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Systematic musicology at the crossroads of modern music research

Abstract

The creative and cultural sector, of which music forms an important part, calls for a research basis that is grounded in a range of scientific disciplines with specialization in music-related technology and music-driven psychosocial interaction. In that music research space, there is a natural and emergent demand for an approach in which boundaries of object-centred and subject-centred research methodologies can be crossed. By putting music and embodied music experiences at the very centre of this research focus, systematic musicology can play an important role as moderator of a trans-disciplinary approach to music research. Evidence for the new position of systematic musicology in the modern European music research space is found in networks that foster systematic musicology, in a recent strategic roadmap for sound and music computing, commissioned by the European Commission, and in two recent National project initiatives, one in Finland and one in Belgium, that support long term research in the domain of systematic musicology.

Introduction

In a lecture entitled "Who stole systematic musicology?" (2003, Universität zu Köln), I once expressed my concern about "systematic musicology"[1]. The main reason for expressing

[1] The use of the term "systematic musicology" reflects the common distinction between "historical" and "systematic" musicology in academia. Apparently, the term "systematic musicology" is common in Continental Europe, but less common in the UK and the US. The term is often used in countries that were influenced by German music research. However, related approaches are sometimes called "cognitive musicology", "empirical musicology", "computational musicology", "systemic musicology", "interdisciplinary musicology" or simply: "musicology". It is assumed that systematic musicology is not restricted to any musical period, geographic area, musical genre or type of musical expression. Systematic musicology differs from the so-called historical musicology in that it is less involved with biographies of composers or the development of musical practices in a particular area or style period, but more with what these practices mean to people and more particularly how these practices can be understood, explained as a system (both from a psychoneuronal and social point of view), and possibly further explored and exploited (for example in connection with technology). The methodology of systematic musicology is particular in that it is often based on a mixture of methods from other sciences, including human sciences and natural sciences. The adjective "systematic" somehow points to the systemic character of the methodology and in fact, much of the discussion about the relevance of systematic musicology is related to the nature of this systemic aspect. The term "systemic musicology" was introduced by Fricke (1993), who defines it as "eine Sichtweise […] die das komplexe Bedingungsgefüge […] von naturgegebenen, genetischen, erlernten und kultur-abhängigen Faktoren in den Vordergrund stellt". The basic idea was that all sciences aim at being systematic in the sense of being

this concern was that at the turn of the new millennium, the number of music researchers had suddenly exploded and this formed a threat to the ongoing research practices of systematic musicology. After a decennium in which systematic musicology had positioned itself as an empirical and computational discipline[2], the amount of researchers working in music engineering and in neuroscience of music quickly outnumbered the small amount of researchers working in musicology departments. This was most noticeable at conferences on music information retrieval[3], where engineers convincingly showed that their tools outperformed almost everything that systematic musicology had explored so far in computational analysis and content-based representation. In a similar way, neuroscience[4] showed that the new brain scanning technologies could offer a fresh look at musical perception and performance, having an effect on our understanding of what music is about. I challenged my audience by saying that the sudden interest in music from engineering was probably driven by a rush for the chicken with the golden eggs, or more concretely, the rush for the over-all content-based search and retrieval system for music on the Internet (the "Music Google"). Equally threatening was the agenda of neuroscience, and the rush for brain localizations, the claim that all musical activities could be explained by just looking at the brain. The conclusion was clear: If music could be better studied by specialized disciplines, then systematic musicology had no longer a value. If everything could be accounted for by engineering and brain science, then systematic musicology would be no longer necessary. Systematic musicology could be classified "vertically", as we use to say for documents that are no longer needed, or it could be taken over by other disciplines, or it could just shrink its ambitions to music analysis, a smaller and less ambitious segment of music research.

In fact, my concern culminated in a discontentment about the fact that systematic musicology did not have a proper answer to this development. Other disciplines had discovered the music topic and they applied good empirical and computational methods. They got the money, they did the research, and they obtained the results. So what? What else

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planned, thorough and efficient, and that "systematic musicology" in fact means "systemic musicology", that is, affecting processes and connections between different levels of things that are constrained and linked together in a system (see also Schneider, 1993).

[2] See e.g. "Journal of New Music Research", the journal "Systematische Musikwissenschaft/Systematic Musicology/Musicologie Systématique", as well as the journals "Music Perception", "Computer Music Journal", "Musicae Scientiae".

[3] Since 2000, a number of initiatives have shown the dynamism of the engineering approaches in music research. The conferences on Music Information Retrieval started in 2000 (see http://www.ismir.net/), the conferences on Computer Music Modeling and Retrieval started in 2003 (see http://www.lma.cnrs-mrs.fr/~cmmr2007/). Related conferences are the conferences on Digital Audio Effects, which started in 1998 (see http://www.dafx.de/), the international conferences on New Interfaces for Musical Expression, which started in 2001 (see http://www.nime.org/pastnimes.html), and the Sound and Music Computing conferences, which started in 2004 (see http://smc07.uoa.gr/SMC07%20Previous.htm).

[4] Reference can be made to the international conferences dedicated to the neurosciences and music in New York, 2000, Venice, 2002, and Leipzig, 2005 (with more than 400 people attending) (See Zatorre and Peretz, 2001; Avanzini et al., 2003; Avanzini et al., 2005).

could a systematic musicologist, living at the beginning of a new millennium, do than acknowledging the power of the new methods? What else could I do than becoming an engineer, psychologist, brain scientist, or perhaps, biologist ... and look to music from that perspective?[5]

During the years before and after the lecture, I had the opportunity to get in close contact with many colleagues and many music research institutes in Europe. Invitations for short study periods at different institutes, among which the Music Technology Group of Pompeu Fabra University in Barcelona (June 2003), and later on that same year, the Kulturwissenschaftliches Forschungskolleg Media und Kulturelle Kommunikation (December 2003) of the University of Cologne, and the Max Planck Institute for Cognitive Neuroscience in Leipzig (May 2005) somehow stimulated my thinking about this problem. There, I saw groups of researchers at work that often had no background in musicology. Could they progress our knowledge about music? Around that period too, I was involved in a number of international meetings on music information retrieval (such as ISMIR, 2004 and CMMR, 2004), and I had my own projects both in a national and international context (e.g. MAMI, COST 287, S2S^2) in which I collaborated with psychologists, engineers and brain scientists. In short, I travelled a lot all over Europe, and I could observe from very close how our colleagues actually dealt with "our stolen discipline" so to speak. And in fact, I must admit, those observations confirmed what I already had observed as editor-in-chief of Journal of New Music Research (from 1987 to 2004), namely, that non-musicologists could advance music research quite a lot. In fact, I had (and I still have) a great time with researchers from other disciplines. They enrich the field and they often contribute with excellent methods and approaches. But what about my own discipline? How could a systematic musicologist survive in such a context? Was there still a tiny little place for a researcher like me, or for the good old systematic musicology as a whole?

By the turn of the millennium, I had already realized that a proper answer to this question was needed. And in fact, raising the question "who stole systematic musicology?" was a strong incentive for reflecting on my own approach in relation to what I considered then to be the new upcoming music research space. Up to then, the entire paradigm of systematic musicology was still largely driven by the research paradigm of the cognitive sciences, to which I had contributed myself through empirical and computational modelling studies (e.g. Leman, 1995; Leman, 1997; Godøy and Jørgensen, 2001). Ultimately, thanks to some time

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[5] This feeling was quite different from the feelings that I experienced in 1993, when systematic musicologists from East and West Europe met, in an euphoric mix from old and young generations. Thanks to A. Schneider for inviting me to this particular setting at Moravany where I had the opportunity to meet the old generation of systematic musicologists from Central Europe. The discussions at Moravany were about the future program of systematic musicology. Young researchers, like U. Seifert and myself at that time, pleaded for systematic musicology to play a role in cognitive science. For a state-of-the art of systematic musicology at the turn of the 1990ies, see the first volume of the journal Systematische Musikwissenschaft (1993), and the contributions from O. Elschek, H-P. Reinecke, J. Jiránek, F. Födermayr, W. Deutsch, L. Burlas, A. Schneider, J. Fricke, U. Seifert, M. Leman, H-W. Heister, B. Schabbing, M. Kartomi, V. Karbusicky and others. (See also Elschek, 1992).

for reflection in Köln (end of 2003), I decided to work on the research paradigm of systematic musicology in a more profound, say "systematic", way, and this finally resulted in my book on embodied music cognition, of which the first versions already circulated among collaborators and friends in 2005 (Leman, 2007).

