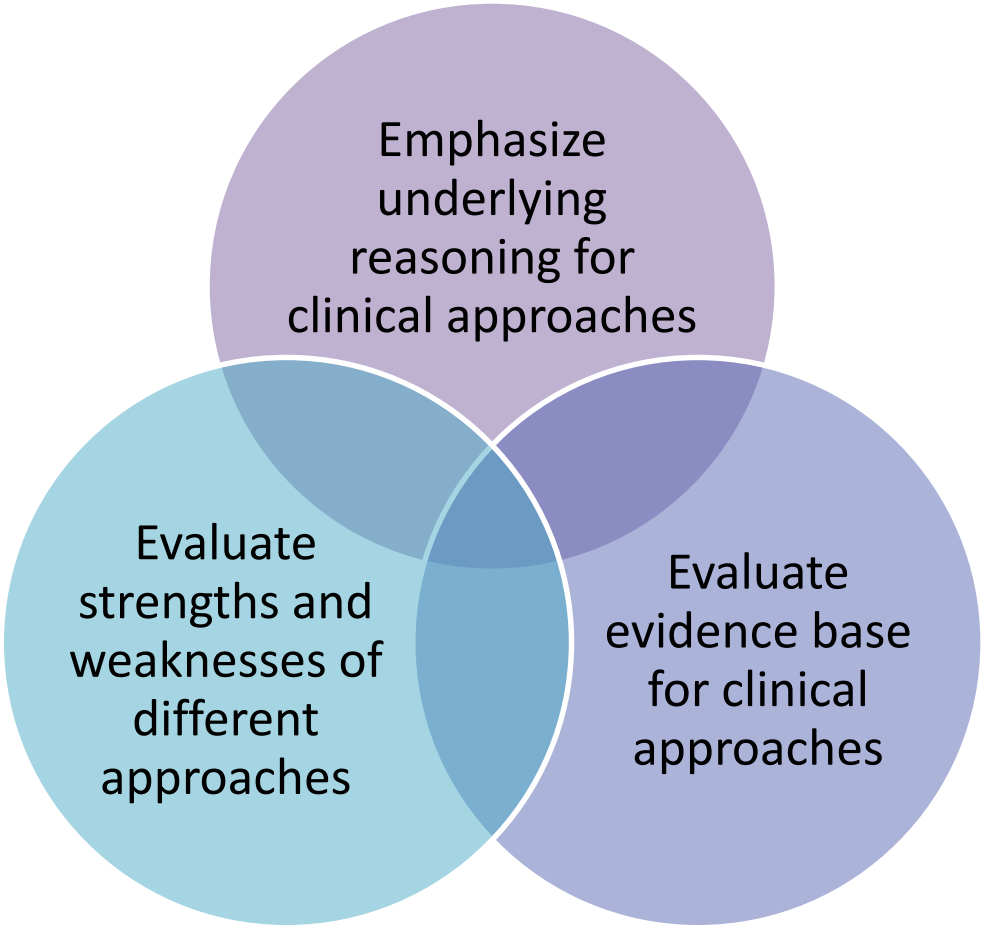
Bloom's Revised Taxonomy & Critical Thinking Skills



- Examine central issues and assumptions in an argument
- Evaluate multiple perspectives
- Recognize important relationships
- Make correct inferences from evidence
- Deduce conclusions from information or evidence
- Interpret viability of conclusions, using evidence
- Evaluate evidence or authority
- Look for--or create--new solutions
- Reframe problems, issues, questions

Potts, 1994; Tsui, 2006

Avoid “Cookbook” Approaches



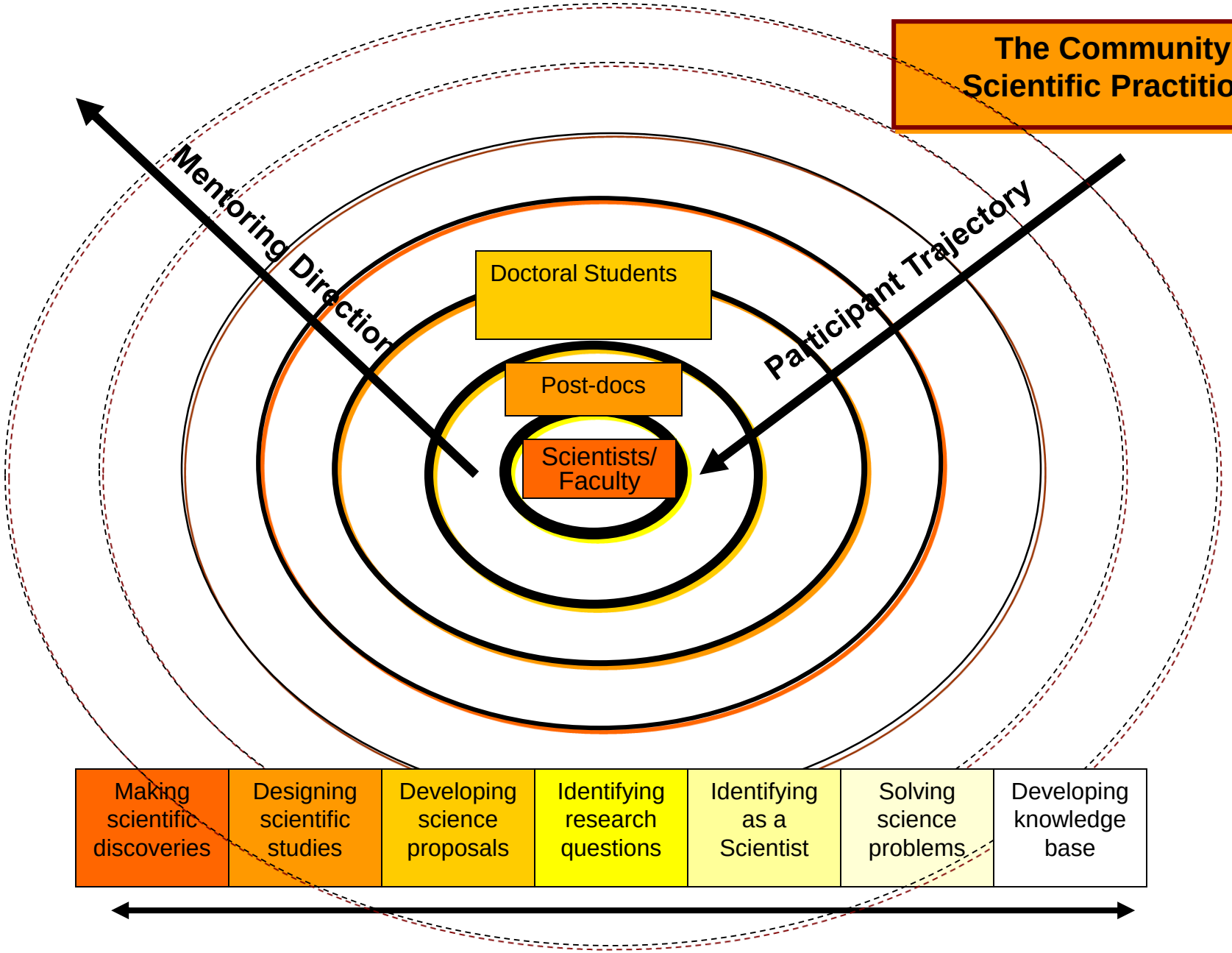
Use Inquiry Based Approaches

Students

- Generate and answer their own questions
- Make predictions
- Evaluate evidence

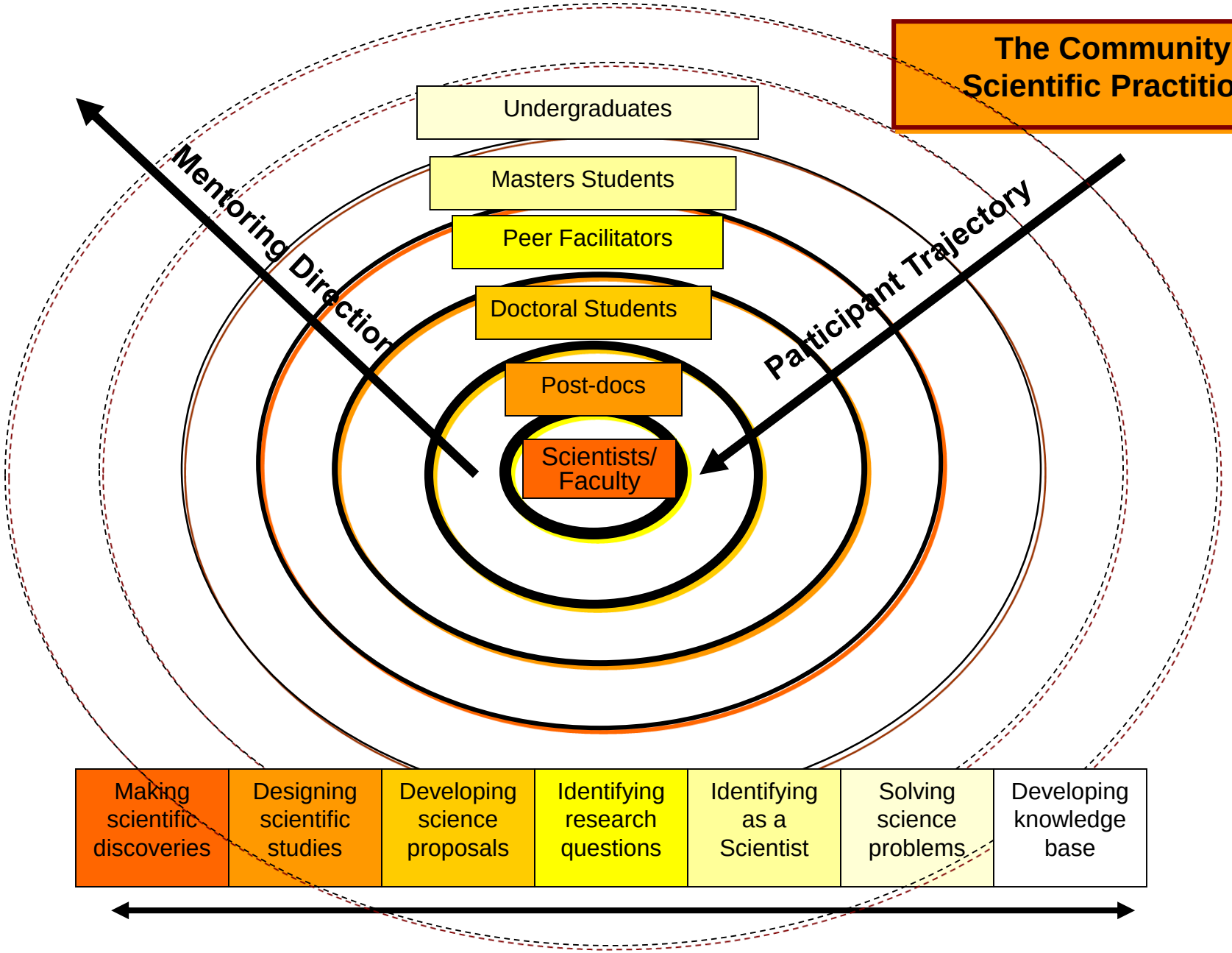
Develop Communities of Practice that Link Researchers and Clinicians

