***1. Extending behavior theory:* Assume our goal is to develop behavior change models that support building an appropriate prevention/intervention framework. How could models that acknowledge complex temporal influences on behavior that span weeks, months, or even years be used to design systems that support change in the moment?**

Behavior change does not usually happen instantaneously; it happens slowly, one small change at a time. If this is true, then behavior change systems should – at any given moment – consider delivering an intervention that will help the user accomplish the next small behavior change. This process sounds somewhat analogous to "local" path planning algorithms, where a robot uses some information about nearby objects (a big rock to the left, a cliff directly ahead, etc.) and some information about its destination (e.g. destination is North-West) to plan its next movements. However, because the robot can only see nearby obstacles, it does not have enough information to plan the precise and ideal set of movements it needs to get from its current position to its final destination. At best, the robot can execute movements that bring it just a bit closer to the final destination.

It might be useful to think of technology-driven behavior change as a similar path-planning problem. Given a mobile device that knows the user's overall behavior change goal, the progress towards this goal, and the obstacles ahead, can a system decide what "in-the-moment" intervention should be delivered next to move the user closer to that goal? In other words, can we develop a path-planning algorithm to drive behavior change systems? We note that the system is unlikely to know what behavior change obstacles will be encountered in the future (just like our robot), and thus cannot possibly plan a complete, perfect path to meet the overall behavior change goal. It could, however, facilitate the small, critical steps toward the larger goal that avoid the obstacles.

To facilitate this vision of a path-planning algorithm for behavior change, we need a way to define the obstacles. Obstacles could be defined by the user's context, emotional state, and other factors such as level of self-efficacy. We would then need to define interventions (like the robot's steps) that are designed to work around these immediate "obstacles" to help the user move toward their goal.

***2. Measurement of behavior:* What is the nature of timing of measurement and information delivery on the effectiveness of feedback delivered by new dynamic systems, and how might a technical system maximize engagement and impact by manipulating the timing of information delivery?**

Let us assume for a moment that we want to design interventions that occur because of an event (e.g., a sudden spike in stress, the presence of a person smoking, proximity to a McDonalds, etc.). Then, we have three choices when it comes to the timing of the intervention:

1. **Case B(efore):** We can trigger the intervention *t* seconds (or some other unit of time) before the event
2. **Case D(uring):** We can trigger the intervention *t* seconds after the event begins (and before the event ends).
3. **Case A(fter):** We can trigger the intervention *t* seconds after the event ends

In each case, we have a different goal, and different technical challenges. For the purposes of brevity, let's focus on Case B. In case B, we assume that we know that the event is coming. We may even know when the event will occur. The goal of the intervention may then be to either prevent the event from happening (e.g., make plans with a different, non-smoking friend), or alternatively, to ensure the event occurs (e.g., deactivate the user's phone to avoid any distracting phone calls).

The technical challenge here is in **predicting** when the event will happen. Prediction is not trivial. It requires capturing an individual's life over a long period of time, and then developing a personal model of the individual that takes into account a variety of temporal, spatial, contextual and psychosocial patterns. With such a model, we could, in theory, predict the next actions of an individual based on his/her current temporal, spatial, contextual and psychosocial state. We note an important assumption here is that the person's actions are predictable in the first place. This may not be the case, or some individuals may have less predictable lives than others. Once we know when the event will occur, we can then leverage what we know about the event to decide on the appropriate timing (i.e., the value of t) of the intervention.

3. Evaluation: **What are the methodologies that should be used to evaluate behavior change systems using new BC&M models? Are there metrics the field should expect to see in publications that will enable incremental progress and major breakthroughs?**

Computer scientists, engineers, mathematicians and others sometimes cast the solution to a problem as lying within an n-dimensional solution space $S = [S_1 \ldots S_n]$. We say that every vector $s = [s_1 \ldots s_m]$ in the solution space S represents a possible – but not necessarily good – solution to the problem. Assume for a moment that there is an optimal or best solution s_b in S. s_b should 1) maximize desired outcomes, 2) minimize undesired outcomes, and 3) meet any unchangeable constraints C (e.g., on earth, we can't easily get rid of gravity). Thinking within this framework, solving a problem can then be thought of as **searching** the space of solutions S for s_b. Maybe we can think of behavior change in the same way – as searching the space of interventions I for the best intervention i_b.

We are rapidly approaching the point where it will be feasible to automate the search for i_b by leveraging **near- or real-time evaluation of mobile interventions**. What if a mobile device could evaluate a person's response to a behavior change intervention before, during and after an intervention is delivered? This would enable clinically-relevant, personalized, N-of-1 studies, in which the device can deliver an intervention i, evaluate the effect of i, and then modify i to improve the intervention's outcome – all within minutes. This process can repeat continuously, effectively searching the space of interventions I, until i becomes the optimal or best solution i_b. The key then is in defining the space of interventions I, the constraints C that cannot be changed, and the method of searching the intervention space. Then a range of approaches from computer science and mathematics could be applied to search I for i_b.

4. What could participants in the meeting collectively do before, during, and after the meeting to significantly impact the field of health behavior change and maintenance? Be as concrete as you can, and think boldly.

To me, the most important product of research institutions and laboratories are young researchers who go on to define and drive research on the next generation of problems. Thus, before, during, and after the meeting, I propose a subset of the group think about how we train the next generation of behavioral, social, and computer scientists and engineers to work in this field. One approach might be to develop syllabi, content, textbooks, and teaching strategies for a transdisciplinary course (or course sequence) on designing technologies for behavior change. The course should bring together the next generation and push them to work in teams to design theoretically-driven systems for behavior change. An important side-benefit of this effort would be consolidation, clarification and definition of the state of the field.

The most important outcome of the course will be the production of early career researchers that know how to work and communicate with researchers from other disciplines to solve big scientific problems in behavior change and technology (and other fields). I have been teaching a similar course (2nd offering in Fall 2012), and I know others (some who will be at the meeting) who have similar teaching endeavors. Thus, it seems we as a group may be in a position to push our courses to the next level, and by extension, ensure the growth and continued influx of new ideas into this exciting field. It is through teaching and training that we cannot only solve the behavior change and technology problems of the here and now, but those of the future.

We should also think carefully about how we continue our discussion and ideas after the meeting. I suspect that we will have an enlightening few days, and I personally will need some time to let all the great ideas marinate and cook. Websites and newsgroups are good for this, but maybe there is something more we can do. We could aim to have monthly or quarterly video conferences on Google Hangout or a similar system. We could try to use social networking services specifically designed for scientists, such as ResearchGate, to keep each other connected to what others are doing. Finally, we could aim to invite those we meet out to our individual institutions for talks or possible sabbaticals, so that the discussion can continue at the institutional level.