Publishable summary: Future BNCI periodic report 1 Jan – 31 Dec 2011

This document is a publishable summary of progress during the second and final year. It reflects completion of part 3.1 of the "Guidance notes on project reporting" and follows the structure required therein. The four section headlines (shown in ***bold and italic*** text) reflect the different subsections required therein. In addition, please see the publicly available Final Report for more detail.

I. Summary description of project context and objectives

Future BNCI was a Coordination and Support Action within Theme ICT-2009.7.2. Informally, we were part of the "BNCI Cluster", a group of thirteen European projects devoted to BNCI research that were funded during Challenge 7.2. Our project focused on coordinating and supporting activities of this cluster, as well as advancing the BNCI research community in other ways.

Our overall project objectives included:

- **A thorough literature review of relevant academic references and commercial developments** to consolidate existing knowledge and establish what is known and not known;
- **Targeted discussion with the top academic and commercial stakeholders through email, informal discussion, and the mechanisms shown below** to establish a common framework on which a community can be built;
- **Organisation of events including a conference, workshops, and special sessions** to encourage participation, disseminate the findings of the targeted discussions, and stimulate further discussion;
- **Establishment of electronic resources such a single centralized website** with definitions, a database of key articles and research groups, relevant news from businesses and the popular media, a discussion forum, lists of relevant conferences and other events, a Wiki, materials from classes about BCIs and related topics, and a research blog to provide a starting point for a common EU BNCI community and engage stakeholders and the public at large;

(Source: Description of Work)

II. Description of the work performed since the beginning of the project and the main results achieved so far

The work performed is presented in terms of our objectives. The black vs. white bulletpoints under each of the four objectives distinguish work in the first year from work in the second year.

1) **A thorough literature review,** reflected through:
    - D2.2, D3.2, and D4.2, the reports on the WP2-4 topics;
    - D5.2, the report about (Re)Defining BCIs, which addressed relevant literature;
    - o D2.4, D3.4, and D4.4, the three book chapters;
    - o D5.4, the BNCI and hybrid/multimodal systems report, which was associated with an additional four peer-reviewed publications;
    - o D2.5, D3.5, and D4.5, the three mini-roadmaps, which contained literature reviews and further discussion and analysis;
    - o D5.5, the roadmap, which has updated reviews from the three mini-roadmaps as well as other updated literature reviews and new literature reviews; and
    - o D5.6, the Springer book, which has many different contributions on different BNCI-related topics spanning four sections.
- **Targeted discussion with the top academic and commercial stakeholders,** reflected through:

- - Attending many conferences and events (2010 and 2011);
  - Interaction with our Advisory Board (2010 and 2011);
  - Email (2010 and 2011);
  - Articles that were produced in collaboration with stakeholders (2010 and 2011);
  - Guest lectures at our events (2010 and 2011);
  - The interviews, which have recorded discussion with top stakeholders;
  - The presentation videos, which present stakeholders discussing or presenting issues;
  - The roadmap, which includes project summaries and numerous quotes and contributions from both academic and commercial stakeholders.
- **Organisation of events,** specifically:
  - The FBNCI conference near Graz;
  - The FBNCI booth, "BNCI village", and networking session 3178 at ICT 2010;
  - Eight workshops – six conventional workshops, and two others (one evening social in Washington, DC and one roadmap-workshop in Barcelona);
  - A cluster teleconference in March 2011 with many EU stakeholders.
- **Establishment of electronic resources such a single centralized website**, which:
  - Had its initial infrastructure online Feb 2010.
  - Went online April 2010, including content across different BCI components;
  - Underwent frequent updates to many different components (2010 and 2011);
  - Includes free peer-reviewed articles produced through FBNCI in open-access journals (2010 and 2011);
  - Includes summary information about all workshops and some slideshows;
  - Includes reports from the workshops at our 2010 conference;
  - Includes reports on different components of BCIs;
  - Includes video interviews of major stakeholders in BCI research;
  - Includes a five minute video about the Utrecht BCI conference produced by FBNCI in collaboration with other groups.

Although our project was not required to produce any publications other than our Springer book, we produced too many peer-reviewed publications to list within the four page limit of this document. Our Final Report contains a complete list, as well as a list of talks and other dissemination activities.

Allison, B.Z. and Neuper, C. (2010). Could anyone use a BCI? In: *Applying our Minds to Human Computer Interaction*, Tan, D.S. and Nijholt, A. (Eds.) Brain-Computer Interfaces. Human-Computer Interaction Series, Springer Verlag, London, 35-54.

Allison, B.Z., Leeb, R., Brunner, C., Müller-Putz, G.R., Bauernfeind, G., Kelly, J.W., and Neuper, C. (2012). Toward smarter BCIs: Extending BCIs through hybridization and intelligent control. *Journal of Neural Engineering,* 013001.
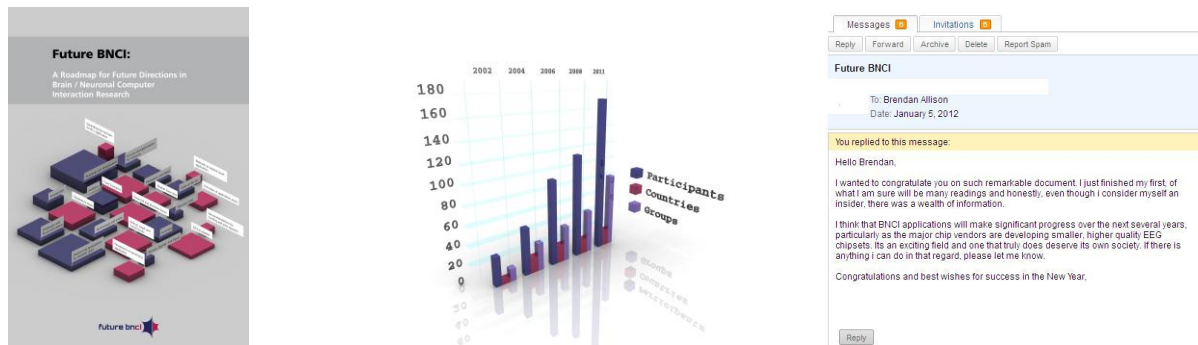
Allison, B.Z. (2011). Trends in BCI research: Progress today, backlash tomorrow? *ACM Crossroads*, 18(1): 18-22.