The Community of Scientific Practitioners



Adapted from Lave & Wenger (2000)

The Community of Scientific Practitioners



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Adapted from Lave & Wenger (2000)

Knowledge Translation

"exchange, synthesis and ethicallysound application of knowledge—within a complex system of interactions among researchers and users."

Canadian Institutes of Health Research (http://www.cihr-irsc.gc.ca/e/8505.html).

SESSION 4: NEED FOR KNOWLEDGE TRANSLATION IN P&O - PANEL DISCUSSION

Panelists: **Tom Doherty (representing manufacturers)**
Gerald Harris, PhD (representing researchers)
Walter Afable, CP (representing clinicians)
Chris Robinson, CPO, MBA, ATC, FAAOP (representing educators)
Facilitator: **R.J. Garrick, PhD**

Summary:
The key talking points provided in advance to the panel included:

(1) Why is KT important in the field of P&O?
(2) From your perspective, who are the primary stakeholders for KT efforts in P&O?
(3) What are the KT needs of these primary stakeholders?
(4) From your perspective, what can be done to facilitate KT efforts in P&O?

Tom Doherty, Central Region Business Manager for Ottobock US HealthCare, began by discussing the need for scientific knowledge. Demographic data are needed to understand the characteristics of specific groups. Published clinical research is useful as is published basic science. The Ottobock product cycle is an open ended cycle, accessible at any stage. Often an idea leads to a model, which then leads to a prototype that is then assessed in the lab and in clinical trials, and ultimately leads to a startup business. That startup business might then be purchased by a larger company. There is an inverse relationship between risk and acquisition cost, and company development cost. Many of Ottobock's products were initially developed by others, purchased by Ottobock, and then produced and marketed by Ottobock. So, where is the fit between developer and company? A developer will come to an existing business with an idea, while a company develops strategies, seeking practitioner input. The match is the shared goal of both sides.

Gerald Harris, director of the RERC on Technologies for Children with Orthopedic Disabilities, explained that their goal is *"national impact on researchers and healthcare providers through research findings and the evolution of improved assessment and evidence based evaluation tools."* Currently their RERC is working on 7 research projects, 4 development projects, and training and dissemination projects. In particular, their projects focus on cerebral palsy, clubfoot, and osteogenesis imperfecta. Dr. Harris described several of their outputs as examples.

Walter Afable, Clinical Operations Manager of the Prosthetics & Orthotics Clinical Center, Wheelchair & Seating Center, and Rehabilitation Engineering at the Rehabilitation Institute of Chicago (RIC), provided general, anecdotal evidence concerning higher occurrences of audits and ongoing work to minimize exposure to audit risks in clinical practices. He explained that practitioners report they have no time to engage in EBP and that the tools available present perceived challenges and obstacles. The question is then, how do we create the time, access to resources, and opportunities for access? The practice manager must demonstrate the potential for positive impact to the bottom line of the business and justify the need for EBP. It is also important to identify who the knowledge seekers are and work with them to develop the competencies necessary to participate in EBP.

Christopher Robinson, Assistant Professor of Physical Medicine and Rehabilitation at Northwestern University, explained that while the profession has made great strides in the volume and quality of research being disseminated in scholarly literature and scientific meetings, students (clinicians) are not necessarily in tune with research results coming out of the lab since most research is published in peer-reviewed journals. NUPOC will implement a new forum with the start of the MPO program that will better prepare and train students to conduct and actively engage in research. In addition, references and published research will be integrated into the manuals so students will be engaging in EBP. This will help close the information loop and help students understand that *"without evidence, everything we do is irrelevant."*

During the ensuing question and answer session, Dr. Wu explained that convincing clinicians to change how they practice takes time and persistence, using the example that it took two years for the removable rigid dressing (RRD) to *"go across the street"* to RIC. Dr. Wu expressed his belief that a non-governmental organization could be very helpful in bridging the gap between development projects and clinical practice for projects focused on technologies for developing countries. Walter Afable pointed out that although the RRD was slow to be adopted by RIC, it remains the standard of practice at RIC.

Laura Miller suggested that students contact the editorial board of journals for which they have read articles and volunteer to be a reviewer. This would provide an opportunity for students to include the clinical perspective in all articles, which is something that is lacking in some articles written by non-clinicians.

Christopher Robinson stated that educators need to ensure they instill a desire for research in their students. He noted that Certified Orthotists and Prosthetists are not commonly listed as authors, but this trend has been reversing in recent years. Dulcey Lima asked if anything in the certification process mandates continuing education in clinical practice such as journal clubs. She believes monitoring could increase participation. Christopher replied the American Board for Certification in Prosthetics, Orthotics and Pedorthics (ABC) has no set criteria; however, some practices, especially those with residents, emphasize participation in journal clubs and case study discussions. Tom Doherty stated that the more progressive practices conduct journal clubs and case study discussions to take the burden off the individual practitioners. Gerald Harris pointed out that the residency program is a great way to increase the publication of clinically-oriented articles. Stefania Fatone pointed out that many residencies are located in disparate environments, so resources and support vary dramatically between residency sites. Christopher Robinson pointed out that the National Center on Orthotic and Prosthetic Education (NCOPE) directs students to choose between a research and a clinical track, with the clinical track allowing students to engage in new ways, such as discussing case studies, at their practices. As a former small practice owner, Don McGovern stated that staying in business and getting reimbursed are important concerns of business owners, so incorporating research often falls by the wayside. He also mentioned that when it comes to training students, we cannot emphasize research at the cost of clinical skills.

SESSION 5: CHALLENGES TO KNOWLEDGE TRANSLATION IN P&O

Speaker: **John Michael, CPO, MEd, FAAOP, FISPO**
Assistant Director, Northwestern University Prosthetics-Orthotics Center (NUPOC)

Summary:
When it comes to challenges to KT in P&O, there is a common theme of facilitating a change in behavior in a particular audience. In general, there needs to be a change in the behavior of the target audience; research and technology confusion needs to be reduced and eliminated; and solutions to the challenges to KT in P&O need to be found and applied.

The target audience is P&O clinicians. In the clinical world, every patient is a special case. CPOs are pragmatic clinicians who reduce real world impact of disability on individuals from a variety of orphan populations by integrating commercially available technology into one-of-a-kind prototypes. In other words, clinicians integrate knowledge of products to benefit each individual within real-world constraints.

Researchers seek knowledge, however the process is slow and incremental. Development projects apply the results of research to solve problems, usually by feasibility studies and the creation of prototypes. Many believe most R&D results are not practical. Product development synthesizes Research and R&D into an affordable, useful, and practical reality. To achieve effective results, each stage is rigorous.

Currently there are four issues in knowledge management, each with a proposed solution. At this point in time efforts are being made to work on issues 1-3 (refer to page S5.8).

(1) Volume of applicable research
    a. Solution: Systematic reviews, Clinically Appraised Topics, and Evidence Notes
(2) Difficulty accessing research publications
    a. Solution: Public access to electronic publications
(3) Limited skill in appraising research evidence
    a. Solution: Critical assessment/research literacy training
(4) Lack of time for dense reading
    a. Solution: Increased guilt

In addition to issues in knowledge management, there are knowledge to action barriers that still need solutions (refer to page S5.9).

(1) Structural (financial disincentives)
(2) Organizational (lack of facilities)
(3) Peer barriers (local customs for care)
(4) Professional barriers (attitudes)
(5) Patient interaction (communication)

As we work to find solutions, it is important to identify knowledge brokers. Passive KT strategies, such as peer reviewed articles and web-based summaries, increase awareness of outcome measures but do not increase use. We can learn from the physical therapy field. They are active and their multicomponent interventions improve EBP and behaviors. We need to capitalize on the fact that P&O practice is heavily influenced by peer leaders' experiences.

Following the presentation, Walter Afable asked, how do you identify knowledge brokers? Ingrid Masterton responded that the broker has to be someone in whom others are invested. It is important to identify a person in each location as a peer leader and foster in those peer leaders a need to know. Stefania Fatone stated that we not only need to identify them, but also incentivize them. John Michael stated that changing behavior is an active process: fitting a person with a device to learn a method is more effective than listening to a lecture. Sustained practice is also important and is more effective than one time experiences.