In retrospect, my answer to the question about the need of systematic musicology in the modern music research space was much inspired by observations and discussions with colleagues from outside musicology. Somehow, I got strongly convinced that the modern music research space was much in the need of an approach, and a vision, that could go beyond the confines of the proper disciplines. Today, I am still convinced that the formulation of this vision, as well its implementation and validation is a major task of systematic musicology. Indeed, many researchers working in non-musicological disciplines of music-related research realise that music is more than just an application domain onto which their methodologies can be applied „out of the blue". Music is far too complex, far too multifaceted, and far too much integrated in our social and cultural environment to reduce it to a single approach or to conceive it merely as a domain of application. The study of how people move in accordance with music is a good example of this. A purely physical approach about how people move in response to music is likely to ignore the important role of cultural learning and goal-directed behaviour (intentionality) through posture and expressiveness. In a similar way, asking subjects to fill in a questionnaire about their social and cultural background and their intentions will hardly be sufficient for understanding their engagement in non-verbal forms of musical expression. It is even more likely that neither method may be sufficient, and that a proper method, involving the interaction of several disciplines and methodologies is needed. Similar observations can be made in the field of music information retrieval where user-oriented studies are needed that complement the engineering applications (Lesaffre et al., in press).

While it appeared to me that many researchers agreed that dealing with music necessitates a proper approach that is driven by the musical task, I observed at the same time that it was very rare that researchers went beyond the boundaries of their own disciplines. Apparently, academic careers depend more on the mastering of advanced measurement methods and analysis methodologies, than the ability to transcend the boundaries of the proper discipline, especially for a topic that is often considered to be fancy and pleasant. Hence the fact that music is more often seen as a domain for the application of proper methodologies than as a domain that can generate a proper methodological approach from inside. But I agree, one should be very careful in making such statements, because even when music is conceived as a domain for applying the "Eigen-methods" of the discipline, then the outcome may still be highly relevant for the cultural and creative music sector. There is a subtle balance between the goals, the means and the results of music research.

Anyhow, I got the feeling that all disciplines of modern music research were in the need for an approach and a vision that could link the different disciplines and their methodologies. Was this something of interest? Was this an opportunity for systematic musicology? I thought it was, although I realized that it would not be an easy bargain. Somehow, music researchers from outside musicology had to become convinced that the discipline of systematic musicology could offer something that is of value to them, a kind of glue that "cannot be

stolen", so to speak. And therefore, the question was: What is this glue? What is of such a value in systematic musicology that it can appeal to a broad range of researchers working in other disciplines?

What follows is a state-of-the-art of this quest, showing how, in a world with a growing interest in music research, a new role for systematic musicology is gradually emerging. I will argue that the ability to transcend the proper discipline in response to the driving forces of the musical topic is one of the major characteristics of systematic musicology and that it is precisely this feature, combined with the attitude of putting music and people at the centre of the focus, regardless of whatever scientific method, approach, or discipline, is used, makes systematic musicology rather unique (and therefore quite necessary) in modern music research. However, the realization of this ambition is highly depending on a vision, a perspective, or a glue, that may appeal to all partners involved. In what follows, I will try to clarify what this vision and glue could be (or at least, how I see it at this moment) and how, by taking concrete actions to realize that vision, systematic musicology is gradually acquiring a new place in the modern music research space.

Transdisciplinary music research

Music research that goes beyond the boundaries of the involved disciplines can be called „transdisciplinary". The term "transdisciplinary", perhaps even more than the term "interdisciplinary"[6], suggests that music cannot be fully understood by a single discipline, or by different disciplines that are just put next to each other without much interaction.

Would transdisciplinarity be something of value and convincing for systematic musicology? For sure, transdisciplinarity has always been a core idea of systematic musicology. Since the late 19th Century, systematic musicology has been promoted as an integrated multidisciplinary approach involving disciplines such as psychology, sociology, acoustics, physiology, neurosciences, cognition sciences and computer and technology (Elschek, 1992, Schneider, 1993). Systematic musicologists aimed at understanding how people engage with music, how music perception and performance work, and how music appears as an aesthetic and social phenomenon. The approach was first related with Gestalt theory and, later on, with information psychology and cybernetics. In the 1970ies, with the advent of computers, this culminated in an approach that was closely related with the cognitive sciences. Up until today, the cognitive sciences still offer a main scientific research paradigm to systematic musicology. A key aspect of this paradigm is that it relies on scientific measurement for gathering empirical data, and on data-analysis and computer modelling for hypothesis testing (Leman and Schneider, 1997).

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[6] Recent work on a roadmap for music research in the UK (http://music.york.ac.uk/dmrn/roadmap/) uses the term "transdisciplinary" extensively, whereas the (Continental) S2S^2-roadmap uses the term "multidisciplinary" (S2S^2, 2007). The difference between terms such as „multidisciplinary" and „trans-disciplinary" and perhaps also „interdisciplinary" is subtle and I would propose to use the terms here as synonym, rather than considering "multidisciplinary" as the union of disciplines and "interdisciplinary" as the intersection of disciplines, whatever that may mean.

Since a few years, the terms “transdisciplinarity” and “multidisciplinary” have appeared in several contributions that aim at identifying the role of systematic musicology in relation to modern music research. Honing (2004) refers to a revitalization of systematic musicology that is based on empirical observation and rigorous method, the growing role of formalization and the notion of testability and falsification, and music cognition research. Parncutt (2007) claims that the diversity of systematic musicology is compensated by interdisciplinary interactions with the system of subdisciplines that makes up systematic musicology. He argues that the future development, and perhaps survival, of musicology will depend on the degree to which musicological institutions can achieve a balance between subdisciplines that are rooted in both natural sciences and humanities.

In short, transdisciplinarity has strong historical roots and it pops up as a key term in the actual discussion. The reason for using this term is that music is considered to be a highly multifaceted phenomenon, involving all human faculties and very different social and cultural contexts. Single disciplines often focus on particular aspects of these faculties and therefore fail to address important aspects that go beyond the confines of the discipline. A transdisciplinary approach would thus address the subjective and context-dependent way in which humans deal with music, without neglecting the physical environment in which music is perceived either. However, the real question is: how does transdisciplinarity work in practice, and how could it work as an effective instrument leading to practical results that otherwise cannot be obtained?

Music’s key role in society

The transdisciplinary nature of music research may be a strong asset to the development of activities that foster music’s key role in personal development and social bonding. Let me first go a bit deeper into this aspect, because it provides a strong humanistic argument in favour of the necessity of a research discipline that supports this role. Afterwards, I come back to the way in which the umbrella term “trans-disciplinarity” can be deployed in music research and how systematic musicology is related to this.

It is known that the attractiveness of music is often rooted in the local cultures of people where it forms an important aspect of their active life. Music has appeal to active music makers, and it is used a lot for the accompaniment or support of social activities, such in religious activities, gaming or entertainment (dancing). Music is also known to strongly contribute to personal development, self-respect and pride, and it is considered to be a key factor of personal development. Music consoles, makes people happy, and it communicates cultural values and stimulates self reflection. Moreover, music is an excellent tool to promote respect for the diversity of social/cultural identity, the care of cultural heritage (preservation and archiving), openness to cultural change and new forms of expression, democratic access to culture and knowledge, and a culture of participation and participation in culture.

All this is of great value, and the intrinsic character of these values is a reason to put music in the centre of the picture. I claim that music is of such value that it requires our full attention as a topic, in such a way that other disciplines should support its study and contribute with methodological solutions that fully obey the requirements and the consequences of putting music at the centre. In other words, by putting music at the centre,

we call upon musicology as a central research discipline. However, music is rooted in values that go beyond the study of its objective patterns. Music is experience, innovation, creation, expression, community, feeling of togetherness and knowledge, and much more. Therefore, these intrinsic values of music necessitate an approach that accounts for these values and that go beyond the confines of a single approach. Hence, driven by the values of the topic, the research approach should already be transdisciplinary. But there is more!

