STUDII

Computer Simulation as Research Method in Ethnomusicology
(e.g. Romanian Bucium Music and Arabian Taqsim) *

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Prolog

Scris în anii 1990-91, acest articol conține – din punctul de vedere actual – pe lângă multe idei bune, o serie întreagă de naivități. Cred că interesul său constă astăzi mai ales în aceea că el poate fi privit ca reprezentând o pagină de istorie. Este vorba de anii 1985-1995 şi de un anumit context român-german.

În acei ani, computerul era ocazional folosit în etnomuzicologie mai ales cu scopul arhivării materialelor, iar primele experimente de simulare a muzicii clasice ale lui David Cope existau mai ales teoretic. Dar nu se prea vorbea de simularea la computer a unor limbaje muzicale etnice. În 1989, curând după emigrarea mea, când am primit o bursa la *Internationales Institut für vergleichende Musikstudien und Dokumentation* din Berlin şi am avut acces la un bun computer IBM, am ales ca temă *Muzica de bucium românească* şi am început să lucrez mai mult "pe cont propriu" la programarea simulării acestei muzici. Am fost privit cu multă curiozitate de către diferite persoane de pe scena berlineză etnologică a timpului (între alții, Max-Peter Baumann, directorul Institutului, Ulrich Wegner, "sfetnicul" său principal, Artur Simon, directorul Muzeului de Etnografie, Susanne Ziegler, colaboratoare, Joseph Kuckerz, şeful secţiei de etnomuzicologie din cadrul Freie Universität-Berlin, Rüdiger Schuhmacher, asistentul său dar şi altii, cum ar fi prof. Helmut Schaffrath din Essen sau prof. Robert Günther din Köln) dar nu am primit niciun sprijin real, domeniul le era străin. Apoi am

extins lucrul asupra *maqam*-ului *bayati*, de data asta „controlat" de prietenul şi colegul meu de la Institut, Habib-Hassan Touma, un specialist în muzica arabă, care nu înceta să se minuneze de "autenticitatea" melodiilor simulate... Lucrul, desfăşurat paralel cu alte preocupări, mi-a luat peste un an și s-a finalizat într-un program complex, constituit din câteva module, cu funcționare interactivă (programul accepta ca *input* câteva date-cadru: genul dorit, durata piesei, forma *output*-ului etc.)

Pe baza acestui program am redactat un text explicativ. Acest text a fost prezentat în 1992 la cea de a 52-a sesiune a *Study Group on Computer Aided Research* din cadrul ICTM de la Viena, însoțit de numeroase exemple muzicale și transcripții comparative între piese autentice și cele simulate. Comunicarea mea a trezit un interes excepțional între specialişti și s-a decis chiar ca viitoarea sesiune a grupului de lucru respectiv să fie dedicată exclusiv acestei teme. La această sesiune nu am mai luat însă parte, iar de la o publicare imediată m-a reținut (ca întotdeauna...) intenția de a revizui și îmbunătăți prima formă; iar când am avut prilejul, am preferat să public altceva. Au trecut câțiva ani, apoi s-a ivit o ocazie neașteptată: prof. Franz Födermayr din Viena m-a solicitat să ofer un articol pentru volumul festiv dedicat entmuzicologului (ceho)slovac Oskar Elschek, la recomandarea acestuia. Intre multe alte merite, el era unul dintre primii care, împreună cu soţia sa, Alica Elschekova, iniţiase la Bratislava un sistem de clasificare a arhivei etnomuzicale cu ajutorul computerului. Era într-un fel, exact ceea ce aşteptam, aşa că am revizuit imediat, completat, extins etc. şi însoţit cu noi exemple muzicale prima formă a articolului ce vegeta în sertar şi apoi l-am predat prompt. A urmat prelucrarea redacţională a textelor volumului, totul mergea perfect. Dar... am făcut două mari greșeli (și nu pentru prima oară în viața mea): am trimis singura formă completă a întregului material, deci originalele unice, apoi, înainte de finalizarea colaborării noastre, m-am certat serios cu redactorul, prof. Födermayr, deoarece acesta s-a amestecat într-un fel absurd în formatarea materialului. După ce i-am expus deschis şi cam dur ce gândesc despre asemenea amestecuri, el s-a simţit jignit şi nu a mai reacționat – articolul a fost scos din volum iar eu, în pofida cererilor mele repetate, nu am mai văzut