Challenges to KT in P&O

John W. Michael, MEd, L/CPO
Fellow, ISPO & AAOP
Associate Director, NUPOC

Challenges to KT in P&O

1. Target Audience: Clinical CPO
2. Research & Technology Confusion
3. Challenges to KT in P&O
4. Potential Solutions?

Target Audience:

Craig Taylor (1954)

“Prosthetics {& orthotics} involves, to a unique degree, a combination of science and technology with the practical arts. Every amputee {person with a disability} is to some extent a special case.”

Target Audience:

- **~5000 Certified practitioners in USA**
- **2003: 8 accredited educational programs**
  - **21 FT faculty**
  - **2 Doctoral level**
  - **8 Masters level**
  - **11 Bachelors level**
- **CPOs are pragmatic clinicians who:**
  - **Reduce the real world impact of disability on individuals**
  - **From a variety of orphan populations**
  - **By integrating commercially available technology**
  - **Into one-of-a kind prototypes**
- **Key clinical skill = Integration of knowledge with products to benefit each individual within real-world constraints**

Research & Tech Confusion:

Charles Pritham, CPO (1994)

- ***Research*** **seeks knowledge, in slow & incremental steps that often simple verify clinical experience**
- ***Research & Development*** **uses the results of *Research* to solve problems, usually by feasibility studies and creation of prototypes. "Most R&D results are not practical."**
- ***Product Development*** **synthesizes Research & R&D into an "affordable, useful & practical reality".**

To achieve effective results, each stage is rigorous!

Challenges to KT in P&O:

Knowledge Management

1. **Volume of applicable research**
2. **Difficulty accessing research publications**
3. **Limited skill in appraising research evidence**
4. **Lack of time for dense reading**

Knowledge to Action Barriers

1. **Structural [financial disincentives]**
2. **Organizational [lack of facilities]**
3. **Peer Barriers [local customs for care]**
4. **Professional barriers [attitudes]**
5. **Patient interaction [communication]**

Possible Solutions:

Knowledge Management

1. **Volume of applicable research**
   - Systematic reviews, CATS and Evidence Notes
2. **Difficulty accessing research publications**
   - Public access to electronic publications
3. **Limited skill in appraising research evidence**
   - Critical assessment/research literacy training
4. **Lack of time for dense reading**
   - Increased guilt

Possible Solutions:

<u>Knowledge to Action Barriers</u>

1. **Structural [financial disincentives]**
   Increased guilt
2. **Organizational [lack of facilities]**
   Increased guilt
3. **Peer Barriers [local customs for care]**
   Increased guilt
4. **Professional barriers [attitudes]**
   Increased guilt
5. **Patient interaction [communication]**
   Increased guilt

Knowledge Brokers:

- **Passive KT strategies such as peer reviewed articles and web-based summaries increase awareness of outcome measures but did not increase use.**
- **Active, multicomponent interventions improve evidence-based knowledge and behaviors in PTs**
- **Since P&O practice is heavily influenced by peer leader's reported clinical experiences, could this be a fruitful approach tailored to this audience?**

SESSION 6: FINDING SOLUTIONS TO KT IN P&O - SMALL GROUP DISCUSSIONS

Small Group Assignments:

Group	A	B	C	D	E
Location	Smart Room	2nd Classroom	Conference Room	Student Lounge	Cafe
Facilitator	Kiki Zissimopoulos, MS	Oluseeni Komolafe, PhD	Rebecca Stine, MS	Matty Major, PhD	Erin Boutwell, MS
Participants	Brigid Driscoll, CO	Elizabeth Halsne, CO	Shenan Hoppe-Ludwig, CO	Dulcey Lima, CO	Donald McGovern, CPO, FAAOP
	Laura Miller, PhD	Terry Supan, CPO, FAAOP, FISPO	Linda Ehrlich-Jones, PhD, RN	Walter Afable, CP	Jose Luis Zavaleta
	John Brinkmann, CPO/L, MA, FAAOP	Ingrid Masterton, MPT	Christopher Robinson, CPO/L, MBA, ATC, FAAOP	Desmond Masterton, CO, CPed, MS	John W Michael, MEd, CPO/L, FAAOP, FISPO
	Jerry Harris, PhD, PE	Yeongchi Wu, MD	Tom Doherty	Craig Heckathorne, MSc	Jennifer L Flagg, MBA
	Stefania Fatone, PhD	Steven Gard, PhD	Denise Drane, PhD	David Tiemeier, PhD	RJ Garrick, PhD

Objectives of the Small Group Discussion:
Having learned about KT with respect to both research and technology and identified some of the challenges and barriers to KT in P&O, take half hour as a small group to brainstorm solutions to KT in P&O. Please transcribe/record the ideas generated. Before reconvening as a large group, identify at least three ideas to share with everyone.

Questions for Discussion:

- What KT activities have you observed/experienced? What mechanisms work well? Why? For whom?
- What do P&O stakeholders want/need with regard to KT?
- What do you think are the solutions to the challenges/barriers in KT? Are you aware of other barriers/challenges to KT and how would you suggest they be resolved?

Group A (reported by John Brinkmann):

(1) Online audio/PowerPoint Combos
   a. Online learning center with certificates for participation
   b. Have the author/researcher involved and offer insight
(2) Residency based methods
   a. EBP monthly meetings
   b. Journal Club
   c. Add content to NUPOC blended learning Blackboard [or Canvas] site even after graduation
   d. Workshops for sale
(3) Interfacing with insurers
   a. Claims are often decided by people unfamiliar with the field. Educate case managers so informed decisions can be made.

Group B (reported by Beth Halsne):

(1) Generalized topics
   a. Involve all stakeholders early on
   b. Researchers should inform practice with clinical content by disseminating via different avenues. One way to achieve this is to produce different versions of manuscripts (less intimidating).
   c. Re-education of already trained practitioners
      i. Use new graduates to help educate current practitioners

Group C (reported by Christopher Robinson)

(1) Content should be delivered in an interactive and multi-sensory manner.
(2) Make research important
    a. Implement change in 5-10% increments of time and do not try to do too much too soon
    b. SMART – simple, measureable, achievable, realistic, and timely
(3) Go higher up and work with administration
(4) Improve communication between clinicians and researchers
    a. Make research accessible
    b. Make information flow both ways
        i. Clinicians should also be informing researchers
        ii. It is difficult for that conversation to occur

Group D (reported by Desmond Masterton)

(1) Students have access to Elaine Owen for ankle-foot orthosis tuning. We can have students read the article, provide direct access to the author, and incorporate information into patient model encounters so that students are engaging in EBP in a low-risk environment.
(2) Currently KT is in a vacuum or is out of context. We need to make it real.
    a. Journals are written backwards for clinicians
    b. We need to use the Internet to get information out
(3) Lack of interaction among clinicians
    a. Inability to connect with others, especially with those with expertise
    b. Learning is social
(4) Currently there is a bottom up influence: Parents force treatment.

Group E (reported by John Michael)

(1) Effective online education
    a. Khan Academy
        i. 10 minutes maximum
        ii. Single focused topic
        iii. Ability to fast forward or slow down vs. live lecture
        iv. Allows more flexibility; available 24/7
    b. Look at knowledge management literature from other fields
        i. Physical Medicine residents have special sites they access and run themselves. Can we do the same?
    c. Accessibility?
        i. Online Learning Center is hard to navigate; re-organize info
            1. Flow of Information: researchers → practitioners → users
            2. Have different tabs for different users
        ii. Share links between organizations
        iii. Make use of social media
        iv. Open source journals
        v. How to bring traffic to a website: Google key words
(2) Influence senior managers
    a. Show practice advantages
        i. Use technology, such as videos, to improve clinical experience (video analysis)
        ii. Use more effective and time efficient methods
(3) Reach a wider audience
    a. Different generations learn differently
        i. Target younger generations as opposed to older
    b. International exposure?

SESSION 7: DISSEMINATING, TRACKING AND EVALUATING NEW KNOWLEDGE IN P&O

Speaker: **Jennifer Flagg, MBA**
NIDRR Disability Rehabilitation Research Program (DRRP) KT4TT

Summary:
The three Knowledge Transfer tools are (1) Need to Knowledge (NtK Model), (2) Knowledge Value Mapping (KVM), and (3) Level of Knowledge Use Survey (LOKUS).

The NtK Model is relevant to government sponsors and grantees of Research and Development projects, which are expected to create technology-based innovations capable of generating beneficial socio-economic impacts and do so in the near term future (refer to page S7.4). NtK Model assumptions include (1) socio-economic impacts start with a validated need, recognized by stakeholders, and addressed through delivery of innovations via market mechanisms, (2) the industry is the customer for R&D outputs, (3) the three different methods create knowledge outputs in three different states, each with unique value (refer to page S7.5), and (4) the decision to implement knowledge rests with recipient stakeholders and not with the producers.

The goal of the KVM questionnaire is to determine how to reach target audiences efficiently and effectively. It explores six ways in which national organizations may interact with new knowledge generated through scientific research: (1) Creating Knowledge, (2) Identifying Knowledge, (3) Translating Knowledge, (4) Adapting Knowledge, (5) Communicating Knowledge, and (6) Using Knowledge (refer to page S7.16). The KVM results are communicated via electronic means, formal journals and conferences, and are used internally by national organizations. These national organizations use incentives to attract member attention, whether they use webcasts, Continuing Education Units (CEU), or certificates. For this reason, national organizations can serve as effective mediators, and translation and dissemination networks.