Music: a vibrant economical sector

According to a recent European study (KEA, 2006), music has a strong economic value as well. As an important part of a vibrant cultural and creative sector, the European music sector represents about 40% of the world-wide activity in this area, and employs about 650,000 workers in this sector. The study claims that the whole cultural/creative sector to which music belongs is in total twice as large as the auto-mobile sector, and as large as the ICT sector, with remarkable growth figures of about 20% over five years. The sector represents 2,6 % of the GNP (compared with chemistry and rubber/plastics industry: 2,3%). Total annual return is € 654 Billion.[7]

Interestingly, of all "content industries" (such as film, TV, art, heritage), music is the one which has been most affected by the digital revolution. Since the year 2000, the creation-production-distribution-consumption chain for music went almost entirely digital. Music is pushing broadband development (e.g. Napster and P2P) and mobile networks (GSM/GPRS, UMTS) and it has stimulated the uptake of broadband subscription and ICT by mass consumers (e.g. PCs, mobiles). Music stimulates e-business (e.g. iTunes), new management tools (e.g. Digital Rights Management, Audio-fingerprinting, Watermarking) and retrieval methods (Music information retrieval).

Moreover, music industry is currently transforming itself into a so-called experience-based economy. Musical audio is now distributed via large networks of ICT channels (broadband, mobile) and services start to provide an added economical and experiential value (Kusek and Leonhard, 2005). The impact of music on media consumption has been huge in recent years. Also in education, music has been a driver for young people to develop interest in science and ICT.

In short, music is a core economical factor whose innovative role in society (e.g. both with respect to technology development and new business models) requires its own line of research and support. It is justified to say that music is more than just a domain of application, and it is justified to say that music research requires a proper approach, given its wide scope and close relationship to a booming creative and cultural sector. Clearly, this is something that systematic musicology cannot handle on its own. Methods and approaches from different fields are needed, and in this perspective, the interest in music from other disciplines is a real opportunity, rather than a threat. Yet what is needed is a re-positioning of the discipline of systematic musicology in this new landscape for music research.

[7] Compare with car industry = € 271 Billion in 2003, ICT factories = € 541 Billion in 2003.

Music at the core of innovation

Apart from the social/cultural value and the economic value, I want to add a third value that is very specific for music, namely its value as incubator for innovation. This aspect too requires a very proper consideration because there are at least two reasons why music and art in general, may be expected to play an increasingly important role in modern society (Leman, 2005):

- First of all, music is so deeply connected with the technology of our society that it starts driving the development (of parts) of this technology. This is a quite natural thing to happen because if tools are used to be expressive, then one is always inclined to go beyond what is actually possible, and therefore, being expressive pushes innovation and drives new developments. Examples can be given from the development of electronic music in the 1950ies-1960ies, where analogue audio-equipment was used to create new musical sounds and where the first steps were taken to develop a content-based approach to musical information processing. The recent quest for a „Music Google" can indeed be seen as an outcome of this development. In more recent times, there are signs that real-time interactive music systems push the frontiers of sensing, multi-modal multimedia processing and gesture-based control of technologies in a similar way as did the former research on synthesis and content-based processing. More researchers become aware of the fact that gesture technologies developed for interactive music and multimedia may also be useful in other areas.
- Secondly, music is so deeply connected with our social life that it starts driving new approaches to social communication, as art is always intended to be communicated and to involve social interaction. Recent developments in music research have pushed back the frontiers of networking into technologies that deal with semantics as well as new forms of human-human and human-machine interaction. Music is an excellent domain to develop technologies that focus on non-verbal communication patterns (related to gesture, corporeal articulation, kinetics and bioparametric sensing and related information processing) and therefore it is an excellent domain to develop patterns of communication that relate to corporeal social interaction.

In short, there is much to say in favour of the idea that music drives innovation in technology and in social interaction, because the context of music creation is constantly pushing for being more expressive, more human-friendly and more and different flavours. The interplay between music, technology and social interaction creates a huge market for innovation and creative development that links up with the ICT sector and the upcoming creative and cultural sector.

The intrinsic human value of music (e.g. for personal development and social bonding), the role of music in culture and economy (e.g., the development of new and massive internet-based business models), and its driving force for innovation and technology development (e.g. content-driven and socially embedded technologies), has forced systematic musicology to catch up with these activities. Could systematic musicology function as a moderator in this modern music research space? Could it become an agora for music research, a place where

science meets art, a location where innovation and creation meets methodology and systematicity?

The modern music research space

Unfortunately, despite the enormous social-cultural, economical and innovative value of music, music research is still a rather small-scale enterprise in terms of number of people and institutes that work on innovation and supporting services for the cultural and creative sector. Even after the booming period of the millennium turn, the number of researchers working in music research is still rather limited. A survey [8] done within the context of the S2S^2-project (S2S^2, 2007) reveals a trend that apart from a few exceptions (e.g. IRCAM in Paris), institutes working on music (in musicology, engineering, psychology, brain research) tend to be rather small (mean: about 2-3 professors, 10 PhD students), although the number of doctoral dissertations and internationally peer reviewed papers has been growing over the past decennium. In general, the European music research space is characterized by a relative large number of small institutes and a small number of larger institutions which, together, form research networks through changing coalitions. The small-scale character of the institutes is compensated by the collaborative international networks that emerged during the past 10 to 15 years. This allows the centres to specialize in niche areas, such as sound synthesis (physical modelling), sound archiving, and interactive music systems and so on.

The ill-defined goals at long term and the bottom-up short-term emergent output structure (in contrast with a well-defined long term goal and a top-down long-term planned output structure) resembles the way research in microbiology is organized (although, admitted, institutes in biology tend to be much larger than those of music research). According to Nowotny et al. (2001), the uncertainty in large parts of modern science is an inherent feature of the research activity. Uncertainty does not mean that the field has no vision, or that a vision is impossible. Rather, it means that there is no concrete planned goal at long term, except some vague idea of what all these research activities are up to. Many things happen at the same time and it is rather unpredictable which output will survive, or what the effect of a small contribution will be on the whole field. In music research, the field is characterized by a multitude of objectives that focus on different music processing topics and a multitude of facets of how humans interact with music. The vision is not about a concrete scientific research goal, a concrete device or machine, but rather about what music may mean to people. In other words, the vision is about the relationship between music research and society. The vision is about goal-directed research in function of societal benefits. Clearly, in this context of discovery there is no single controlling instance, although the output is largely driven by society.

The control of the broad range of research activities is not something that systematic musicology should claim, or that any other discipline should claim. The music research field is simply too broad and the number of people working in systematic musicology is simply too small and not fully educated to cover all aspects involved. Therefore, collaboration with other

[8] The website http://smcnetwork.org/ has recently been created to develop a better and more up to date statistics of music research.

disciplines is the only possibility, something that is highly needed in order to create a fruitful context of discovery that supports the creative and cultural sector. The role of systematic musicology in this universe or research can be that of a moderator, to help steering the development of a vision, to keep track of research outputs, to guarantee their relevance to music, that is, to make sure that psychosocial musical practices can profit from the developments, in other words, to keep focus on the music and what it does to people.

Surveys like KEA and S2S^2 show that Europe has a flourishing music research space that plays an important role in the development of a cultural and creative sector. This research space is based on multiple scientific disciplines, in which systematic musicology is one next to others. For example, in the S2S2 survey, with its focus on sound and music computing, a distinction is made between broad-focus content areas, in-focus content areas, and narrow-focus content areas. The broad focus areas include:

- Systematic musicology, covering music semiotics, score analysis, social-aesthetic aspects of music, computational models for music analysis and other aspects
- Auditory and music perception-action, covering psychoacoustics, music perception, computational approaches and models
- Auditory and music cognition, covering sound-based cognition, music cognition, artificial intelligence
- Music acoustics, covering acoustics of musical instruments, room acoustics
- Audio signal processing covering systems, sampling and quantization, spectral and time spectral representations, digital filters
- Hardware and software, covering sensors and actuators, real-time systems, output devices, software platforms, software engineering aspects.