niciodată materialele. Și nu am mai putut să le refac, deoarece schimbasem în această perioadă configurația computerului (software și hardware) şi nici nu mai aveam timp, astfel că ideea și munca a câtorva ani s-au pierdut definitiv. Ca și consemnarea în timp oportun a unei eventuale priorități românești în formularea unei idei ce a devenit curând relativ comună. Ce a rămas este doar prima formă a comunicării din 1992.

Dar există şi o „pre-istorie" a acestei experienţe. Înainte de emigrarea mea din 1987 avusesem în România pe rând toate computerele care circulau pe vremea aceea - desigur ne-oficial și la preţuri astronomice: ZX, Spectrum, Commodore 64 si 128 - iar interesul meu s-a îndreptat imediat spre ceea ce se va numi curând AI ("artificial inteligence") şi anume, centrat asupra domeniului gândirii componistice văzute ca un algoritm; priveam asta ca pe un fel de joc, dar un joc serios, pasionant, cu perspective fantastice. Prietenia mea cu Cornel Cezar din anii 1985-87 se baza între altele şi pe interesul nostru comun pentru programarea la computer – temă complet necunoscută altor colegi ai noştri, dacă facem abstracţie de Aurel Stroe şi Lucian Meţianu, care erau în legatură cu *Centrul de calcul*; dar nu o asemenea colaborare limitată ne doream noi. Fără a dispune de o calificare profesională în acest domeniu, noi eram pregătiţi să explorăm domeniul pas cu pas, o atitudine încăpăţânat-empirică, care ne acorda însă o libertate deplină, ca şi satisfacţia de a descoperi ceva noi înşine. Astfel ne-am iniţiat noi în programare la computer, ca autodidacţi, fiecare „realizare" costându-ne zile şi nopţi de experimentări. Un alt element comun cu Cezar, de asemenea cu totul "exotic" pentru alții, era interesul nostru comun pentru astrologie. Cezar a folosit computerul pentru a scrie un program de calcul al pozițiilor astrelor pe o astrogramă, temă la care a lucrat minuţios ani de zile, folosind tabele cu date siderale sau documentație de programare ce circulau "pe sub mână" prin copii xerox; odată calculate corect datele astrologice (ceea ce manual ar fi luat câteva zile de lucru intens și ar fi produs ușor greșeli) se putea trece la interpretare, ceea ce necesita nu numai informare din cărți speciale, ci și un anumit talent psihologic. Asemenea servicii sau programe există azi deja la preţuri foarte modeste, dar în acei ani era ceva unic. Între prietenii cărora soţia mea de atunci,

Teodora, devenită specialistă în astrologie, le-a făcut astrograma, se numărau Ştefan Niculescu, care era pur şi simplu entuziasmat de descrierea intimă a caracterului său, ca şi Adrian Iorgulescu, care mi-a mărturisit de curând că şi acum este încă surprins de exactitatea nu numai a descrierii sale, dar şi a prezicerilor de viitor, de neimaginat de acum vreo 30 de ani, care s-au împlinit apoi pentru el întocmai. In ceea ce mă priveşte, eu "cedasem" ocupaţia de astrolog soţiei mele, mult mai dotată, eu preferând să lucrez între altele banda de magnetofon ce va însoţi piesele pentru pian "Opt Compoziţii Statice" – din câte ştiu, prima încercare românească de a programa şi genera complet muzica cu un calculator (Commodore 64 dispunea de un generator de sunet pe trei voci, fiecare paramentru fiind editabil şi reuşisem să obţin şi software corespunzătoare) - apoi ca "ajutor" pentru redactarea unor liste de durate şi înălţimi de sunete pentru cvartetul de coarde nr. 4, terminat în 1986. Bunul meu prieten Octav Nemescu apela la soţia lui, Erica, pentru obţinerea materialelor primare ale unei benzi pe care apoi le prelucra la el sau la mine acasă, în Drumul Taberei, noi având amândoi, între altele, câte un magnetofon Grundig destul de bun. Se poate imagina cât timp ne lua prelucrarea, mixarea repetată etc. a unor sunete primitive, pentru a obţine ceva acceptabil.

