How Young Can Our Design Partners Be?

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ABSTRACT
For this work-in-progress presentation, we report on our experiences working with young children as technology design partners. Our team from the Human-Computer Interaction Lab has extensive participatory design experience in working with 7-11 year old children. Here we describe our first year working with 4-6 year old children and the ways that we altered our methodologies to meet the unique needs of our younger design partners.

Keywords
Children, Participatory Design, Educational Applications.

CHILDREN AS TECHNOLOGY DESIGN PARTNERS

Over the past four years, the University of Maryland has been partnering with children as a way to understand what is needed to develop new technologies for children. This partnership has been heavily influenced by research practices over the past 25 years, including the cooperative design of Scandinavia (e.g., Bjerknes et al. 1987, Sundblad 1987, Greenbaum and Kyng 1991), the participatory design of the USA (e.g., Blomberg and Henderson 1990, Johnson et al. 1990, Greenbaum 1993, Schuler and Namioka 1993) and the consensus participation of England (e.g., Mumford and Henshall 1979). As Greenbaum and Kyng (1991) have explained, 'We see the need for users to become full partners in the cooperative system development process...Full participation of (users) requires training and active cooperation, not just token representation' (1991).

These approaches to co-design attempted to capture the complexity and somewhat 'messy' real-life world of the workplace. It was found that many times there were not sequential tasks accomplished by one person, but many tasks done in parallel and in collaboration with others. Interestingly enough, this description could also easily refer to the complexity and 'messiness' of a child's world. By the 1990s, these co-design practices were being adapted and applied to research with children (Druin 1997, Druin 1999, Druin et al. 2001, Druin In Press, Benford et al. 2000).

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At the University of Maryland, twice a week, children ages 7-11, join researchers from computer science, education, psychology, art, and robotics to design new technologies together. Over the summer, the team meets for two intensive weeks, eight hours a day to continue our work. Children have remained with our team as long as four years and as short as one year. Together we pursue projects, write papers, and create new technologies. This intergenerational design team has produced research projects that include digital libraries for children (Druin et al. 2001), storytelling robots (Druin et al. 1999), and whole rooms that can be interactive storytelling experiences (Alborzi et al. 2000). Design partnerships with children have not been isolated to the University of Maryland. Children as co-designers became a critical part of the research methodology of a three-year project funded by the European Union's i3 Experimental School Environment initiatives (Benford et al. 2000, Taxen et al. 2001). KidStory was a collaboration between almost 100 children and 25 adult researchers in Sweden and England to develop new collaborative storytelling technologies for children. From 1998-2001, Researchers at the Swedish Institute of Computer Science, the Royal Institute of Technology, Sweden, and the University of Nottingham collaborated with the University of Maryland in generalizing design partnership methods with children.

Out of this research, numerous materials and methods have been developed that can support children and adults as they gather field data, initiate ideas, test, and develop new prototypes (Druin 1999). Team members use their unique skills and learn from each other throughout the process. We have found that no single technique is appropriate for all teams, so a combination of approaches has been developed that we now call "Cooperative Inquiry" (Druin 1999 and Druin In Press).

These techniques do not necessarily offer a magic formula for working with children, but rather a philosophy and approach to research that can be used to gather data, develop prototypes, and forge new research directions.

THE CLASSROOM OF THE FUTURE

In the fall of 2001, we began a new technology design team with a kindergarten class (ages 4-6) at the Center for Young Children, a private preschool on the campus of the University of Maryland (See figures 1 and 2).