In-focus content areas are:

- Sound modelling, covering models for sound synthesis, physically-based modelling, digital audio effects, artificial reverberation, binauralization, 3D sound and virtual acoustics
- Sound analysis and coding, covering auditory-based audio signal processing, perceptual coding, content-based audio processing and audio descriptors, content description and transmission languages, content-based transformations and synthesis
- Music information processing, covering feature extraction and classification, automatic transcription, music information retrieval, computer assisted composition
- Music performance, covering performance analysis, emotion and expression in music performance, computational models and control of music performance

Narrow-focus content areas are:

- Multimodal interfaces, covering multimodal perception, gesture and multimodal analysis, Representations of multimodal data, control mappings and interaction strategies, multimodal synthesis and rendering, assessment, evaluation, validation of models

- Sound design and auditory display, covering auditory warnings, sound in human computing interfaces, sonification, sound design
- Applications areas, covering digital and virtual musical instruments, interactive performing arts, museum interactive installations, edutainment, entertainment, multimedia and new media, therapy and rehabilitation

Obviously, in this list, systematic musicology has been assigned a specific role quite close to traditional approaches in musicology. This is certainly an area that is "difficult to steal" because it requires particular skills in music that are rather typical. However, the systemic basis of systematic musicology is in fact much broader, as it was influenced by the experimental research in psychology and computational modelling in engineering. The broad approach to systematic musicology covers other broad/in/narrow content areas that are situated in the psychosocial domain and it is likely to involve a number of other content areas as well that are not covered in this list, such as anthropology, ethnology, and perhaps even medialogy.

Anyhow, both the KEA study and the $S2S^2$ study show that Europe's potential power in music research, compared to US and Japan, is large. This can be attributed to Europe's deep involvement with music over the past centuries, and its success in having produced strong musical paradigms rooted in very appealing music systems (such as modality, tonality and different historical styles from early medieval times up to the present), together with its long tradition in humanistic (read musicological) and scientific approaches to music. However, the US seems to be more versatile in terms of bringing a good idea into the market. The lack of continuity in research funding is often one of the major difficulties of the European small scale institutes, even more so when those institutes are operating in humanistic disciplines. The problem of discontinuous funding is more dramatic for small institutes than for large institutes. Core know-how in the hands of a small number of people makes these small institutes vulnerable to a sudden loss or a failure in getting a new project that could guarantee the position of a post-doc.

The European research space for music is organized as a network of small institutes, and temporary consortia are formed by changing coalitions among the members of the pool that defines music research. Transdisciplinarity in this context implies that small institutes have to cross the boarders of their own institute and establish collaborations with other institutes. This can be done at home (own university) or abroad, possibly at an international level. Often the dynamics of the research field also implies that young researchers have to be flexible and change institutes throughout Europe according to the available opportunities. Young systematic musicologists in Europe have to be active in this core music research business and they need to develop a healthy ambition to play a prominent role in this broader European music research space.

Identifying the challenge for music research

Given the above background, it is possible to go deeper into the major challenges for music research and to reconsider the claim that transdisciplinary will make systematic musicology attractive and necessary in the music research space. In other words, how can an umbrella

term like “transdisciplinarity” or “interdisciplinarity” be deployed, and what can systematic musicology contribute to this?

When looking at the state-of-the-art of the disciplines that took music as their research topic it is of interest to ask to what extent these disciplines have encountered the boundaries of their own methodologies. It is my personal experience that young engineers, or brain scientists, sooner or later admit that research on music is a bit harder than expected. And the likely reason for this is often that the discipline handles music from a third-person viewpoint, that is, the viewpoint of music as an encoded physical energy, as a simple body movement, or as brain activation, whereas the human way of dealing with music is based on a first-person viewpoint, that is, based on actions, beliefs, intentions, interpretations, experiences, evaluations, and significations. Indeed, one could claim that in contexts where music is embedded in technology, music needs to be handled from the viewpoint of a physical signal and subsequent feature extraction and therefore, the engineering methods are appropriate. This reasoning is completely valid, but there is another side to it as well, namely that real users involve technologies in view of their intentions, values, beliefs and significations. Real users have a background. They are educated, belong to a particular culture, have a particular expectation, intention and so on. Hence, technology development needs much more than just signal processing and feature extraction. It also needs to take into account how people think, feel, experience, and interact with each other. At this point, it is clear that the engineering approach should be broadened with approaches from other disciplines. And it is also clear that this aspect is still insufficiently taken into account. Similar remarks hold for brain science in that brain activations may not reveal the semantic experience of the subject involved with music. Or can we reduce music to a disembodied brain? Can we deprive subjects from their environment, put them in a scanner and ask them not to move, while we know that 97% of the people do move when they listen to music? Clearly, more is needed to develop current music research practices in the direction of a more comprehensive approach.

The semantic gap that exists between music as third-person observation and as first-person experience is a serious problem and it forms a threat to music research as a whole. Indeed, access to music remains a problem when the retrieval technologies are insufficiently taking into account the user’s search intentions, personal attitudes and social/cultural contexts. Interactive music making is problematic when the interaction is not sufficiently based on the subject’s action-intended control of musical objects. Brain research is problematic when the technologies for brain measurement reduce musical experience to limited conditions where it can be measured.

More effort is needed to adapt these technologies to the study of realistic musical conditions. As my target is more related to the upcoming cultural and creative sector (and less to brain research at this moment) I will focus here mainly on engineering, arguing that the pure engineering approach to music is necessary but not sufficient for contributing to the cultural and creative sector. In similar terms it could be argued that brain research is necessary but not sufficient in that it needs more than just a series of photographs of how an individual human passively responds to music. In both approaches, it can be argued that there is a subjective, corporeal, and social component to be taken into account which is currently not taken into

account at this moment, but which is necessary in view of the supporting services for the creative and cultural sector. I will argue that it is exactly at this point that systematic musicology can make the difference and regain its role as an attractive core discipline for music research.

Object-based approaches to the semantic gap problem

Consider the engineering approach in more detail. The classical approach to the semantic gap problem is object-based in the following sense: Starting from the sound, the approach uses feature extraction and classification methods to transform the sound (as object) into concepts which humans can mentally access. As such, it becomes possible to align musical audio with symbolic music scores, to use high-level semantic terms (such as "happy", "sad", "loud", "soft", "harmonious", "dissonant", "static", "dynamic") to search for music in a database, or to use musical gestures in an interactive system. However, many of the engineering solutions, not only those that make the connection with natural language, appear to be far from sufficiently robust for use in practical applications. In some cases, like in score transcription[9], it looks as if the use of more powerful stochastic and probabilistic bottom-up modelling techniques such as Hidden Markov Chains, Support Vector Machines, Neural Networks do not close this gap much further. In other words, it looks as if the bottom-up methods have reached their platform. Yet the semantic gap is not closed. To the contrary, there is evidence that the semantic gap problem cannot be solved with the current bottom-up engineering paradigm[10].

Among experts (see e.g. S2S^2, 2007), there is a growing understanding that the engineering techniques are excellent and necessary, but that the approach may be too narrow, and therefore insufficient. Briefly listed, the current approach can be characterized as follows:

- Unimodality: The focus has been on musical audio exclusively, whereas humans process music in a multi-modal way. Humans rely on multiple senses (modalities) such as visual information and movement.
- Structuralism: The focus has been on the extraction of structure from musical audio files (such as pitch, melody, harmony, tonality, rhythm) whereas humans tend to access music using subjective experiences (movement, imitation, expression, mood, affect, and emotion).

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[9] In audio-to-score alignment, the target for audio analysis is known, namely as the musical score. Instead, in musical audio transcription the target is not known and each note must be recognized. In a polyphonic context, the latter poses a much more fundamental problem for feature extraction and classification.

[10] Paiva (2006) demonstrated that the classical bottom-up approach has reached its performance platform. In his study on melody extraction from polyphonic audio he showed that even the most advanced methods nowadays available show only a small increase in performance of the model. He used state-of-the-art techniques in auditory modelling, pitch detection and frame-concatenation into music notes and compared different methods. Yet, the results are still far from being sufficiently robust for use in practical applications. Similar observations have been made in rhythm recognition, timbre recognition, genre recognition and other applications that focus on the perception of musical structural features.