The LOKUS is a questionnaire for web-based self-reporting. Psychometric analysis shows LOKUS to be valid and reliable for measuring change in level of knowledge use. The survey itself has 4 Levels/5 Types: (1) Non-awareness, (2) Awareness, (3) Interest, and (4) Intended Use ← → Modified Use (refer to page S7.26). The results of the survey maps values of user categories that is useful for tailoring material to their needs and interests. It is important to ensure tailored information is available, to ensure information is easy to access, and to send reminders.

Key Points:

(1) NtK Model is useful for planning R&D projects when socio-economic impact is the goal.
(2) KVM provides insights regarding how to reach stakeholder groups.
(3) LOKUS can be used to determine uptake and use of new knowledge.
(4) Information about all tools and projects is available at http://kt4tt.buffalo.edu

Disseminating, Tracking and Evaluating New Knowledge in P&O

Jennifer L. Flagg

Center on Knowledge Translation for Technology Transfer

http://kt4tt.buffalo.edu

School of Public Health & Health Professions

University at Buffalo (SUNY)

Funded by NIDRR, US Department of Education, PR# H133A060028

S7.2

Three KT Tools

Need to Knowledge (NtK Model)

Knowledge Value Mapping (KVM)

Level Of Knowledge Use Survey (LOKUS)

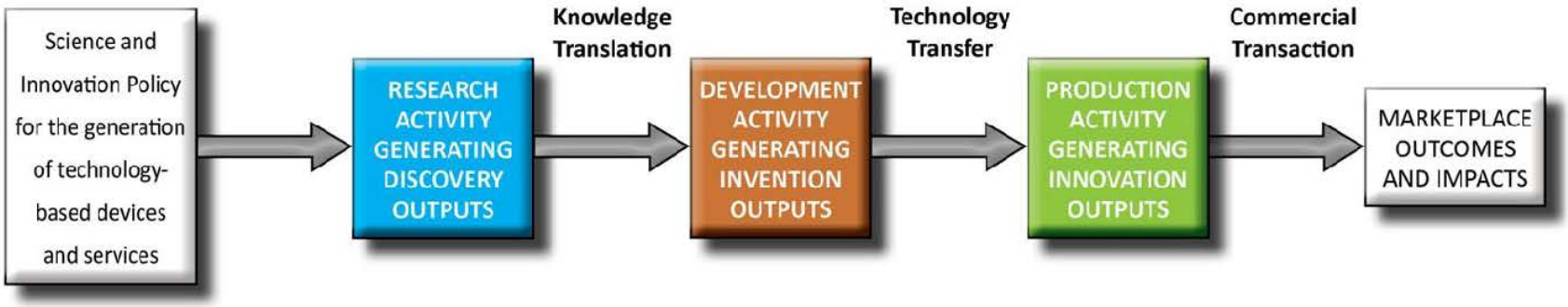
University at Buffalo
The State University of New York
CAT
NIDRR
NATIONAL INSTITUTE ON DISABILITY AND REHABILITATION RESEARCH

Focus of Need to Knowledge Model

The NtK Model **is** relevant to government sponsors and grantees of *Research & Development* projects which are expected to create technology-based *Innovations*, capable of generating beneficial socio-economic impacts, and do so in the near term future.

The NtK Model **is not** relevant to government sponsors or grantees of basic or inquiry-driven "R&D" projects, with no explicit intent to generate socio-economic impacts, nor expectations for application in any specific field or in any defined timeframe.

Three Methods & States



R&D for Innovation

- *Each Method has own rigor and jargon.*
- *Actors are trained and operate in one method and over-value that method.*
- *Academic & Government sectors dominate policy at expense of Industry.*
- *Methods are actually inter-dependent.*

NtK Model Assumptions

- Socio-economic impacts start with a validated need, recognized by stakeholders, addressed through delivery of innovations via market mechanisms.
- Industry is customer for R&D outputs due to ability to design & deploy market innovations in short term.
- Three different methods (R/D/P) create knowledge outputs in three different states (Discovery, Invention, Innovation), each with unique value.
- Decision to adopt/implement knowledge rests with recipient stakeholders ***not*** with the producers.

PDMA NPD Handbooks

Stage/Gate Structure

CIHR KTA Model

Scientific Method

Need to Knowledge (NtK) Model

Literature Review to Identify Supporting Evidence

Keyword Searches: **12,692 articles**

Inclusion Criteria Applied: **298 articles**

Review of Abstracts for Relevance: **212 articles**

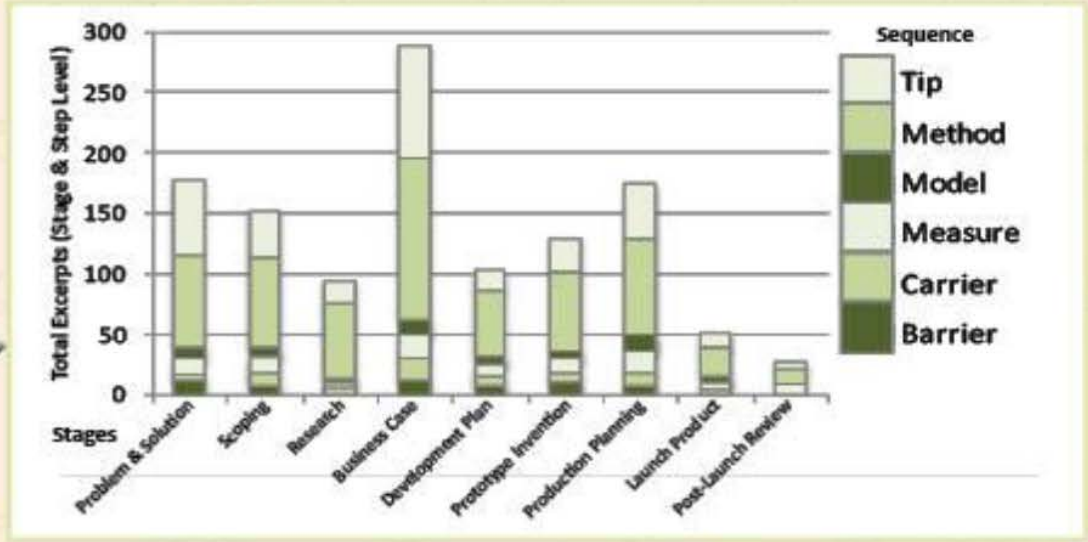
Review of Articles for Key Lessons: **1208 excerpts**

Information Gathered from Each Article

- Citation, Annotation, Potential User Groups
- Relevant work settings, Study methodology
- Excerpts classified by:
  - Placement within NtK model
  - Type of information: method, model, measure, barrier, carrier or tip
  - Primary Excerpts: Author's conclusions
  - Secondary Excerpts: Paraphrased conclusions from prior publications

NtK Model Components

- **3 Phases -** represent activities/decisions to generate outputs in three states
  - **9 Stages and 9 Gates** (537 excerpts)
  - **58 Steps** (674 excerpts)
  - **70 Tips** (71 excerpts)
- **3 KTA cycles** (264 excerpts) - stakeholder mechanisms for moving knowledge from one state to another



TOOLS
Embedded at Step level

RESOURCES
- Publications
- Tech Transfer Template
- Modules/Guides

CASE EXAMPLES
Embedded at Stage level

Knowledge Base

- Search for citations or excerpts
- Search by: Keyword, Knowledge User Group or Settings

In the past year, NtK Model Used/Noted by:

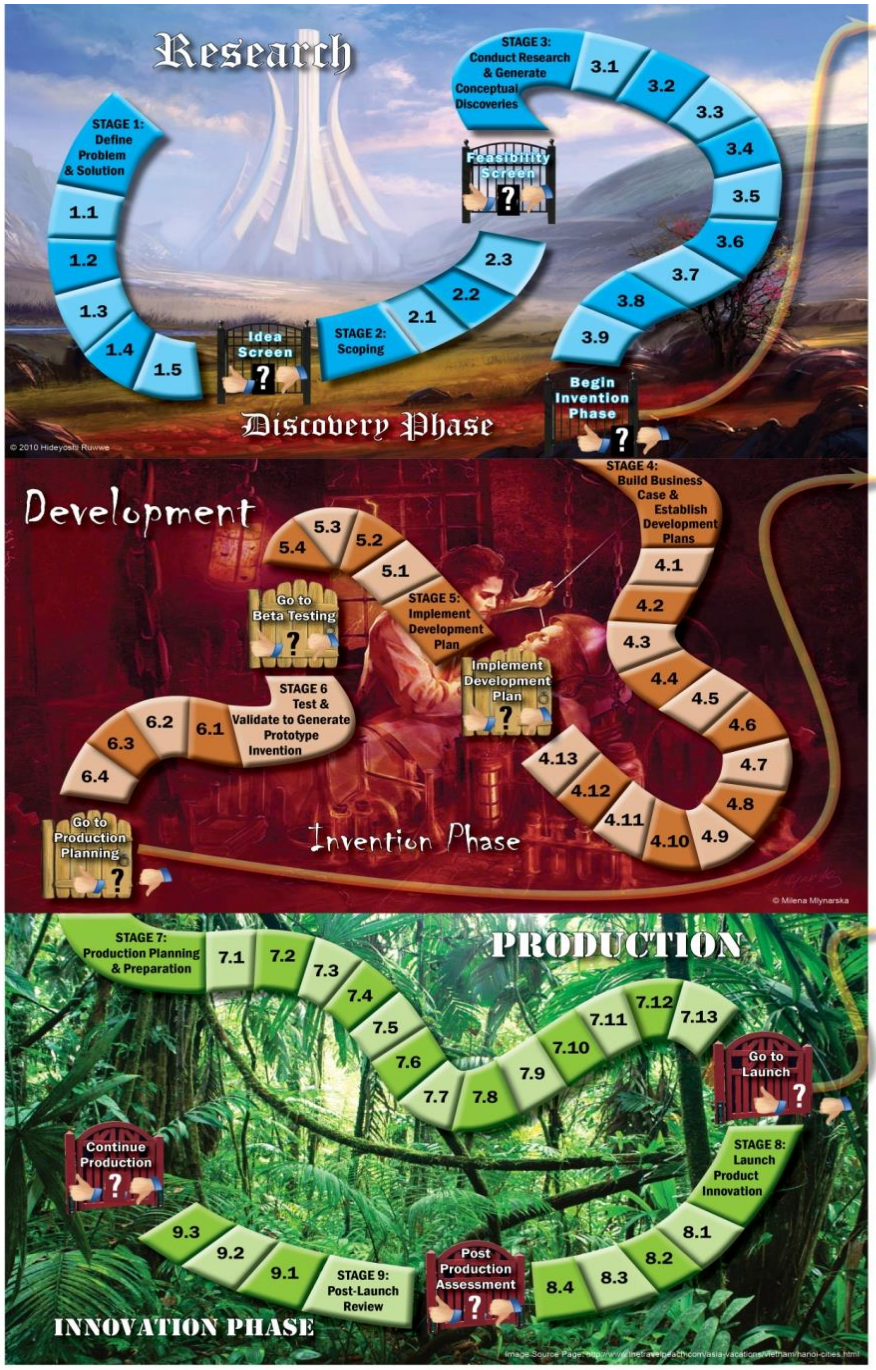
- PDMA - The Source
- Technology Transfer Tactics
- NIDRR Grantees
- AAATE, ATIA, CIHR