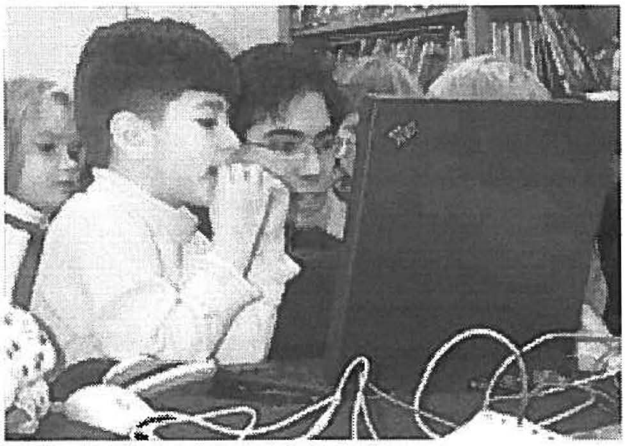


Figure 1. Working with our Kindergarten Design Partners

This team is part of a five-year project funded by the National Science Foundation that we call "The Classroom of the Future." The goals of the Classroom of the Future project fall into two categories: technological and educational. Therefore, we expect the outcomes of our research will include a better understanding of the input and output devices necessary for children to use technology, as well as methods to effectively design these technologies and use them in the classroom. Our team is developing new "embedded" technologies that can be a seamless part of any physical object in schools. We can expect that children's activity patterns will be supported by technologies that encourage active exploration, experimentation, and play. This is consistent with educational research that advocates the active construction of knowledge and skills for young children's learning environments (Eisner 1994, Department of Education 1995, Harel & Papert 1990, Papert 1980, Report to the President 1997, Ringstaff et al. 1993, Sandholtz et al. 1990, Vygotsky 1978).

Currently, we partner with two schools to develop technologies, which will be integrated into the classroom of the future. At the Center for Young Children (CYC), we are working with a kindergarten class of 23 children (ages 4-6) and two teachers. One teacher works with our group during most sessions. The teachers rotate so they can both participate in the design process. We also work with two kindergarten teachers at Yorktown Elementary School (YES), a public school in Maryland. Each YES teacher comes to the CYC once a month to take part in our design sessions. The kindergarten children and teachers at YES will evaluate and improve the designs of the technology, that we have built with the children at the CYC. Adult members of the team from the HCIL meet with both the CYC and the YES teachers every few months to discuss ways to continually improve our partnership.

Figure 2. The Center for Young Children, Where We Partner with Children and Teachers

A YEAR OF PARTNERSHIP

The first step we took towards partnering with young children was to help them understand that they can be inventors of technology who have ideas that matter in the process of creating new technologies. The first time we went to the kindergarten classroom our team spoke to the class as a whole. We introduced ourselves and explained that we design new technologies for kids such as robots and drawing games. The class was informed that we work with older children to make educational technologies and we now want to work with their kindergarten class to make technologies for younger children. Next, we initiated a series of activities designed to motivate the children to explore the design process, feel like inventors, and to help them become familiar with us as partners. Again this is consistent with the educational literature that suggests asking a child to actually "become" a scientist, artist, or inventor is an important component of a learning experience (Cooper & Brna 2000, Dewey 1902, Dewey 1936, Gardner 1983, Harel & Papert 1990, Shneiderman 1998).

During one of our first design sessions we worked with the class as a whole to design "computer mice of the future". The class was split into small groups. Each group was given a laptop with a computer mouse. The children used the mouse and observed each other using the mouse. They decided what they "liked" and "didn't like" about it. The children's likes and dislikes were dictated to the adults who wrote their comments on "sticky notes" (e.g. post-it notes). One idea was written on each note. These sticky notes were gathered together and grouped according to idea. Then, the whole team discussed the children's responses. We have seen that this process of invention can strengthen children's problem-solving skills (e.g., Fields 1987, Hill 1998, Hudson 1994, Lewis 2000, McCormick et al. 1994, Spoehr 1995).

At our next session the team again split into small groups. This time the children made pencil sketches of their ideas for the mouse of the future, in their notebooks. Adults helped the children annotate their drawings. The third time the group met, we split into teams and showed each other the sketches we made during the previous session. The groups decided what the best ideas were and collaboratively made three-dimensional sketches or low-tech prototypes of the mice of the future. The whole class gathered together and the children presented their low–tech prototypes to the rest of the group.

The team continued to use these methods to redesign a toy, a backpack, robots and more. In all cases, the children: (1) interacted with a technology, (2) watched others interact with technology, (3) decided what they liked and did not like about the technology, (4) sketched their ideas for a new version of that technology and then (5) combined their best ideas to create a model of their new technology.