- Bottom-up: The focus has been on bottom-up (deterministic and learning) techniques whereas humans use a lot of top-down knowledge in signification practices.
- Perception oriented: The focus has been on the modelling of perception and cognition whereas human perception is based on action-relevant values.
- Object/Product-centred: Research has focused on the features of the musical object, whereas the subjective factors and the social/cultural functional context in musical activities (e.g. gender, age, education, preferences, professional, amateur) have been largely ignored.

In short, the approach starts from the object but does not take into account the proper context and the subjective factors that define how users would like to access music, such as knowledge of the domain or the context in which the technology is used.

Why human sciences are needed to solve the semantic gap problem

More input should come from a better analysis of the subjective human being and its social/cultural context. Such a subject-centred approach would involve:

- Multi-modality: The power of integrating and combining several senses should be considered. Moreover, it is likely that the integration of auditory, visual, haptic, kinaesthetic sensing offers a reduction of the ambiguity of the perceived stimulus.
- Context-based approach: The study of the broader social, cultural and professional context and its effect on information processing is needed. Indeed, the context is of great value for the disambiguation of our perception. Similarly, the context largely determines the goals and intended musical actions.
- Top-down: Knowledge of the music idiom is needed in order to better extract higher-level descriptors from music so that users can have easier access to these descriptors. Traditionally, top-down knowledge has been conceived as a language model. However, language models may be extended with gesture models as a way to handle stimulus disambiguation.
- Action: Research may focus more on the action-oriented component of human behaviour. This implies a new approach to the perception of structural form (or Gestalt) as well because perception of structure is then conceived from the viewpoint of affordances. In other words, one could say that people do not move just in response to the music they perceive, rather they move to disambiguate their perception of music, and by doing this, they signify music. This aspect needs much more attention as it plays an important role in music mediation technologies.
- User-oriented: Research should involve the user in every phase of the research. It is very important to better understand the subjective factors that determine the behaviour of the user.

It is my understanding that the subject-centred approach which is prevalent in this viewpoint should be based on an empirical and evidence-based methodology, so that it connects with object-centred approach. Clearly, this subject-centred approach is not something that is readily available in engineering, nor is it readily available in experimental and/or cognitive psychology, and perhaps not even in systematic musicology as we know it today. Yet, I see it as a main task of systematic musicology to come up with a proper proposal of how to put

music at the centre of human activities. In that sense, my proposal does not entail a rejection of the disembodied approaches in music research. Rather, what I propose is an extension of this approach with an embodied approach that puts the interaction between music and the subject in the centre. This can be done by a better linking of the currently prevailing object-centred account, which is characterized by a focus on audio, structural features, bottom-up data processing, perception oriented modelling and object/product-centred development, with a new type of subject-centred approach, which would be characterized by a focus on multi-modality, context-based processing, top-down data processing, action-based modelling, and user-oriented development.

Systematic musicology "transcends" natural and human sciences

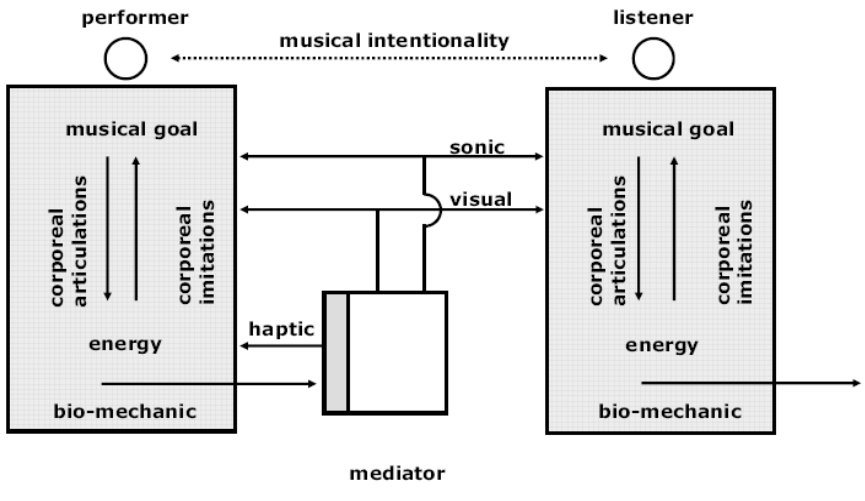
In view of the above analysis it becomes clearer what the role of systematic musicology might be, namely, to foster the development of a transdisciplinary approach that uses object-centred and subject-centred methodologies for researching the relationship between music, mind, embodiment, social interaction and physical environment.

Systematic musicology has a certain tradition in dealing with transdisciplinarity and it offers an education that is much in the spirit of combining natural and human sciences. So yes, there is a value in having a transdisciplinary approach, and systematic musicology is well placed to contribute to problems in engineering and in brain science.

Closing the semantic gap with embodiment

The combination of object-centred and subject-centred approaches is an important point on the agenda of my conception of systematic musicology. Deep inside this approach is the viewpoint that music is related to the interaction between body, mind, and physical environment; in a way that does justice to how humans perceive and act in the world, how they use their senses, their feelings, their emotions, their cognitive apparatus and social interactions. I have tried to develop this core systemic topic in my book on embodied music cognition and mediation technology (Leman, 2007). In that book, I see the tight coupling between action and perception as a key to link all disciplines that deal with music research and I propose a solution for the semantic gap in terms of an embodied approach. In particular, I argue that music signification has a strong corporeal aspect and that this corporeal aspect is largely unexplored until today. The proposed (minimal) model is shown in Figure 1.

Figure1. Music communication: the body as link between mind and physical environment



The central idea of this model is that the human body supports action causation and perception from a musical goal to bio-mechanical, haptic, sonic, and visual energy. This proceeds back and forth via corporeal articulations and corporeal imitations, so that goal-directed action at the higher level of intentionality can be established. This intentional level is embedded within subjective experience, while the physical channels through which communication proceeds can be approached from an objective viewpoint.[11]

Clearly, in this approach, mental musical activity is not reduced to physics, nor is gesture and meaning reduced to the biomechanics of the human body, or to a mere disembodied approach of mental representation and cognition. Instead, the human body is considered to be a core component of a mediation system that relates the mental with the physical environment. In this context, transdisciplinarity means that disciplines which address the mental world, the physical environment and the human body are involved and used to focus on the musical aspect. Clearly, progress in this domain can only be made when the disciplines transcend their boundaries and take the relationship between music and humans as a goal to develop new methods and approaches. In my opinion, it is the task of systematic musicology to educate, promote and research into scientific methodologies that transcend the boundaries of limiting approaches. From that point of view, whatever can support music understanding should be used, including engineering, brain research, biology, cultural studies and so on, but in genuine music research, music and the tight connection between mind and body, and between the exchange of physical energy and the generation of interaction patterns at the level of intentionality (Figure 1), will always remain a central issue to which the methodologies have to be fine-tuned.

A role as moderator at the crossroads of modern music research means that systematic musicology is in charge of a discussion that makes sure that music research is conducted towards the realisation of a vision that fosters the development of our understanding and use of music as a cultural and societal value, as an economic value, and as a value for innovation and creation within an framework that subscribes the tight connection between musical mind, body, physical environment and social interaction. While this (I repeat) cannot be done by one single discipline, but instead by many disciplines that work together and transcend their boundaries, systematic musicology can clarify the vision and well as the transdisciplinary research paradigm that implements the realisation of this vision through empirical approaches and methodologies. Understanding the role of musical mind and body in relation to the physical and technological environment is a huge task but one that is absolutely necessary for all disciplines involved in music research.

[11] The approach is related with the perception theoretical notions of emulation and simulated perception (e.g. Berthoz, 1997). Historical roots can be found in the work of Piaget, Apostel, Maturana and Varela (e.g. Maturana and Varela, 1980). Reference can also be made to European projects (e.g. ENACTIVE, ConGAS, EMCAP).

Embodiment and social interaction

Thus, in the above model, a systemic approach to embodiment is proposed as the key feature that will help systematic musicology to develop solutions for core problems in music-related psychosocial interaction. By implementing this idea in research and in education[12], I believe that systematic musicology will be able to re-establish its position in the modern music research space.