S7.8

Knowledge Translation
KT4TT
Technology Transfer

"Gamification" of Technological Innovation

Progress through three Methods of Knowledge Generation, and the effective Communication of three Knowledge States, may be circuitous and iterative, punctuated and prolonged, risky and unpredictable, yet still be planned, implemented and accomplished through the deliberate and systematic efforts of key stakeholders.



NtK Model Value

- **Technology Grantees:**
  - Proposal structure – Review Panel liked.
  - RERC Tech Transfer/ SBIR Phase II Plans.
- **Program Sponsors:**
  - Assess proposals; Track progress.
  - Compliance enforced – Funding continuation?
- **Organizations:**
  - PDMA's "The Source"; Tech Transfer Tactics;
  - CIHR; CEUD; DIT; ATIA; AAATE.

Knowledge Value Mapping Questionnaire

Reaching Target Audiences efficiently and effectively

University at Buffalo
The State University of New York
NIDRR
NATIONAL INSTITUTE ON DISABILITY AND REHABILITATION RESEARCH

New Requirements

- ***Sponsors & Grantees tasked with:***
  - **Communicating findings to non-traditional audiences.**
  - **Demonstrating evidence of knowledge use.**
- ***New unfunded mandates to:***
  - **Translate findings into appropriate language and formats.**
  - **Identify channels for communication.**

Rationale for KVM

- Reach diverse and non-traditional audiences.
- Communicate findings efficiently and effectively under current constraints.
- Employ broker organizations with appropriate membership.
- Understand how each values research to properly tailor message.

AT: Six Stakeholder Groups

- Researchers (Scientist & Engineer)
- Clinicians (Therapist/Educator/Counselor)
- Consumers (PWD & Family Member)
- Manufacturers (OEM & VAR)
- Policy Implementers (government/agency/ program administrator)?
- Brokers (attorney/employer/consultant)

Knowledge Value Mapping Study

- Multiple Comparative Case Studies
- National Organizations -AAC Stakeholders
  - ATIA – Manufacturers
  - ASHA – Clinicians
  - ISAAC – Consumers
  - AHEAD – Brokers
  - OSERS – Policy Implementers
  - RESNA – Cross-Stakeholder (Pilot)

The **KVM Questionnaire** explores six ways in which national organizations *may* interact with new knowledge generated through scientific research:

1) **Creating Knowledge:** Conducting research internally or funding others to do research for your organization;

2) Identifying Knowledge: searching for research findings that have already been produced by others;

3) Translating Knowledge: paraphrasing research findings to make them more relevant and understandable;

4) Adapting Knowledge: interpreting research findings to improve their fit within your organization's context;

5) Communicating Knowledge: disseminating or demonstrating research findings through various media;

6) Using Knowledge: applying research findings to situations within your organization or membership;

Question #1. Relative to other activities, how frequently does your organization engage in **Creating Knowledge** through Research activity? That is, conduct or perform your own research or pay/fund others to do research for you?

For what purpose are you conducting research or funding research performed by others?

Who conducts the research?

Who are the main intended users of the research knowledge your organization creates?

Probing Questions regarding KVM:

Question #7. Please describe any incentives that your organization uses to encourage your internal associates or members to become aware of, or apply new research-based knowledge.

Question #8. How does your organization measure the levels of awareness, interest or application of new knowledge among your memberships? What is being measured in each case?

Question #9. What percentage of your members have education/training in a research field equivalent to a Masters or Doctoral degree?

Question #10. Can you identify or suggest any ways in which researchers could help your organization facilitate the flow of knowledge from them as the sources, through your organization and out to your members?

KVM Results

- All surveyed national organizations seek, review and use research results internally.
- All communicate research via electronic means, while some use formal journal/conference outlets.
- Those with internal expertise adapt findings to context – but all respect author's original intent.
- All use incentives to attract member attention – webcasts, CEU's, certificates, content advisors.

National organizations can serve as effective mediators and translation/dissemination networks.

Ranking importance across various types of knowledge use

	Very Important	Important	Moderately important	Of little importance	Unimportant	Not applicable
To create or revise industry standards or clinical protocols is …	AHEAD ASHA OSERS RESNA	ATIA	ISAAC			
To build laboratory instruments or clinical tools is …	RESNA	ASHA OSERS		ATIA	ISAAC	AHEAD
To create freeware (hardware, software) for free download or access is …		OSERS	ISAAC	RESNA		ATIA AHEAD ASHA
Designing new or improved commercial devices or services is …	ATIA RESNA	ISAAC ASHA OSERS				AHEAD
For other purposes is … **–Promote the AT field** **–Inform policy or practice**		ATIA RESNA AHEAD				

KVM Results

Table 2 Target audiences for dissemination through national organizations

	National organization					
Audience	**ATIA**	**AHEAD**	**ISAAC**	**ASHA**	**OSERS**	**RESNA**
Clinicians and practitioners	X	X	X	X	X	X
Consumers and families	X		X	X	X	X
Policy makers	X	X		X	X	X
Educators and employers	X	X	X	X	X	
Manufacturers	X		X		X	X
Others	X				X	

KVM Results

- ***Recommendations for researchers***
  - **Increase engagement!**
  - **"Translate" from research jargon to practical terms**
  - **Explain the findngs and implications, and give them a call to action**
    - What? So what? Now what?
    - Distribution ready formats

LOKUS

- ***Level Of Knowledge Use Survey***
- No existing instrument fit study purpose.
- Created **LOKUS** Questionnaire for web-based self-report (VOVICI).
- Five Levels; each containing multiple types, dimensions and activities.
- Psychometric analysis shows **LOKUS** to be valid and reliable for measuring change in level of knowledge use.

Purpose of the KT intervention studies

Problem: Sub-optimal level of demonstrated impact from R&D investment, so OMB mandates Federal programs demonstrate evidence of uptake & use.

Solution: NIDRR selected Knowledge Translation as model and method to generate evidence.

Challenge: Identify KT best practice models that are :

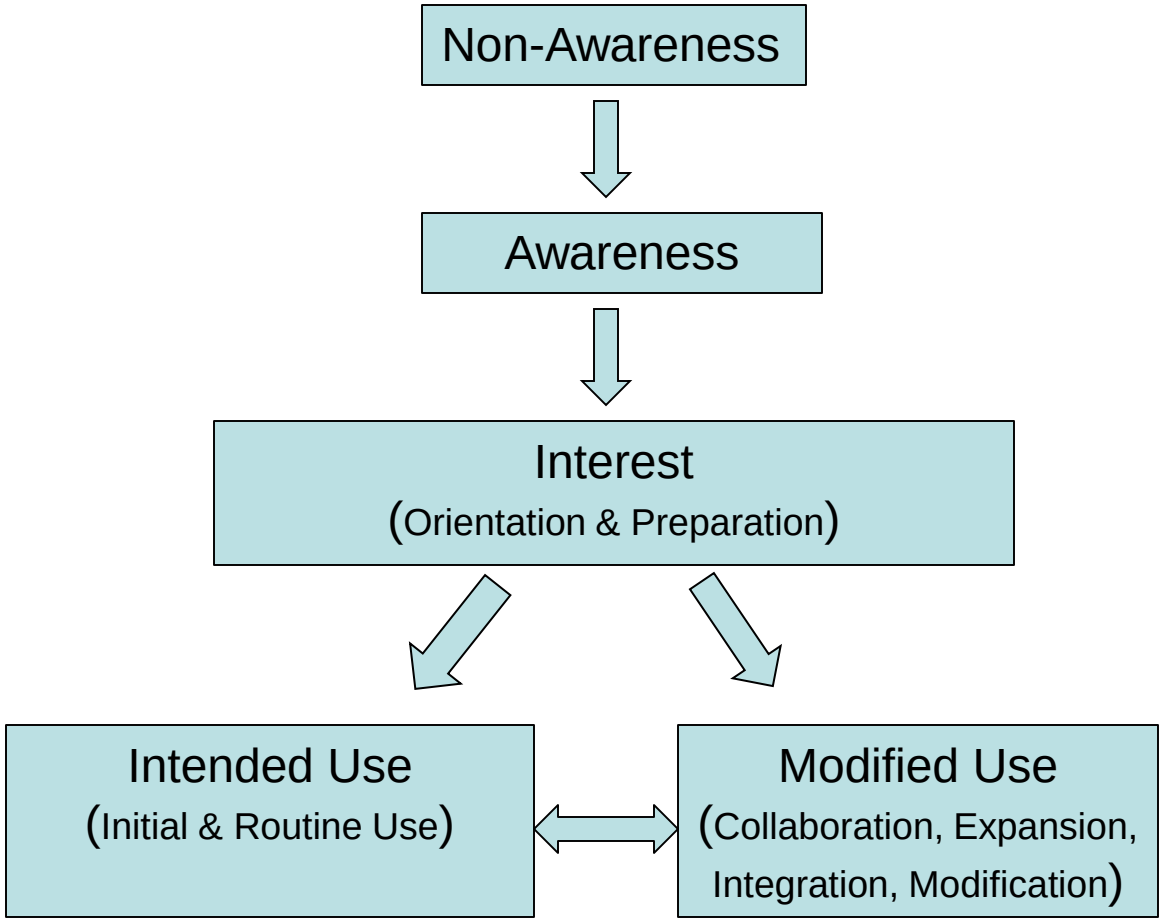
- Effective: increase K use by relevant stakeholders;
- Feasible : easy to implement; and
- Useful: K producers (technology grantees) can document evidence of impact from their project outputs