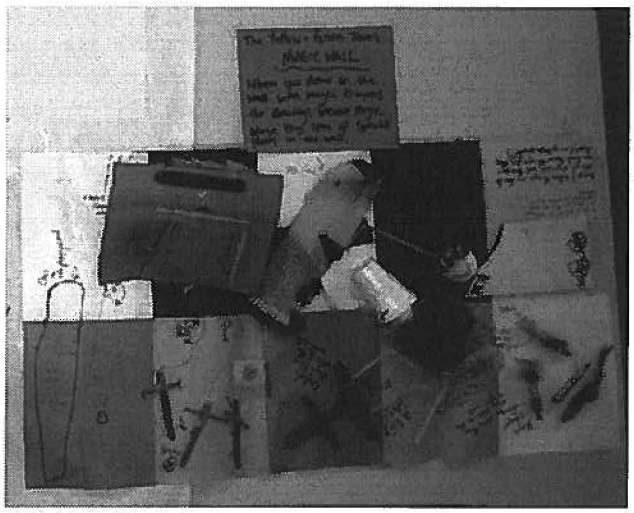
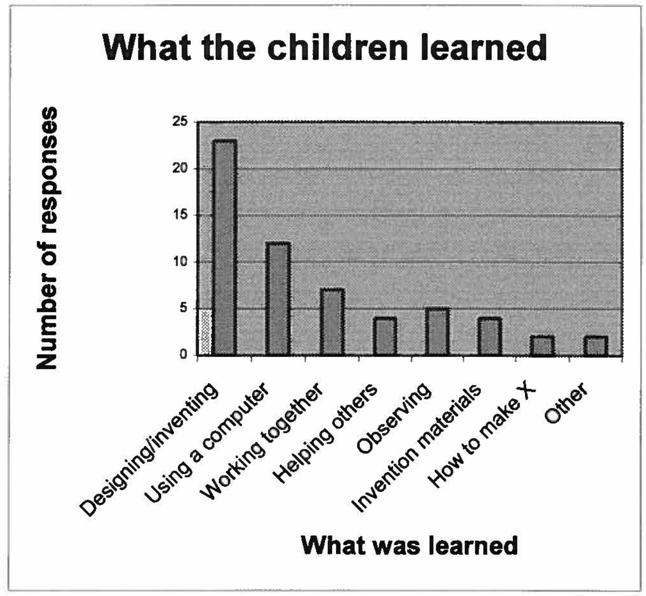


Figure 3. Low-Tech Prototype

After a year of partnership we asked the children to reflect on how they felt about being design partners. We asked 22 children to write in their journals. They answered the following two questions: What three things did you learn about being a design partner? and What two things were hard about being design partners? The children's responses are displayed as a chart in tables 1 and 2.

Most of the children felt that they had learned how to design. Many also thought that they had learned how to better use the computer or specific applications on the computer. This was not necessarily one of the goals of our research, but it was an unintended benefit.

The children found it difficult to work in groups. This is typical for children in this age group who are learning how to work and play with others. From an adult perspective it was often hard to get the children to listen to each other's ideas. However, the children did not appear to have arguments during the design sessions. The children reported that it was difficult to come up with ideas. We have found that this is a typical response of children in their first year of design partnership. The children also found it difficult to write. This is to be expected since most of the children that we worked with are not yet proficient readers or writers.



Tables 1. Children's Reflections

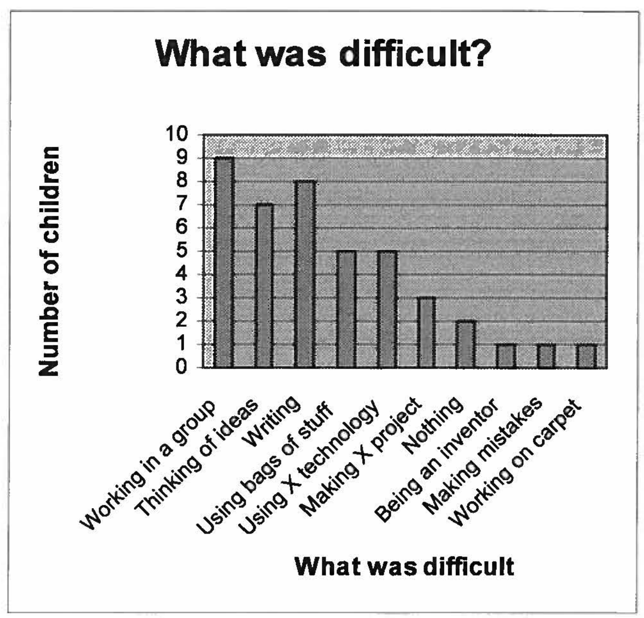


Table 2. Children's Reflections

NEW METHODS FOR WORKING WITH YOUNG CHILDREN AS DESIGN PARTNERS

Working with younger children has required our team to alter our design methods. We made eight changes to our methodology over the course of our six months with the children (See table 3 for a listing). These alterations were made after meeting with the CYC and YES teachers.