După emigrarea mea din 1987 și când am dispus în fine de un computer „mai serios" (la început au fost Amiga 500 apoi 2000, pe lângă Atari, pe atunci cu totul noi şi - pentru muzică şi grafică – chiar mai bine dotate decât computerele IBM) am lucrat mai întâi, pe linia lui Cezar, un program de ilustrare muzicală a datelor astrologice: caracterele descrise de o astrogramă primeau un corespondent muzical, şi nu ales la întâmplare, ci care să descrie arhetipal strict datele respective (poziţia soarelui, ascendentul, raporturi între astre, cele 12 case etc., respectiv trăsăturile de caracter corespunzătoare); audiţia se desfăşura pe difuzorul computerului, abia după un an am reuşit să cuplez un sintetizor Korg M1, standardul MIDI fiind o noutate încă ne-generalizată. După reluarea legăturilor cu România, Cornel Cezar s-a arătat desigur foarte interesat de această idee, dar între timp trecusem de mult de pe Amiga 2000 pe un computer IBM şi datele - din nou - nu mai erau compatibile. Dealtfel eu eram acum

interesat de programarea unui limbaj muzical etnic, sarcină pasionantă, pe care am îndeplinit-o curând, dar - cum am arătat - fără a fi reuşit să „valorific" rezultatul.

Cam asta este istoria acestei tentative. Din toată această preocupare intensivă de ani de zile nu a rămas decât un text, destul de abstract în lipsa unor exemplificări muzicale, text ce este publicat în fine după trecerea a peste două decenii de la conceperea lui, când semnificația lui s-a dizolvat în timp... între timp există limbaje de programare sau chiar programe complete, care pot imita orice, inclusiv muzică savantă sau genuri ale muzicilor etnice; eu însumi pot realiza acum o asemenea simulare rapid şi comod. Cred că cele relatate aici pot ilustra însă ceva din ideea enunțată într-o comunicare de prin 2005, o idee referitoare la generația mea: "*generația Liviu Glodeanu, Mihai Moldovan, Corneliu Dan Georgescu, o generație, care - dintr-un motiv sau altul - nu a ajuns la împlinire*".

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In 1990-91 I worked in *The International Institute for Traditional Music* of Berlin on two computer programs to simulate improvisation in traditional music. I chose for this firstly the Romanian *bucium-music* and secondly the Arabian *taqsim* in *maqam bayati* for the relative simplicity and originality of their essential homophonic musical language.

I had at my disposition as reference material for the first case 100 transcriptions selected from ca. 600 *bucium, tulnic, trâmbiță* records from the Archive of *The Institute for Ethnological and Dialectological Research* in Bucharest, the concentrated study by Gottfried Habenicht (Freiburg) (1967), and my book (1987) with a typology of this music, which I studied 1981-82 in Romania. For the second case, I used 17 transcriptions of *ud, kamanja, nay, qanun* records made by Habib Hassan Touma (Berlin) and his exemplary book for my purpose about Arabian music (1980). I shall set here only some implications of this experience, related to the particularities of the musical analysis in this respect.