Given the above model, there is a good reason for expanding embodiment with a component of social interaction. In fact, both embodiment and social interaction are strongly related with each other as they fit with the above-mentioned cultural and psychosocial value of music. Indeed, the articulations of the human body in music making and other musical activities such as listening and dancing are functioning in a natural context of social interaction. In this context, humans communicate expressive gestures along corporeal-based communication channels that are rooted in social cognition. It is likely that these expressive gestures form part of a social language that appeals to an essential component of human being. Therefore, concepts such as "behavioural resonance", "corporeal interaction", "expressive gesture", "synchroni-zation" and "entrainment" are key concepts in our understanding what music is about. In my view, these concepts form the core concept of a new approach to systematic musicology (Leman and Camurri, 2006).

This new systematic musicology is different from the past in that it differs radically from the disembodied approaches of the cognitive sciences that were still dominant in musicology at the turn of the 21st Century[13]. However, it should be admitted that the focus on the perception of musical structures (such as pitch, rhythm, tempo, harmonic progression, articulation and so on) has been historically important and this will remain important in the future. Yet, a focus on musical structures is not sufficient to understand the complex phenomenon of music. What is needed is more attention for the values and goals of what music is all about, and what these values and goals mean to people[14]. In that sense, the role of

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[12] See the summer schools on systematic musicology (ISSSM), organized in Jyväskylä (1999, 2001) and Ghent (2006, 2007, 2008).

[13] The classical approach to systematic musicology is based on a theory that is rooted in the analysis of musical structures, their representation and inherent regularities. This approach has its roots in the Cartesian divide between moving bodies and the experienced self, and it is still dominating much of the music research today. In that respect, the modern and up to date music compendium by G. Loy (Loy, 2006) is still reminiscent to Descartes' Musicae Compendium of 1619. However, let it be clear that there is no reason to discard this good old mathematical "disembodied" approach to music at all. Instead, my plea is to extend this powerful approach with a new chapter that does justice to the embodied involvement with music. In that sense, I plea for an extension of tradition music cognition towards an embodied approach. Apparently, even Descartes, in his compendium, already suggested the need for doing this.

[14] As it will be clear by the previous paragraphs, I conceive the subject-centred approach in the sense of an empirical and computational approach, rather than in terms of a postmodern narration. However, the latter is a reality in (historical) musicology and therefore, this reality should be evaluated in terms of its possible contribution to a music research space that

systematic musicology is to push approaches towards elaborating the focus on structural aspects towards more comprehensive embodied approaches of music understanding. In retrospect one could say that what was „stolen“ from systematic musicology was in fact the disembodied component, namely, the (wrong) idea that music is merely about structures, and that human involvement with music is merely about perception.

As the communication model of Figure 1 suggests, non-verbal communication patterns, for example, the responsive and expressive movements of body parts are key indicators of the musical communication. It can be assumed that they are also key indicators of the social embodied musical communication and the role of expressiveness in gesture. Up to now, the understanding of these corporeal types of non-verbal communication in their social interactive context is very poorly understood. I do believe, however, that certain states of social entrainment (based on the mutual adaptation of non-verbal expressive corporeal communication patterns) can be somehow perceived by the human mind as a state of optimal experience or “flow”. This form of direct experience with music can be contemplated and the awareness of social entrainment that can be accessed in terms of semantic descriptions (i.e. descriptions of signification) as well. It is not excluded that these descriptions can be partly related to the (objective) measurements of the human body so that these descriptions can be used in connection with content-based technologies (e.g. the “Music Google”). We may assume that the process of signification, from corporeal signification to cerebral signification is a central factor that contributes to personal development and social well-being. This type of model, which connects mental, physical and social aspects, offers an attractive perspective which is much needed in music research. In my opinion, systematic musicology has the tradition and the competence to play a leading role in developing a transdisciplinary music research that focuses on these aspects.

Transdisciplinarity thus emerges from two sides, first, from a call for innovative services that support a broad range of activities in the creative and cultural sector, second, from a call for solving the semantic gap as the major obstacle for a breakthrough in content-based music technologies (the “Music Google”). In both cases, it is unlikely that solutions will come from one single discipline, say engineering or brain science. Instead, an approach that puts music at the centre and that further transcends the boundaries of objective and subjective descriptions, of mind and embodiment, of physics and intentionality, and of individual and social interactions is going to be transdisciplinary in that it combines methods and techniques from many different sciences, both natural sciences and human sciences. At the crossroads of music research, systematic musicology functions as a moderator of transdisciplinary viewpoints, approaches and methodologies. Without such a moderator, there would be more dispersion of the approaches as well as a risk that the research narrows down to risky commercial applications. An example of the latter is again related to our “Music Google”. According to the current state of the art in content-based music retrieval, certain techniques work quite well for simple commercial music but not for classical music or other types of non-western music. Should these techniques be commercialized, then? Clearly, their usage

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supports the cultural and creative sector. Unfortunately, and as far as I know, this has never been done, though I believe that embodiment may offer a possible point of connection.

would favour the retrieval of simple commercial music and disfavour the retrieval of more complicated, non-western, and non-commercial musical approaches. More people would get access to commercial music but the limitations of the technology would narrow down the broad spectrum of music that is actually available (even via internet). Therefore, there is clearly a task for systematic musicology to point to these dangers and to contribute to the development of technologies that can handle any type of music. Up to now, the state-of-the-art in music retrieval technology is too much focused on Western concepts and it is the task of systematic musicology to enlarge this viewpoint (see Moelants et al., 2007, Tzanetakis et al., 2007).

The S2S^2-project: a roadmap for transdisciplinary music research

Having revealed what makes systematic musicology in my view a necessary partner in music research, I now turn to the discussion of the research strategy that would guarantee impact on music research at long term. Having a good concept (although still open for discussion and refinement), the strategy is to implement that concept in the structures that support the creative and cultural sector. These structures involve the actual research, the educational system, and innovative industrial and social-cultural creative applications. Much of what follows is based on work of the S2S^2-consortium on a roadmap for sound and music computing research.

S2S^2 stands for Sound to Sense, Sense to Sound which, in fact, is exactly about this relationship between physical encoding of music and music as experience. The S2S^2-project was based on an interdisciplinary consortium of music research laboratories in Europe, with the major task of writing a roadmap for sound and music computing. The consortium included the Media Innovation Unit, Firenze Tecnologia, Firenze, Italy (N. Bernardini), the Music Acoustics Group of the Kungliga Tekniska Högskolan in Stockholm, Sweden (R. Bresin), the Music Technology Group of the Universitat Pompeu Fabra in Barcelona, Spain (X. Serra), CSC - Dept. of Information Engineering, University of Padova, Italy (G. De Poli), the Austrian Research Institute for Artificial Intelligence of the Austrian Society for Cybernetic Studies in Vienna, Austria (G. Widmer), the Département d'Etudes Cognitives of the Ecole Normale Supérieure in Paris, France (A. de Cheveigné), the Laboratoire d'Etude de l'Apprentissage et du Développement of the Université de Bourgogne in Dijon, France (E. Bigand), the Institute for Psychoacoustics and Electronic Music of the Universiteit Gent in Ghent, Belgium (M. Leman), the Laboratory of Acoustics and Audio Signal processing of the Helsinki University of Technology in Espoo, Finland (V. Välimäki), the Vision, Image Processing and Sound Laboratory of the University of Verona, Italy (D. Rocchesso), and the Laboratorio di Informatica Musicale of the University of Genova, Italy (A. Camurri).

On the 16th of April 2007, this consortium launched a roadmap on Sound and Music Computing in the headquarters of the European Research Council in Brussels. The roadmap is in fact an ambitious document, of less than 100 pages, that aims at defining the major challenges for future music research. As a guide, it will have impact on the future strategic planning for sound and music research of the European Commission. In what follows, I will briefly introduce the rationale behind this roadmap and I show how transdisciplinary

systematic musicology is inscribed as a core aspect of the European music research as it is envisioned for the future.

Content of the S2S^2-project

The S2S^2-project has produced three major outcomes, namely a book containing the state-of-the-art in sound and music computing[15] a series of summer schools that addressed the education of young music researchers[16] and of course, the roadmap itself, which is a text of about 100 pages. The first text was edited by X. Serra, M. Leman and G. Widmer and is available as pdf on the internet[17].