Changes to Design Methods
Amount of Writing
Less Sticky Note Reflections
Small Group Interaction with Adults
Fewer Whole Group Presentations
More Design Exploration
More Adult Facilitation
Bulletin Boards for Parents and Class Communication
Website for coordination with teachers

Table 3.

We knew before we went into the classroom that young children cannot write as well as the 7-11 year old children that we regularly work with. Therefore, we developed activities that would require less writing for the children. For example, the children we work with in our lab often write their thoughts or answer questions in their lab notebooks. Instead, our younger team members draw in their notebooks and adults annotate their entries.

The older children on our lab team typically write nine sticky notes when they are analyzing something. They write three things they like, three things they don't like and three more sticky notes on a third category. The third category varies based on project, but it is often "improvements". When we work with kindergarteners we typically ask them to make four to six sticky notes. They record two things they like, two things they don't like and occasionally two things about a third category. Since the majority of the young children we work with are not proficient writers, we ask them to draw pictures that illustrate their thoughts. Then the children dictate their likes, dislikes, etc. and the adults annotate the children's sketches.

When we began working with the kindergarten class, 23 children and eight adults were working in one room. When we split into groups and began designing, the atmosphere was noisy and chaotic. This made it difficult for the children to get one-on-one time with the adults in a way that is appropriate for "partnering" as opposed to "teaching". This situation was discussed at meetings with the teachers. Together we decided to take out one group of five or six children and work with them in a different room. The rest of the class stayed in the classroom. One teacher would come with the small group as long as there was enough teacher coverage in the classroom. Working with small groups outside of the classroom seemed to work better. The children appeared more focused and excited about their work with adults.

It has been well documented that it is challenging for young children to stay focused on certain tasks. In our experience we have found that the children we work with cannot sit still long enough for all the groups to present their ideas at one time. Therefore, we have one group present their ideas at the end of a design session. This structure enables each member of each team to present their ideas to an audience capable of listening to them.

Given that the children work in different groups we believe it is critical that the groups share their work with the rest of the class. Each child in a group is given the opportunity to explain their work, when their group gives a presentation. We ask children to present their work because it helps them clarify their ideas, recognize their accomplishments and improve their communication skills (Norton 1992). Also, the children are able to see what their classmates have done by simply looking at the bulletin board.

We have also found that young children need more opportunities to explore their ideas before building new prototypes. Therefore, we added an extra step in our design process. Whereas the older children in our lab team generally; observe and explore a technology, write sticky notes and then build low-tech prototypes. The kindergarten children; observe and explore a technology, write sticky notes, *sketch ideas in their notebooks*, and then build low-tech prototypes as a team. By adding this step to the design process we give children more ways to explore and refine their ideas.

We have also found that when we work with young children, the adult partners need to offer more ideas, start discussions, and propose more design suggestions. In general, the young children we work with have a harder time collaborating than do the children in our lab design group. In order to get input from all of the children we often have to pause a discussion to ask what a specific child thinks about a subject. Sometimes we have an adult sit next to a child who tends to interrupt or dominate the conversation. If this child feels that he has to speak, he can whisper his idea to the adult without disturbing the group discussion.

A *Classroom of the Future* bulletin board was set up to display the children's work. We did this to inform the children and parents about our activities. The purpose of this was to help children remember what they made, when they were between design sessions. This also brought their design work into the classroom, and hopefully initiated discussions. We have also found that our scheduled activities could not be planned very far in advance. The way one session went greatly affected what the team did during the following sessions. However, it was important for the teachers to know what could be planned in advance, so that they could plan their classroom activities appropriately. For this reason we set up an internal website. This website is easily editable by anyone, anywhere at anytime. Our team posted the schedule on this website and any member could change it at any point. We have found that the teachers check the website weekly to see what the group will be doing and how many children will be participating. The teachers from YES also check the website to get an update on the team at the CYC.