My goal was to simulate *improvisation* in traditional music. I understand by "improvisation": *the apparently unpredictable combination and variation of some music formulae according to special syntax rules*. There exists a difference in principle between this acceptance and the classical definition

> "das gleichzeitige Erfinden und Ausführen von Musik ohne offenkundige unmittelbare Vorbereitung" [Ferand 1958: Sp. 1093].

I make a distinction between *improvisation as action* (which implies „nonmusical factors" like intention of performers, context, concrete particularly of performance e.g. preparation, spontaneity, orality) and *improvisation as result* (which implies only "musical factors" i.e. music structures).

The "improvisation" is not an opposite notion to "composition", but a synchronous and complementary one: in fact these two aspects are not separable.

> "Performance practice is always in some respects an improvisatory process, and the musical thinking that goes into composition surely must always have at least a bit of the kind of thinking that goes into improvisation" [Nettl 1991: 4].

Improvisation and composition are not "fundamentally different processes", but "parts of the same idea, as opposite ends of a continuum" [Nettl 1974: 6].

> "The fine line between improvisation and composition may be difficult to establish […] in some instances, such as a line may not even exist" [Hood 1975: 26]. "Like every composition, improvisation rests upon a series of stylistic conventions and rules" [Kartomi 1991: 54]. "Improvisation does not mean creating something utterly new" [Sárosi 1986: 152]."Improvisation was linked with oral tradition, and it was sometimes assumed that all music not notated must be in some way improvised" [Nettl 1991: 3].

Anyway

> "The essential difference between improvising and

> composing […] is not the fact that one is unwritten and the other written. It is that the one is still in the process of being worked and reworked while the other has reached a relatively fixed, worked-out form" [Kartomi 1991: 55].

In this acceptance the *improvisation as a result* is bound with notions like "variation", "changing", "flexibility", "new", "out of system", "unexpected", "surprise", or, by Kaden, "stochastischer Prozeß", "schwebende Verknüpfungen", "Entropiemaxima und –minima" [Kaden 1981 : 113-115].

> "Wer Improvisation zu analysieren hat, bekommt es also mit dem Zufall zu tun und muss diesen in sein methodisches Kalkül einbeziehen" [Kaden 1981: 108].

I understand by "music language" (in a free acceptance, which considers only the formal aspect of a complex phenomenon): *a unitary, coherent music system, with a precise social function* (e.g. a traditional music genre). I understand by "computer program to simulate the improvisation into a music language": *a set of procedures, which are able to generate theoretically an infinite number of new valid pieces of music based on the data, which define that musical language*.

These are all controversial notions, so I do not try to elucidate them, but only to make more precise the acceptance, which I use in this paper.

The *bucium* and the *taqsim-music* are two very different musical languages, even when both are improvised.

The *bucium-music* may be seen in some way as a symbol of folk music. It is a primitive pastoral pure instrumental music, anonymous and orally "created" and transmitted, with a well-defined traditional functionality as signal, ritual (e.g. as funeral music) and today most as divertissement. Although the name *bucium* comes from the Roman *buccina,* the oldest unequivocal mention of the instrument dates from the 15th century [Alexandru 1956: 12-13], and there exist no records or notations before Béla Bartók (1910), followed by George Breazul (1929), Harry Brauner (1930), Constantin Brăiloiu

(1931), Tiberiu Alexandru (1936). The attempt at reconstituting the history and the evolution of this music are due above all to Romeo Ghircoiașiu (1963) and Vasile Tomescu (1978).

Setting aside what we owe to Béla Bartók, a basic contribution to the study of the Romanian alphorn signals is due to Tiberiu Alexandru (1956), who defined the types of instruments and their specific musical scale, and Gottfried Habenicht (1967), who defined the three areas where this music is found, and this associated particularities. The results of my own research (1981-82) consist of ca. 300 new records, a description of functional, contextual, organographical, musical structural, regional and historical aspects, and the working out of a typology of this music (1987).

