# Keynote

# Text representation of music: from word processing to rule-based composition/improvisation

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The *Bol Processor* project originated in 1980 as a word processor facilitating the transcription of quasi-onomatopoeic syllables used as an oral notation system for Indian drumming. It grew up as an expert system (BP1) mimicking the ability to compose variations on a musical theme or assess their acceptability. *Pattern grammars* (a subset of type-2 formal grammars) proved appropriate for modelling the musical system under study. A stochastic learning device was implemented to infer weights from sets of examples accepted by the grammar, with the effect of enhancing the aesthetic quality of productions. None the less, field work revealed limitations inherent to the expert system approach when it comes to modelling sophisticated human improvisation skills.

In 1989 a numeric-symbolic learning device (QAVAID) was implemented in Prolog II for inferring grammars from examples. However, it has never been used in fieldwork because of its slow operation on portable computers of that time.

The next implementation of *Bol Processor* (BP2) addressed the issue of music composition and improvisation in the *MIDI* and *Csound* environments of electronic music. A new challenge was to deal with superimposed sequences of events (polyphony) within the framework of text-oriented rewriting systems. This was achieved by means of *polymetric representation*. Minimal descriptions of polyphonic/polyrhythmic structures may be "expanded" by the system to produce arbitrarily complex musical scores. This representation makes it possible to produce sophisticated time-patterns from information comprehensively imbedded in compositional rules, thereby maintaining the consistency of interpretation. This is a major discovery for computer music, as "human-like" phrasing is no longer achieved by randomness nor "interpretation rules".

Producing the actual performance requires additional information which the *Bol Processor* encapsulates in metrical/topological properties of "sound-object prototypes". A time-setting algorithm modifies sound-objects taking into account physical timing and their adjacent sound-objects, much in a similar way human speakers modify the articulatory properties of speech sounds with respect to the speaking rate and influence of adjacent segments (coarticulation).

Many composers and music teachers support the *Bol Processor* approach because of its underlying paradigm of text representation, i.e. "composing with pen and paper". It found its way long before the invention of markup languages, at a time only graphic interfaces were expected to capture the sophistication of compositional processes.

BP2 is currently implemented for MacOS 9 and MacOS X. The project has been open-sourced by Sourceforge at `http://sourceforge.net/projects/bolprocessor/` with the help of Anthony Kozar.

**Bernard Bel** is a computer scientist with background in electronics. In 1979 he started collaborating with anthropologists, musicologists and musicians on a scientific study of North Indian melodic and rhythmic systems. In 1981 he built the first accurate real-time melodic movement analyser (MMA) for the analysis of raga music. In 1986 he joined the French National Centre for Scientific Research (CNRS) in Marseille to continue a research on the rule-based modelling of training methods in traditional Indian drumming. He studied artificial intelligence under Alain Colmerauer and graduated with a PhD in theoretical computer science in 1990. Between 1994 an 1998, Bel was deputed to CENTRE DE SCIENCES HUMAINES (CSH, New Delhi) to carry on projects in the fields of computational musicology and social-cultural anthropology. He displaced his focus to "innovative" music forms: different ways of associating musical experience with information technology, and questioning the usual modernity/tradition dichotomy outside Western urban culture. In 1998 he joined LABORATOIRE PAROLE ET LANGAGE (CNRS, Aix-en-Provence) as a member of a team specialised in speech prosody and formal representations of language. Together with colleagues at CNRS he created the Speech Prosody Special Interest Group (SproSIG) under the banner of the International Speech Communication Association (ISCA).