Continuing Work

Our next step is to adapt and develop the children's ideas into new interactive technologies accessible to 4-6 year old children. The goal of this portion of the research is to make something new for the classroom, find the best ways to integrate it into the classroom and enable the children to see their ideas realized.

To reach these goals, we conducted "inventor meetings". At these meetings children and inventors (adults who are not a part of the kindergarten design team) discuss design ideas. Together they are deciding what ideas will become high-tech prototypes. Some ideas the children have include: an advanced robotic pet that can dance, a "magic" wall and "magic" keys that can open special objects like a castle or a treasure chest.

Our current focus has been to build a "magic wall." With this technology, two children can hold "magic keys" in one hand, and finger paint simultaneously with the other. Children can draw stories that come to life with zoomable software our lab has been creating. The special hardware for this technology was developed with the support of the Mitsubishi Corporation.

We are currently using the magic wall with our partners at the CYC and observing how they use this new technology. Next year we plan to develop more applications for the magic wall and bring it in to other classrooms to see how they will use a technology designed by 4 to 6 year old children.

Conclusion

Through our research, we have found that in fact, young children can work together with adults and function as design partners. But, it is important to realize that 4-6 year old children have their own needs and opinions. Therefore, methods must be developed specifically for young children in order to successfully partner with them. We have found that if design methods are refined to meet the needs of young children, then new technologies can be developed in partnership.

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References

Alborzi, H., Druin, A., Montemayor, J., Sherman, L., Taxen, G., Best, J., Hammer, J., Kruskal, A., Lal, A., Plaisant Schwenn, T., Sumida, L., Wagner, R. and Hendler, J. 2000, Designing StoryRooms: Interactive storytelling spaces for children. Proceedings of Designing Interactive Systems (DIS) 2000, 95-104.

Becker, N. & Welch, B. 2000, Electronic portfolios. (Conference Proceedings of the National Educational Computing Conference).

Benford, S., Bederson, B., Akesson, K., Bayon, V., Druin, A., Hansson, P., Hourcade, J., Ingram, R., Neale, H., O'Malley, C., Simsarian, K., Stanton, D., Sundblad, Y. and Taxen , G. 2000, Designing storytelling technologies to encourage collaboration between young children. Proceedings of ACM CHI 2000 Conference on Human Factors in Computing Systems, 224-231.

Bjerknes, G., Ehn, P. and Kyng, M. 1987, Computers and democracy: A Scandinavian challenge, (Alebury, Aldershot, UK).

Blomberg, J. L. and Henderson, A. 1990, Reflections on participatory design: Lessons from the Trillium experience. Proceedings of ACM CHI 90 Conference on Human Factors in Computing Systems, 353-359.

Cooper, B. & Brna, P. 2000, Classroom Conundrums: The Use of a Participant Design Methodology, (Educational Technology & Society, 3(4)).

Dewey, J. 1902, The child and the curriculum. (University of Chicago Press, Chicago, IL).

Dewey, J. 1936, The theory of the Chicago Experiment. In K. C. Mayhew & A. C. Edward (Eds.) The Dewey School: The Laboratory School of the University of Chicago 1896-1903. (Appleton-Century, NY).

Department of Education. 1995, Design and Technology in the National Curriculum, (HMSO).

Druin, A. 1999, Cooperative inquiry: Developing new technologies for children with children, Proceedings of ACM CHI 99 Conference on Human Factors in Computing Systems, 223-230.

Druin, A. In Press, The role of children in the design of new technology, Behaviour and Information Technology.

Druin, A., Bederson, B., Hourcade, J. P., Sherman, L., Revelle, G., Platner, M., and Weng, S. 2001, Designing a digital library for young children: An intergenerational partnership. Proceedings of ACM/IEEE Joint Conference on Digital Libraries (JCDL 2001), 398-405.

Druin, A., Montemayor, J., Hendler, McAlister, B., Boltman, A., Fiterman, E., Plaisant, A., Kruskal, A., Olsen, H., Revett, I., Plaisant- Schwenn, T., Sumida, L. and Wagner, R. 1999, Designing PETS: A personal electronic teller of stories, Proceedings of ACM CHI 99 Conference on Human Factors in Computing Systems, 184-192.