The S2S^2-roadmap contains three parts, namely, (i) a description of the context and main trends in which music research operates, (ii) a state-of-the-art and identification of the research points and open issues, and (iii) a description of the research challenges.

i. Context: This consists of the research context, the educational context, the industrial context, and the social/cultural context. These contexts tell us about the societal framework in which music research is currently operative. It is mentioned that transdisciplinarity is necessary in research, for industrial development and cultural applications, but that it is rather difficult to implement the educational part.
ii. The state-of-the-art then focuses on the main open issues. A distinction is made between research that focuses on sound and research that focuses on music. In between, there is the interaction between sound and music. For each research field (sound, interaction, music), there is an analytic and a synthetic component. The analytic component goes from encoded physical (sound) energy to meaning (sense), whereas the synthetic component goes in the opposite direction, from meaning (sense) to encoded physical (sound) energy. Accordingly, analytic approaches to sound and music pertain to analysis and understanding, whereas synthetic approaches pertain to generation and processing. In between sound and music, there are multi-faceted research fields that focus on interactive aspects. These are performance modelling and control, music interfaces, and sound interaction design. The nature of these distinctions reveals the inherent transdisciplinary character of the research field, as both the analytical (from sound to sense) and the synthetic (from sense to sound) approaches.
iii. The challenges part looks ahead and identifies the key challenges for music research together with the strategies with which to face them. These challenges fit with the open problems that were identified in part (ii), and they are constrained by the contexts which were identified in

[15] This book is currently edited by D. Rocchesso, to be published by LOGOS-Verlag in 2008.
[16] Reference can be made to the summer schools on sound and Music computing held in Barcelona 2004, Genova 2005, Barcelona 2006, Stockholm 2007.
[17] See http://smcnetwork.org/roadmap. Recently, this text has been reworked and polished to be published as a first frozen version in a special issue of the Journal of New Music Research, Vol. 36, Issue 3, 2008 (edited by N. Bernardini and G. De Poli). This issue contains the three main parts of the roadmap as separate articles, together with a roadmap from IRCAM (by H. Vinet) and a viewpoint from the US (by R. Dannenberg) and Japan (S. Hashimoto). See http://www.tandf.co.uk/journals/ spissue/nnmr-si.asp

part (i). It may be of interest to give a brief summary of the challenges that have been identified.

Challenge 1: to design better sound objects and environments

- Strategy 1: Seek directions in which to extend the notion of musical instrument
- Strategy 2: Improve technologies for pervasively producing, transforming and delivering sounds
- Strategy 3: Intensify research in sound modelling that goes beyond imitation towards capturing the communicative potential of sound
- Strategy 4: Promote research in fields involved in the shaping of natural, artificial and cultural acoustic ecosystems
- Strategy 5: Promote research on the effect of environmental constraints on artificially diffused sound and music
- Strategy 6: Promote studies aimed at reducing sound and music pollution in public and private ecosystems

Challenge 2: to understand, model, and improve human interaction with sound and music

- Strategy 1: Promote computational modelling approaches in human auditory perception and cognition research
- Strategy 2: Provide extensive augmented perception paradigms
- Strategy 3: Intensify research on expressivity and communication in sound and music
- Strategy 4: Develop an embodied, integrated approach to perception and action
- Strategy 5: Intensify multimodal and multidisciplinary research on computational methods for bridging the semantic gap in music
- Strategy 6: Intensify interaction with the arts

Challenge 3: to train multidisciplinary researchers in a multicultural society

- Strategy 1: Design appropriate multidisciplinary curricula for SMC
- Strategy 2: Promote broader integration of Arts and Sciences
- Strategy 3: Promote cross-cultural integration
- Strategy 4: Promote better coordination in Higher Education
- Strategy 5: Enhance education resources for Higher Education.
- Strategy 6: Promote the dissemination of available Higher Education in SMC.

Challenge 4: to improve knowledge transfer

- Strategy 1: Promote dissemination of SMC research and objectives among the general public
- Strategy 2: Promote projects containing artistic components
- Strategy 3: Promote the awareness of the various models of IP protection of research results
- Strategy 4: Promote venues for meeting industry experts

- Strategy 5: Promote direct industrial exploitation of research results
- Strategy 6: Promote academic quality standards.

Challenge 5: to address social concerns

- Strategy 1: Identify social needs relevant to SMC development; develop methods for the evaluation and assessment of SMC technologies in social contexts
- Strategy 2: Expand existing SMC methodologies (currently targeted at individuals) to understand music in its social dimension
- Strategy 3: Promote development of technologies and tools for broader collaboration, information and communication engagement; emphasise user-centred and group experience-centred research and development
- Strategy 4: Exploit cross-fertilisation between human sciences, natural sciences, technology, and the arts
- Strategy 5: Expand the horizon of SMC research through a multi-cultural approach.

Above, I have described how this roadmap relates systematic musicology to other disciplines. In this description of the main challenges, it is evident that the transdisciplinary approach is a central feature. For example, in Challenge 2, Strategies 4-6 mention integration, multimodality, multidisciplinarity and interaction with arts. The notion of multidisciplinarity is taken up explicitly in Challenge 3, where the need for multidisciplinary curricula is addressed. In Challenge 4, the mentioning of cross-fertilisation between human sciences, natural sciences, technology, and the arts contains an explicit reference to multidisciplinarity. Reference to augmented perception, expressivity, embodiment and multimodality support the core challenges for music research. In Challenge 5, there is an explicit call to develop music technology in its social dimension. The latter aspect is not unimportant. After all, as mentioned, music is a very important aspect of all human cultures. Music gives meaning to life. It is a basic ingredient of cultural, group and personal identification and social bonding. Music affects the mental and bodily health of people.

Towards centres of excellence in Systematic Musicology

In the context of a flourishing European music research space, there have been a number of initiatives that contributed to the development of systematic musicology. Starting in 1993, the International Society for Comparative and Systematic Musicology (with seat in Hamburg) has organised a number of international conferences at Moravaný, 1993, Hamburg, 1994, Schloss Zeillern, 1995, Brugge, 1996, Berlin, 1997, Oslo, 1999, Jyväskylä, 2001, with several publications[18]. In recent years the Society has supported the educational activities of an international consortium of systematic musicology centres, consisting of the University of Hamburg, Köln, Jyväskylä, Oslo and Ghent. As a practical outcome, this consortium has organised several International Summers Schools on Systematic Musicology (ISSSM)[19].

[18] See http://www.uni-hamburg.de/Wiss/FB/09/Musik/systematicmusicology.html
[19] See e.g. www.ipem.ugent.be/ISSSM2007

The Conference on Interdisciplinary Musicology (CIM) is an initiative to create a forum for constructive interaction among all musically and musicologically relevant disciplines. CIM especially promotes "collaborations between sciences and humanities, between theory and practice, as well as interdisciplinary combinations that are new, unusual, creative, or otherwise especially promising". The first Conference on Interdisciplinary Musicology (CIM04) was held in Graz, 2004, then in Montreal, 2005, Tallin, 2007, and Thessaloniki, 2008.[20]

Recently, two centres for systematic musicology have received a substantial funding for long term (6 to 7 years) research in areas that affect the creative and cultural sector. Though these are national initiatives, they express a clear sign that countries are willing to invest more into systematic musicology research, provided that it supports the creative and cultural sector. The first centre is located in Jyväskylä and is supported by the Academy of Finland. The overall theme of the research in this so-called "Finnish Centre of Excellence in Interdisciplinary Music Research" is "the human as a listener, experiencer, and performer of music. Within this theme, research will investigate areas including perception and learning of music, musical emotions, and the connection between music and motion. The research is empirical and makes use of modern technology, such as brain imaging and motion capture devices as well as computer modelling". The centre combines the expertise of two research teams, namely, the Music Cognition Team (University of Jyväskylä, Department of Music, lead by Petri Toiviainen) and the Brain and Music Team (Helsinki University, Department of Psychology, lead by Mari Tervaniemi).

The second centre is located at IPEM, Department of musicology, Ghent University, where a long-term ("Methusalem")-project has been started up on a topic related to embodied music cognition and mediation technologies for cultural/creative applications ("EmcoMetecca"). The project will focus on the development of empirical and computational approaches that foster embodiment and social interaction in music contexts. While the Finish project is build around collaboration between a music department and a department of brain science, the Belgian project is built around core research in systematic musicology with a substantial collaborative component in the area of electronic engineering. Both are example initiatives at the National and University level.