Nijboer, F., Clausen, J., Allison, B.Z., and Haselager, P. (2011). The Asilomar survey: researchers' opinions on ethical issues related to brain-computer interfacing. *Neuroethics*, 1-38, doi: 10.1007/s12152-011-9132-6.

Nijboer, F., Clausen, J., Allison, B.Z., and Haselager, P. (2011). Researchers' opinions about ethically sound dissemination of BCI research to the public media. *International Journal of Bioelectromagnetism*, 13(3): 108-109.

Mühl, C., Nijholt, A., Allison, B. Z., Dunne, S., and Heylen, D. (2011). Affective Brain-Computer Interfaces (aBCI 2011). In: *4th International Conference on Affective Computing and Intelligent Interaction (ACII 2011),* Memphis, USA.

These publications generally reflect progress toward the first two objectives, as do the roadmap and book. Some publications, and the roadmap, also reflect progress in the fourth objective (the website), since many of these materials are available on our website. Unfortunately, we cannot show images from our book here, or on our website, since it is copyrighted. However, Figure 1 has three images that reflect our roadmap and reaction to it. Figure 2 presents some FBNCI events (objective three). Figure 3 presents additional information that is on our website (objective four).

Figure 1: These three images relate to our roadmap. The left image is the cover of our roadmap. The middle image is one of the figures from our roadmap. Both the left and middle panels were developed by a professional graphic artist (Cecilia Puglesi) exclusively for our project. The right image shows one of the replies to the roadmap we received through LinkedIn. The sender's identity is removed for confidentiality, but he is a well-established stakeholder.

Figure 2: The left photographs presents a discussion session at our workshop in Utrecht in May 2011. The middle photograph presents a busy day at our booth in Brussels in September 2010, which we shared with BrainAble and other cluster partners. The right photograph shows the panellists of networking session 3178, which was also in Brussels that day.

Figure 3: The left panel shows an early picture of our website; a quick look at our website shows how much it has changed. The middle panel presents the cover of our slideshow. We presented our talks many places, and put copies on the website. The right panel shows an image from an interview with a stakeholder (Jonathan Wolpaw), which is on our website too.

III. Expected final results and their potential impact and use (including the socio-economic impact and the wider societal implications of the project so far)

The expected final results are similar to the results presented in the last section, since the project is now over. We do have a follow-up plan, which is in our roadmap. The project's final results and potential impact can be assessed in terms of goals we stated in the DoW:

- Develop clear standardized terminology;
    - We have helped to develop standard terms like "hybrid" and "BNCI";
    - We have worked to establish a "BCI Society" that can further develop standards;
    - We published work assessing stakeholders' views on terms and standards:
    - We had a cluster teleconference, workshops, and other events to foster common terms.
- Identify specific opportunities and roadmaps;
    - Our roadmap (which includes mini-roadmaps) discusses opportunities;
    - Some publications also discuss opportunities, both with BCI and related fields.
- Encourage discussion and collaboration among key academic and commercial stakeholders;
    - The workshops and conference fostered discussion and collaboration;
    - Some publications review relevant issues and survey relevant opinions;
    - We fostered discussion through emails, personal discussions, and web-based mechanisms, mainly the LinkedIn BCI Discussion Group;
    - We collaborated extensively with other projects and groups.
- Disseminate knowledge and strategic objectives to established and new groups and to the public at large.
    - The mechanisms described above all disseminate knowledge and strategic objectives to both groups;
    - The website also contains text and downloadable materials.

We expect that the socio-economic impact will include raising awareness of B(N)CIs and their availability/appeal to wider groups. This could make consumers more interested in BCIs, leading to an economic boost for relevant companies. We also hope that our funding recommendations will help to change the current reality that the economic impact is primarily within the US. As our roadmap notes, the overwhelming majority of BCIs that are sold come from the US. Providing more funds to BCI research efforts that include European businesses could shift attention toward Europe.

The wider societal implications for many groups – different end users (including different healthy users, different groups of patients, and their carers), current and potential researchers in different disciplines, companies, doctors and support staff, and the public at large – are considerable. We have extensive information available to different groups, much of it written for intelligent laypeople without extensive technical material. We produced not just literature reviews but also discussion and commentary, which could lay the groundwork for major developments later. For example, our efforts to start a BCI Society, survey users about their opinions regarding standardization, produce video materials, and encourage discussion of technology could all help foster both future synergy within the research community and increase general awareness of BCIs well after the project ends. We also address ethical issues and hope this effort results in socio-economic and wider societal impact by encouraging attention to relevant issues, developing guidelines, and increasing funding as needed.

IV. Address of the project public website

The public project website is www.future-bnci.org. It includes contact information for the partners.