Purpose: Develop and evaluate KT intervention strategies that are feasible for use by technology R&D projects and effective in increasing use of new knowledge by potential users.

Relevance of LOKUS

- Sponsors & Grantees seeking to demonstrate evidence of knowledge use by stakeholders.
- Compare strategies for communicating knowledge.
- Differentiate between “Levels” of knowledge use:
  - Non-awareness to Awareness (Conceptual)
  - Awareness to Interest (Motivational)
  - Interest to Use (Action)
    - As intended As Modified
- Appropriate for All Stakeholders.

LOKUS Survey – 4 Levels/5 Types



Method

- ***Map values of user categories for tailoring material to their needs and interests.***
- ***Measure baseline awareness and use of all innovations among a sample of knowledge users from each of six categories.***
- ***Divide sample of user into three conditions: 1) Full KT intervention, 2) Standard KDU, 3) Control.***
- ***Measure post-intervention awareness and use of all innovations among sample.***

Research Design

		Baseline Assess-ment	Intervention Delivery (4 Mo.)	Follow/up Test 1	Intervention Delivery (4 Mo.)	Follow/ up Test 2
Five Stake-Holder Groups	T_1	O	X_{1a}	O	X_{1b}	O
Five Stake-Holder Groups	T_2	O	X_2	O		O
Five Stake-Holder Groups	C	O		O		O

Where T1 = group exposed to TTDK; T2 = group exposed to TDK; C = Control group; O = Observation (via LOKUS); X1a and X1b are components of TTDK method; & X2 = TDK method.

Knowledge Translation
KT4TT
Technology Transfer

KT Intervention Results
LOKUS Use Types 1 - 5

Treatment	Pre-Test Mean (S.D.)	Post 1 Mean (S.D.)	Post 2 Mean (S.D.)	Difference $\alpha \leq .05$ x^2 (p)	Post-hoc Test $\alpha \leq .0167$ Z (p)
T1 – KT (N = 72)	1.22 (.68)	1.79 (1.16)	1.69 (1.03)	22.632 (<.001)	Pre vs Post 1 3.826 (<.001) Pre vs Post 2 4.297 (<.001)
T2 – KD (N = 72)	1.26 (.77)	1.76 (1.19)	1.74 (1.16)	13.884 (.001)	Pre vs Post 1 3.330 (.001) Pre vs Post 2 3.206 (.001)
Control (N = 63)	1.38 (.97)	1.51 (1.05)	1.63 (1.22)	6.484 (.079)	

Conclusions

- T1 and T2 strategies effective.
- Generalizable?
- Can lead a horse to water, but…
  - When they are ready, they will sip~
    - Ensure tailored information is available
    - Ensure information is easy to access
    - Reminders!

Key Take Aways

- NtK Model useful for planning R&D projects when socio-economic impact is the goal.
- KVM provides insights regarding how to reach stakeholder groups.
- LOKUS can be used to determine uptake and use of new knowledge.

Information about all tools and projects available at: http://kt4tt.buffalo.edu

Questions?

ACKNOWLEDGEMENT

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APPENDIX B: PRE-MEETING SURVEY

RERC SOS Pre-meeting Survey

Research Survey

The Northwestern University Rehabilitation Engineering Research Center for Prosthetics and Orthotics, funded by the National Institute on Disability and Rehabilitation Research (NIDRR), is conducting this survey in preparation for a State of the Science Meeting to be held in 2012 at the Northwestern University Prosthetics-Orthotics Center (NUPOC).

The purpose of this survey is to investigate the opinions of the Prosthetics and Orthotics community regarding the direction that research in the field of Prosthetics and Orthotics should take over the next 5-10 years.

If you choose to participate in this survey, we will not collect any identifiable information about you. Your responses to this survey are totally anonymous.

The results of this survey will be compiled for discussion at the Northwestern University Rehabilitation Engineering Research Center for Prosthetics and Orthotics State of the Science Meeting to be held in 2012, and will be presented in a report as required by NIDRR, at professional meetings and publications.

It is hoped that the information gathered here will help guide future clinically relevant research in the field of Prosthetics and Orthotics.

We thank you for taking the time to complete this short survey.

RERC SOS Pre-meeting Survey

Demographics

Age:

- ◯ Under 20
- ◯ 20-29
- ◯ 30-39
- ◯ 40-49
- ◯ 50-59
- ◯ 60-69
- ◯ 70-79
- ◯ 80-89
- ◯ 90+

Gender:

- ◯ Female
- ◯ Male

Please indicate your association with the field of Prosthetics and Orthotics (may select more than one):

- ☐ Consumer
- ☐ Educator
- ☐ Engineer
- ☐ Family member or personal companion of consumer
- ☐ Orthotist
- ☐ Pedorthotist
- ☐ Physician
- ☐ Prosthetic/Orthotic Resident
- ☐ Prosthetic/Orthotic Student
- ☐ Prosthetist
- ☐ Researcher
- ☐ Therapist

Other (please specify)

Years of experience in the field of Prosthetics and Orthotics:

- ◯ 0-5
- ◯ 6-10
- ◯ 11-20
- ◯ 21-40
- ◯ 41+

RERC SOS Pre-meeting Survey

Resources

In order of importance, please rank the top 5 resources you use to guide you in your role in Prosthetics and Orthotics (number 1 through 5 with 1 being the most important):

Academic journals	
Clinical colleagues at hand	
Continuing education	
Employer resources	
Family members or personal companions	
Local clinical experts	
Local professional organizations	
Manufacturer publications	
National advocacy organizations	
National clinical experts	
National professional organizations	
Popular press	
Prosthesis and Orthosis users	
Prosthetic and Orthotic magazines	
Regional clinical experts	

Other:

RERC SOS Pre-meeting Survey

Do you conduct or participate in research in the field of…

Prosthetics?

- ◯ No
- ◯ Yes

If yes, indicate the percentage of time you devote to research:

Orthotics?

- ◯ No
- ◯ Yes

If yes, indicate the percentage of time you devote to research:

RERC SOS Pre-meeting Survey

Do you consider that a sufficient amount of research is being conducted in ...

Prosthetics?

◯ Yes ◯ No ◯ No Opinion

Orthotics?

◯ Yes ◯ No ◯ No Opinion

RERC SOS Pre-meeting Survey

Do you consider that the emphasis of current research is appropriate in…

Prosthetics?

◯ Yes ◯ No ◯ No Opinion

Orthotics?

◯ Yes ◯ No ◯ No Opinion

RERC SOS Pre-meeting Survey

Do you consider research to be important to the continued development of th...

Prosthetics?

◯ Yes ◯ No ◯ No Opinion

Orthotics?

◯ Yes ◯ No ◯ No Opinion

Have you identified areas where further research is needed, but you personally lack the ability or resources to carry out the research?

◯ Yes ◯ No

RERC SOS Pre-meeting Survey

Do you consider current research funding is too low & prevents more res...

Prosthetics?

◯ Yes ◯ No ◯ No Opinion

Orthotics?

◯ Yes ◯ No ◯ No Opinion

RERC SOS Pre-meeting Survey

Prosthetics Research (1)

In the order of importance for Prosthetics, please rank the top 5 areas where research should be directed (number 1 through 5 with 1 being the most important):

Ankle joints	
Control of prosthesis	
Elbow joints	
Fabrication	
Feet	
Gait Training	
Knee joints	
Liners	
Materials	
Microprocessor-controlled components	
Outcome measures	
Powered components	
Sensory feedback	
Shock absorbing components	
Shoulder joints	
Sockets/interface	
Suspension	
Terminal devices (e.g., hooks, hands)	
Wrist units	

Other:

.

No Opinion

RERC SOS Pre-meeting Survey

Prosthetics Research (2)

For Prosthetics, please place a check mark next to the 5 least important areas for research:

- [ ] Ankle joints
- [ ] Control of prosthesis
- [ ] Elbow joints
- [ ] Fabrication
- [ ] Feet
- [ ] Gait Training
- [ ] Knee joints
- [ ] Liners
- [ ] Materials
- [ ] Microprocessor-controlled components
- [ ] Outcome measures
- [ ] Powered components
- [ ] Sensory feedback
- [ ] Shock absorbing components
- [ ] Shoulder joints
- [ ] Sockets/interface
- [ ] Suspension
- [ ] Terminal devices
- [ ] Wrist units

Other (please specify)

- No Opinion

RERC SOS Pre-meeting Survey

Orthotics Research (1)

In the order of importance for Orthotics, please rank the top 5 areas where research should be directed (number 1 through 5 with 1 being most important):

Ankle-Foot Orthoses (ankle braces)	
Ankle joints/components	
Cranial Remolding Orthosis (remolding helmets)	
Fabrication	
Foot Orthoses (insoles)	
Gait Training	
Hip Orthoses	
Knee-Ankle-Foot Orthoses (long leg brace)	
Knee joints/components	
Materials	
Microprocessor-controlled components	
Outcome measures	
Powered components	
Reciprocating Gait Orthoses	
Spinal orthoses (back braces)	
Upper-limb orthoses (arm splints)	

Other:

.