As both research groups start their activities in 2008 they will need some time to fully deploy themselves as a critical mass in the modern European music research space. As a matter of fact, these two projects are not the only projects in the field of systematic musicology but I mention these two projects because their amount of support is large and perhaps more endurable than the typical projects that could be obtained in the past by competition in university programs, national research programs and European research programs (lasting 2 to 4 years with typically 1 or 2 full time personnel). Hopefully, this is the start of a new trend in the building of a European space for music research. There are several larger institutes already operative in Paris (IRCAM, which is interdisciplinary and broad) and Barcelona (UPF-MTG, which is more focused on signal processing). The new groups in Finland and Belgium are not that large, and they are likely to focus more on niche areas

[20] See http://www-gewi.uni-graz.at/staff/parncutt/cim.htm

within music research and systematic musicology. Yet the trend may be that Europe is re-shaping its music research space by building slightly larger research groups that have a more stable funding and that are more specialized in different niches of the music research space. The fact that systematic musicology is a player in this development should not come as a surprise. As I have tried to explain, its history and its empirical and computational orientation give this discipline a natural position in the centre of modern music research activities. However, it is necessary that more such centres become available so that a stable critical mass for research can be created and maintained. This is, I believe, the best guarantee for delivering outputs that can have an endurable value for society.

The above initiatives are by no means exhaustive. Rather, they are examples of activities that show the viability of systematic musicology in a rapidly changing European research space. It is very likely that systematic musicology has a bright future, provided that it can position itself at the crossroads of music research that supports the creative and cultural sector. In that sense, I believe that systematic musicology certainly has a value that appeals to a broad range of researchers with backgrounds in engineering, physics, psychology and neuroscience. Its necessity can be justified by pointing to its central role in transcending the boundaries of disciplines and its possible role in solving the semantic gap problem.

Towards centres for creation and public interaction

Supporting research for the creative and cultural sector implies research in areas that foster production, distribution and access to music. In the past, IRCAM[21] has been the main centre in Europe where this strategic alliance between artistic production and scientific research was actually implemented. From the very beginning, IRCAM's objective was to bring science and art together in order to widen the instrumentarium and to rejuvenate musical language. However, in Europe there is now a clear trend towards the creation of more such strategic alliances between art centres and research groups.

Casa Paganini[22] is an international centre in Genova for scientific and technological research in music and performing arts, artistic production of new music projects related to new technologies didactics, international schools and conferences. Casa Paganini is conceived as an incubator for new contemporary musical trends, for research in interactive multimedia systems and digital music technologies. The mission of Casa Paganini also includes research and developments with direct impact on therapy and rehabilitation, sport, edutainment and entertainment, in collaboration with industry (e.g., contributes to new multimedia interfaces and applications) and for cultural applications (museums, science centres). Casa Paganini is led by the University of Genova and in particular by the InfoMus Lab of DIST (A. Camurri) in collaboration with Regione Liguria, Provincia di Genova, and Comune di Genova.

The Sonic Arts Research Centre (SARC)[23] at Queen's University Belfast is a newly established (2004) centre dedicated to the research of music and sound. This interdisciplinary

[21] http://www.ircam.fr
[22] http://www.casapaganini.org/
[23] www.sarc.qub.ac.uk

project has united internationally recognised experts in the areas of musical performance and composition, electrical engineering and signal processing, psychology, and computer science. The Centre is established in a purpose-built facility located alongside the engineering departments of Queen's University. The centrepiece of SARC, the Sonic Laboratory, provides a unique space for cutting-edge initiatives in the creation and delivery of music and audio. The Sonic Laboratory's uniqueness is vested in the degree of flexibility it can provide for experiments in sound diffusion, performance, and sound interaction, within a purpose-built, 3 story tall, variable acoustic space. The Sonic Laboratory contains a unique cluster of audience seats that are outfitted with sensors to measure audience and performer interaction.

A final example is the Bijloke Music Centre in Ghent. After many years of concert organisation, this centre opened its brand new infrastructure in 2007, including one large concert hall (located in a large and unique building dating from the 13th century), and a number of different smaller halls, of which two rooms are dedicated to multimedia performances (a former library and a former anatomy arena). The activities of Bijloke are no longer merely focused on concert organisation but they include many other activities related to music, like exhibits and multimedia workshops. Like Casa Paganini and SARC, Bijloke Music Centre wants to be operative as an incubator for new contemporary musical trends, for research in interactive multimedia systems and digital music technologies. Bijloke Music Centre has set up an agreement with Ghent University to start up joint activities in multimedia performances and related experiments in the context of the “EmcoMetecca” project.

These are just three examples of recent initiatives that show how music research laboratories at universities (both in engineering, musicolog, and music performance) expand their activities in a domain that was up to recent rather separate from academic research. These examples are not meant to given an exhaustive overview of these developments. They just illustrate how music research is currently positioning itself inside one of the core activities of the creative and cultural sector, namely public performance and concerts. As new technologies allow new forms of artistic expression, and as artistic expressions constantly challenge the development of new technologies, it is likely that more institutes for music research will engage themselves in this type of alliances. It shows that the European music research in academia is ready to play a role in this creative and cultural sector and that systematic musicology can be a creative partner in this.

Conclusion

In this paper, I have argued that systematic musicology should take up its role as moderator at the crossroads of music research. The societal and economic value of the creative and cultural sector calls for a broad research basis grounded in different disciplines that specialize in technology, brain and social research. In that context, research on music is no longer the privilege of systematic musicology. On the one hand, it may appear that music research has been “stolen” from systematic musicology. On the other hand, these non-musicological disciplines bring in new and advanced methodologies that push music research into the frontiers of modern science.

I argued that music research in engineering and brain sciences often does not address signification practice and social interaction that makes music important for people. The main problem is the so-called semantic gap problem, that is, the difference between music as encoded musical energy and music as experienced meaning. The methodologies of non-musicological disciplines often do not allow a straightforward bridge from the physical/physiological domain to the relevant musical domain. This is perhaps due to the fact that these disciplines cannot afford investing too much in the musical domain which, by its nature, necessitates a transdisciplinary approach. A bridge between objective and subjective approaches in music is absolutely needed in a context of creative and cultural applications, such as in music information retrieval and interactive music systems. After all, music covers a broad range of phenomena. Music appeals to all human senses and it involves all faculties of human perception and action. It cannot simply be reduced to approaches that just consider either objective or subjective aspects.

Systematic musicology, by tradition, is naturally positioned to transcend the different non-musicological disciplines and motivate them to keep the focus on music. In the past, it is possible that systematic musicology has not been able to position itself in a sufficient way at the crossroads of music research. The reasons for this are manifold yet they may be have been related to the nature of the paradigm of the cognitive sciences which was, until recent, focused much on disembodied approaches (often influenced by linguistic paradigms) that distracted the focus from what music is really about. I consider the specific task of systematic musicology to develop the theory, the research paradigm and the methodology that is needed to transcend the contributions from different disciplines to music research. When music is put at the centre of music research, then there will always be the need for a discipline that somehow keeps the overview and the perspective. In contrast with previous approaches that were disembodied, I argue in favour of an embodied music research paradigm (Leman, 2007). In this paradigm, the human body is considered as the natural mediator between the mind and the physical environment. New mediation technologies can then be developed that extend the human body (the natural mediator) into domains where our mind has otherwise no access. These domains involve music and have a strong social component. In short, embodied music cognition and social interaction put music at the core of the research focus and they necessitate a new methodology that can only be developed by adopting a transdisciplinary perspective that integrates an object-centred account with a subject-centred account. While the former is characterized by the focus on audio, structural features, bottom-up data processing, perception oriented modelling and object/product-centred development, the latter is characterized by multi-modality, context-based processing, top-down data processing, action-based modelling, and user-oriented development. The present paper is a plea for making systematic musicology the discipline at the crossroad of the new music research space. The recent initiatives for long term research in small countries as Finland and Belgium show that after all, systematic musicology is a vital research area. The core of systematic musicology has not been stolen. How could it be stolen? What happened was just an expansion of the music research space, something that was needed to establish a broad interdisciplinary and transdisciplinary research basis for a sector that has both a high human, a high economic, and a high creative and innovative value.

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