Druin, A., Stewart, J., Proft, D., Bederson, B. B. and Hollan, J. D. 1997, KidPad: A design collaboration between children, technologists, and educators, Proceedings of ACM CHI 97 Conference on Human Factors in Computing Systems, 463-470.

Eisner, E. W. 1994, Cognition and Curriculum Reconsidered, 2nd Edition, (Teachers College, NY, USA).

Elmin, R. 1999, Portfolio – sätt att arbeta, tänka och lära. (Gothia, Stockholm).

Fields, S. 1987, Introducing science research to elementary school children. (Science & Children).

Gardner, H. 1983, Frames of mind: The theory of multiple intelligences. (Basic Books, NY).

Greenbaum, J. 1993, A design of one's own: Toward participatory design in the United States, in D. Schuler and A. Namioka (eds), Participatory design: Principles and practices, (Lawrence Erlbaum, Hillsdale, New Jersey), 27-37.

Greenbaum, J. and Kyng, M. 1991, Design at work: Cooperative design of computer systems, (Lawrence Erlbaum, Hillsdale, New Jersey).

Harel, I. & Papert, S. 1990, 'Software Design as a Learning Environment', In I. Harel (ed.) Constructionist Learning, (MIT Media Lab Publication, Cambridge, MA).

Hill, A.M. 1998, Problem Solving in Real-Life Contexts: An Alternative for Design in Technology Education, (International Journal of Technology and Design Education).

Hudson, T. 1994, Developing pupil skills. In R. Levinson (ed.) Teaching science. (Routtedge Press, London, UK).

Johnson, J., Ehn, P., Grudin, J. and Nardi, B. T. K. 1990, Participatory design of computer systems, Proceedings of ACM CHI 90 Conference on Human Factors in Computing Systems, 141-144.

Kostelnik, M., Soderman, A., & Whiren, A. 1999, Developmentally appropriate curriculum: Best practices in early childhood education (2nd ed.), (Merrill, New Jersey).

Lewis, T. 2000, Technology Education and Developing Countries. (International Journal of Technology and Design Education).

McCormick, R., Murphy, P., & Hennessy, S. 1994, Problem-Solving Processes in Technology Education: A Pilot Study. International Journal of Technology and Design Education. 5-34.

Norton, P. 1992, When technology meets subject-matter disciplines in education: Part three: Incorporating the computer as method. (Educational Technology, 35-44).

Papert, S. 1980, Mindstorms Children, Computers, and Powerful Ideas, (Basic Books, NY).

Report to the President on the use of technology to strengthen K-12 education in the United States. 1997, Published by the President's Committee of Advisors on Science and Technology: Executive Office of the President of the United States, Washington, D.C.

Ringstaff, C., Sterns, M., Hanson, S., & Schneider, S. 1993, The Cupertino-Freemont Model of Technology in Schools Project: Final Report, (SRI International, Cupertino, CA).

Sandholtz, J. H., Ringstaff, C., Dwyer, D. C. & Apple Computer. 1990, 'Teaching in High-tech Environments: Classroom Management Revisited First Fourth-year Findings', ACOT Technical Report, No. 10. (Apple Classrooms of Tomorrow, Cupertino, CA).

Schuler, D. and Namioka, A. 1993, Participatory design: Principles and practices, (Lawrence Erlbaum, Hillsdale, New Jersey).

Shneiderman, B. 1998, Relate - Create - Donate: A teaching philosophy for the cyber generation. (Computers and Education).

Spoehr, K. 1995, Enhancing the acquisition of conceptual structures through hypermedia. In K. McGilly (Ed.) Classroom lessons: Integrating cognitive theory and classroom practice. (MIT Press, Cambridge, MA).

Sundblad, Y. 1987, Quality and interaction in computer-aided graphic design (Utopia Report #15), (Arbetslivscentrum, Stockholm, Sweden).

Taxen, G., Druin, A., Fast, C. and Kjellin, M. (2001), KidStory: A technology design partnership with children, Behaviour and Information Technology 20(2), 119-125.

Vygotsky, L. 1978, Mind in Society: The Development of Higher Psychological Processes, M. Cole, V. John-Steiner, S. Scribner, & E. Souberman (eds.) (Harvard University Press, Cambridge, MA)