○ No Opinion

RERC SOS Pre-meeting Survey

Orthotics Research (2)

For Orthotics, please place a check mark next to the 5 least important areas for research:

- [ ] Ankle-Foot Orthoses (ankle braces)
- [ ] Ankle joints/components
- [ ] Cranial Remolding Orthosis (remolding helmets)
- [ ] Fabrication
- [ ] Foot Orthoses (insoles)
- [ ] Gait Training
- [ ] Hip Orthoses
- [ ] Knee-Ankle-Foot Orthoses (long leg braces)
- [ ] Knee joints/components
- [ ] Materials
- [ ] Microprocessor-controlled components
- [ ] Outcome measures
- [ ] Powered components
- [ ] Reciprocating Gait Orthoses
- [ ] Spinal Orthoses (back braces)
- [ ] Upper-limb Orthoses (arm splints)
- [ ] No Opinion

Other (please specify)

-

○ No Opinion

RERC SOS Pre-meeting Survey

Prosthetic Processes

In the order of importance for Prosthetic processes, please rank the top 5 areas below where research should be directed (number 1 through 5 with 1 being most important):

Alignment procedures and tools	
Assessment of assembled devices	
Creating new patient assessment tools or guides	
Practice management in Prosthetics	
Software that assists clinicians or consumers in designing and documenting Prosthetic treatment plans	
Shape acquisition procedures	
Understanding of how current Prosthetic technology affects user performance	

▪

◯ No Opinion

RERC SOS Pre-meeting Survey

Orthotic Processes

In the order of importance for Orthotic processes, please rank the top 5 areas below where research should be directed (number 1 through 5 with 1 being most important):

Alignment procedures and tools	
Assessment of assembled devices	
Creating new patient assessment tools or guides	
Practice management in Orthotics	
Software that assists clinicians or consumers in designing and documenting Orthotic treatment plans	
Shape acquisition procedures	
Understanding of how current Orthotic technology affects user performance	

▪

◯ No Opinion

RERC SOS Pre-meeting Survey

Three most important questions

What do you consider to be the 3 most important questions to be addressed by Prosthetics research in the next five to ten years?

.

◯ No Opinion

What do you consider to be the 3 most important questions to be addressed by Orthotics research in the next five to ten years?

.

◯ No Opinion

RERC SOS Pre-meeting Survey

Based on your experience and knowledge of Orthotics and Prosthetics, please indicate your level of agreement with each of the statements below:

	Strongly Agree	Somewhat Agree	Neutral / No Opinion	Somewhat Disagree	Strongly Disagree
It is easier to fit a body-powered upper-limb prosthesis than an electronic system.	◯	◯	◯	◯	◯
Alignment procedures for lower limb prostheses are standardized and validated.	◯	◯	◯	◯	◯
Lower-limb orthoses are heavy.	◯	◯	◯	◯	◯
Ankle-foot orthoses improve gait biomechanics.	◯	◯	◯	◯	◯
Bench and static alignment are unrelated to the outcome of dynamic alignment.	◯	◯	◯	◯	◯
Current prosthetic technologies can provide abilities and functions that surpass those of able-bodied persons.	◯	◯	◯	◯	◯
Electronic upper-limb prostheses provide better function than body-powered prostheses.	◯	◯	◯	◯	◯
Lower-limb orthoses are cumbersome.	◯	◯	◯	◯	◯

Energy expenditure of walking is reduced by microprocessor-controlled knees compared to non-microprocessor-controlled knees.	◯	◯	◯	◯	◯
Persons with partial foot amputation have a better quality of life than persons with transtibial amputation.	◯	◯	◯	◯	◯
Prosthetic arms and hands exist that function and feel just like real ones.	◯	◯	◯	◯	◯
Shock-absorbing pylons reduce impact during level walking.	◯	◯	◯	◯	◯
The application of inelastic shoulder straps allows a thermoplastic thoraco-lumbo-sacral orthosis to control vertebral levels as superior as T4.	◯	◯	◯	◯	◯
The more expensive the device, the better it works.	◯	◯	◯	◯	◯
Thermoplastic thoraco-lumbo-sacral orthoses control the spine two vertebral levels inferior to the superior trimline and two vertebral levels superior to the inferior trimline.	◯	◯	◯	◯	◯
To wear a lower-limb orthosis,	◯	◯	◯	◯	◯

you always have to buy bigger shoes.					
Varying height in bilateral running prostheses can increase performance beyond that of able-bodied runners.	◯	◯	◯	◯	◯
Lower-limb prostheses are heavy.	◯	◯	◯	◯	◯
Ankle-foot orthoses improve balance and stability.	◯	◯	◯	◯	◯
Persons with partial foot amputation use less energy to walk than persons with transtibial amputation.	◯	◯	◯	◯	◯
Because ankle-foot-orthoses are routinely prescribed we do not need any more research about how they affect function.	◯	◯	◯	◯	◯

APPENDIX C: BACKGROUND READING MATERIALS

Knowledge Translation and Technology Transfer defined:
Lane JP (2010) Facilitating technology-based knowledge utilization. FOCUS Technical Brief (26). Austin, TX: SEDL, National Center for the Dissemination of Disability Research.

Stakeholders and Dissemination:
Lane JP & Rogers JD (2011) Knowledge value mapping of national organizations: A knowledge translation strategy to efficiently communicate research-based knowledge to multiple stakeholder audiences. FOCUS Technical Brief, (32). Austin, TX: SEDL, National Center for the Dissemination of Disability Research.

Tracking Knowledge Translation:
Lane JP (2012) Tracking evidence of knowledge use through knowledge translation, technology transfer, and commercial transactions. FOCUS Technical Brief (34). Austin, TX: SEDL, Disability Research to Practice Program.

Factors influencing Knowledge Translation in Prosthetics and Orthotics:
Andrysek J, et al. (2011) Factors influencing evidence-based practice in prosthetics and orthotics. Prosthetics and Orthotics International 35(1): 30-38.

Barriers to Knowledge Translation in Prosthetics and Orthotics:
Stevens P (2011) Barriers to the Implementation of Evidence-Based Practice in Orthotics and Prosthetics. Journal of Prosthetics and Orthotics 23(1): 34-39.

Outcome of Knowledge Translation Activities:
Hafner B & Geil M (2011) Dissemination of State-of-the-Science Conference Information to Orthotic and Prosthetic Practitioners. Journal of Prosthetics and Orthotics 23(1): 46-49.

State-of-the-Science Pre-Meeting Survey Results:
Schweitzer J & Fatone S (2012) The 2012 and 2006 NUPOC State of the Science Survey Results. Capabilities, 20(3):1-2.

APPENDIX D: AGENDA

NURERC State of the Science Meeting in Prosthetics & Orthotics 2012

October 13, 2012 (8:00 a.m. – 4:30 p.m.)

Spreading the Word: Promoting Clinically-Relevant Knowledge in P&O

Time	Session	Speaker
8:00 - 8:30	Continental Breakfast	
8:30 - 9:15	Greetings/Overview	Steven A. Gard, PhD Stefania Fatone, PhD, BPO(Hons)
9:15 - 9:45	Knowledge Translation (KT) across RERC Activities	Jennifer Flagg, MBA NIDRR DRRP KT4TT
9:45 - 10:15	KT of Development Efforts in P&O	David Tiemeier, PhD Innovation and New Ventures Office (NU INVO)
10:15 - 10:45	KT in P&O Education and Training	Denise Drane, PhD Searle Center for Teaching Excellence
10:45 - 11:15	Break	
11:15 - 12:30	Need for KT in P&O Panel Discussion: Need for KT in P&O Each Panelist speaks for 10-minutes; followed by interactive discussion with panelists and audience.	Panelists: Tom Doherty (representing manufacturers) Jerry Harris, PhD (representing researchers) Walter Afable, CP (representing clinicians) Chris Robinson, CPO, MBA, ATC, FAAOP (representing educators) Facilitator: R. J. Garrick, PhD
12:30 - 1:30	Lunch	
1:30 - 2:00	Challenges to KT in P&O	John Michael, CPO, MEd, FAAOP, FISPO
2:00 - 3:00	Small Group Dynamics: Finding Solutions to KT in P&O (What works? What does not work? What do P&O stakeholders want/need?)	Divide into 3 - 4 groups, each consisting of a Facilitator, Scribe (NUPOC graduate student or postdoc will take notes to PPT), Participants, and Presenter. Groups meet in Smart Room; 2nd Classroom; Conference Room; Student Lounge
3:00 - 3:15	Break	
3:15 - 3:45	Disseminating, Tracking and Evaluating New Knowledge in P&O	Jennifer Flagg, MBA NIDRR DRRP KT4TT
3:45 - 4:30	Summary and Closing	Steven A. Gard, PhD

APPENDIX E: SPEAKER BIOS

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NURERC 2012 State of the Science Meeting Speakers

[Alphabetical order by surname]

Walter Afable, CP

Rehabilitation Institute of Chicago
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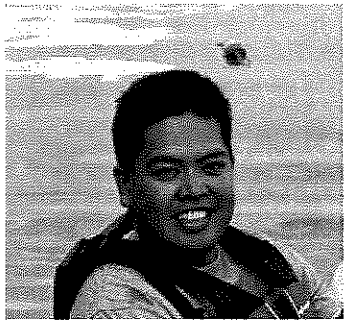

Walter Afable, CP, is an ABC Certified and Illinois Licensed Prosthetist and serves as the Clinical Operations Manager of the Prosthetics & Orthotics Clinical Center, Wheelchair & Seating Center, and Rehabilitation Engineering at the Rehabilitation Institute of Chicago, (RIC). His clinical interests include lower limb adult special-use prostheses. He holds a Bachelor of Science in biomedical engineering from Marquette University (Milwaukee); and received Prosthetic Technician and Prosthetic Practitioner certificates from Century College (White Bear Lake, MN). He completed his prosthetic residency with MD Labs (Chicago). Walter is also a graduate of the Blended Learning Program in Orthotics (BLP 4) at NUPOC. He worked at Dankmeyer, Inc. (Baltimore); and has served as an independent course consultant for Freedom Innovations. Currently, through the National Commission for Orthotic and Prosthetic Education (NCOPE), he serves on an Online Training for Residency Directors committee. He is a member of the American Academy of Orthotists and Prosthetists (AAOP) and serves on the board for its Midwest Chapter (MWCAAOP).

Tom Doherty

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Denise Drane, PhD

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Denise Drane, PhD, leads the Searle Center's research initiatives and oversees numerous in-house program evaluation projects. She holds a doctorate in Speech and Language Pathology from Northwestern University and a Master's degree in Public Health from the University of Sydney. Denise joined the Searle Center in January 2001 and helped to design the evaluation strategy for GSW.

Stefania Fatone, PhD, BPO(Hons)

Principal Investigator, Prosthetist/Orthotist
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Stefania Fatone, PhD, BPO(Hons), is Research Associate Professor in the Department of Physical Medicine and Rehabilitation in the Northwestern University Feinberg School of Medicine. She received her Bachelor of Prosthetics and Orthotics (Honours) degree (1995) followed by her PhD (2001) from La Trobe University, Australia. A post-doctoral fellowship brought her to Northwestern University in 2000 after which she transitioned to a faculty position in 2003. Stefania is one of a small cadre of qualified prosthetist/orthotists with a PhD. She has published over 30 peer-reviewed articles, editorials, and book chapters in the last decade on the effects of prosthetic and orthotic devices on gait and function; the role of the spine in standing and walking; and clinical outcome measures for prosthetic and orthotic practice. Currently, she leads multiple research and development projects at the Northwestern University Prosthetics-Orthotics Center.

Jennifer L. Flagg, MBA

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Jennifer Flagg, MBA, has more than a decade of experience in the commercialization of medical and assistive technology devices, and is a published author in the domains of technology transfer and assistive technology. She is currently leading Research Project 1, which is synthesizing and adapting industry best practices in new product development for use by applied researchers in an academic context; and leveraging knowledge translation techniques to facilitate communication between stakeholder groups leading to meaningful outcomes and impacts from research and development activities. Jennifer holds a Masters of Business Administration and a Bachelor of Science degree in Business Administration and Management with a concentration in Marketing- both from the State University of New York at Buffalo.

Steven A. Gard, PhD

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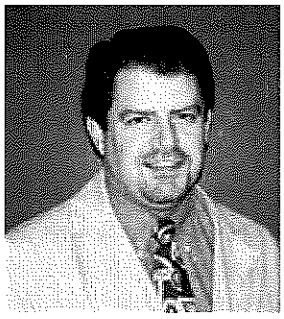

Steven A. Gard, PhD, is Executive Director of the Northwestern University Prosthetics-Orthotics Center for Education & Research; a Research Health Scientist with the Jesse Brown VA Medical Center, Department of Veterans Affairs; and on the faculty of the Department of Physical Medicine & Rehabilitation, Feinberg School of Medicine, and the Department of Biomedical Engineering, McCormick School of Engineering and Applied Science. His research is concerned with the functional biomechanics of human gait, with emphasis on the evaluation and development of prosthetic and orthotic technologies. He serves on the Editorial Boards for the *Journal of Prosthetics and Orthotics*, the *Journal of Rehabilitation Research and Development*, and the *Journal of Neuroengineering and Rehabilitation*.

R. J. Garrick, PhD

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R. J. Garrick, PhD, is Communications Director at NUPOC. Her role is to write and disseminate information about NUPOC research and education programs to interested stakeholders. She produces *Capabilities*, the NUPOC quarterly newsletter, which she writes to be accessible to all who wish to learn about rehabilitation engineering and prosthetics/orthotics. She holds a doctorate in Health Sciences (Tokyo University Faculty of Medicine, Tokyo, Japan). She conducted post-doctoral work at the University of California San Francisco (Epidemiology and International Health), where she was involved in research about congenital and hereditary bone disorders (achondroplasia and osteogenesis imperfecta), psychiatry, and taught History & Philosophy of the Health Sciences.

Gerald F. Harris, PD, PE

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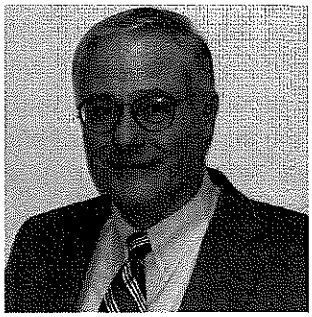

Gerald F. Harris, PhD, PE, is trained in Biomedical Engineering, Human Resources Management and Mechanical Engineering. His research interests include orthopaedic biomechanics, impact biomechanics, rehabilitations engineering and analysis of gait; measurement of human performance, mechanical design; and computerized data acquisition and analysis.

John Michael, MEd, CPO/L, FAAOP, FISPO

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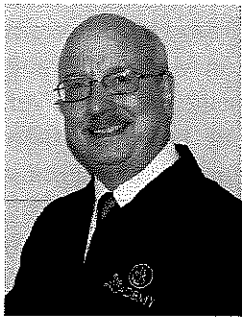

John Michael, MEd, CPO/L, FAAOP, FISPO, has practiced as a clinician and educator in the private sector and University settings more than 30 years. He has published more than fifty peer-reviewed articles and text chapters, and lectured widely in the USA, Canada, and abroad on a variety of prosthetics and orthotics topics. He has served as an Editor and contributor to the *Atlas of Orthoses, the Atlas of Limb Prostheses*, and co-authored the basic text titled *Orthotics & Prosthetics*. He joined the Northwestern University Feinberg School of Medicine faculty in 2009 as the Assistant Director of the NU Prosthetics-Orthotics Center for teaching and research.

Christopher Robinson, MBA, CPO, ATC, FAAOP

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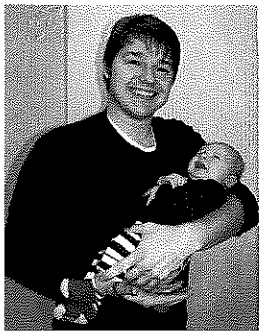

Christopher Robinson, MBA, CPO, ATC, FAAOP, is an Assistant Professor of Physical Medicine and Rehabilitation serving as an educator, researcher and clinician. Chris is a graduate of the University of Iowa, where he studied sports medicine, and holds dual certificates in orthotics & prosthetics from Northwestern University. Chris is a published author in peer-reviewed journals, and textbooks; and he has presented at regional and national professional meetings to orthotists/prosthetists, physicians, and therapists. Chris resides in Elmwood Park with his wife, Lauren, and is the proud parent of a baby boy named Grant.

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David Tiemeier, PhD, is Senior Director at INVO, where he leads a team that builds relationships with faculty, helps to shape University intellectual property, and conducts commercial assessment and licensing of University inventions into start-up companies. His team works to translate basic science into innovative products and services. David holds a BS in Chemistry from the University of Notre Dame and a PhD in Biochemistry from the University of California, Berkeley. He completed postdoctoral studies in Molecular Genetics at the National Institutes of Health and served on the faculty of the University of California (Irvine) Medical School for three years. He has more than 25 years of industry experience, including leadership positions in research and business development with Monsanto, Searle, Pharmacia, Pfizer; and biotech companies NeoPharm, Immtech, and Kalypsys. He was Deputy Director for UChicagoTech, the University of Chicago's Office of Technology and Intellectual Property.

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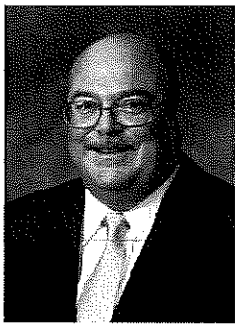

Tom Doherty, BS, is the Central Regional Business Manager for OttoBock since 1998. He manages all aspects of OttoBock prosthetic/orthotic products, patient usage, schools/education, and practitioner interface throughout 21 States. Before coming to OttoBock, he was Sales Representative (1991-1998) for Surgical Appliance Industries, where he specialized in Durable Medical Equipment (DME) and handled sales and education of soft goods orthoses & DME to qualified vendors. He was owner of MSC Upjohn Healthcare Northwestern Illinois (9 counties). He has hired health care professionals to supplement staffing at medical facilities, including hospitals & nursing homes; and high tech nursing staff to care for medically complex patients in home settings. Prior to his work at Upjohn, he worked as a Sales Representative in Clinical Chemistry for Ames Company and Helena Laboratories dealing with lab technologies. He also worked in the Radiology field representing Fuji Medical X-ray film and accessories; and in the Respiratory Therapy field with DHD Medical, where he was responsible for distributing and supporting their Incentive Exercisers & Oxygen accessories. He holds a BS in Business Administration from Saint Joseph's College (Rensselaer, IN).