The magical level of the Romanian *bucium*-music is most associated with the funeral or the wedding rituals, but traditional are also the aesthetical-ludicrous and utilitarian functions. The specific pastoral-agrarian context may be seen as one of the most coherent forms of traditional life of a merely seemingly isolated community, which exhibits a wide area of circulation. The pastoral musical repertoire is characterized through a certain heterogeneity about a steady state nucleus, which includes the music for Alphorn.

In fact, the Carpathian Mountains are the center of an East-European area, which includes such lands or regions as Romania, North-West Bessarabia and Ukraine, South-West Polen, former Czechoslovakia, Hungary and North-East former Yugoslavia. The differences to similar music of the Alps and Scandinavia are relatively important.

The introductory study of my book (1987) comprises also a catalogue of the “minim lexical units”: 825 classified melodic cells (i.e. general pattern and concrete musical form), which represents the completely lexical material employed in the 100 pieces integrated in the typology. Hereby are also examined some aspects like the frequency of occurrence, the flexible connection, the preferential, the monovalent or polyvalent pairing, the repetitive aspect, the incipit/median/finale function of these cells or couplings, some particular forms of

coexistence for some distinct rhythmic systems, e.g. *rubato* and *aksak* as well as the relation amongst pieces within a macro-form or the criteria to distinguish between sometimes indistinct variants.

The instruments in the Romanian space are all variants of Alphorn. There are two categories and five types of such instruments, first described by T. Alexandru (1956). They are defined through form, dimension, material of construction; the best known are the *bucium, tulnic, trâmbița.* These instruments can play exclusively natural harmonic tones.

There are in Romania three well defined geographical areas, first described by G. Habenicht (1967) and several sub-regions, in which were used different segments of this scale: the harmonics 3-8 (in the sub-Carpathian Wallachia-region, i.e. *Muntenia* and in the Southern and Western of *Modova*), the harmonics 4-9 (in the region of *Munții Apuseni*/Western-Mountains) and the harmonics 6-12 (in Northern Transylvania, i.e. in *Maramureș* and *Năsăud,* and in *Bucovina*).

The essentially improvised form consists of an alternation of long tones and repetitions or subtle asymmetrical combinations between for each area typical melodic-rhythmic cells and their variations, all that between an introductory and final formula.

Being relatively isolated in the context of traditional folklore music and inherently dependent on only a well-defined instrument – the Alphorn – this musical category has little and easily detectable intercourse with other genres or species of Romanian folklore; however, at a deeper level, the music under consideration is intimately related to such forms as *doina*, the funeral ritual or the children's folklore.

A brief survey of several less known aspects of a contemporary practice of *bucium*-teams in various regions of Romania, the active participation in contests and festivals etc. as a nationalistic symbol illuminates different, sometimes contradictory results, generally relevant for the contemporary evolution of a musical species that is apparently doomed to disappear.

On the contrary, *maqam* and *taqsim* are important notions of cultivated traditional Arabian music already in use in the 14th century [Touma 1980: 1].

> "The *maqam* represents a unique improvisatory process in the art music of a large part of the world. Geographically this region includes the countries of North Africa, the Near East and Central Asia […] In this vast area, three principal spheres of musical culture can be distinguished, namely, the Turkish, Persian and Arabian, in which the maqam phenomenon is widely cultivated. In Turkey this musical form is called *makam*; in Azerbaidjan*mugam*; in Uzbekistan *shash-maqom*; in Iran *dastgah*; and in the Arab world *maqam*" [Touma 1989: 38].

The *maqam* is determinated by two factors: tonal and temporal.

> "The tonal-spatial component is organized, molded, and emphasized to such a degree that it represents the essential and decisive factor in the maqam; whereas the temporal aspect in this music is not subject to any definite form of organization" [Touma 1989: 39].

Touma considers that some notions like "motivic groups", "definite variation" [Idelsohn 1913], "melodic pattern" [Sachs 1943: 290], "melody models produced by the same modal scales" [Gerson-Kiwi 1967] are not compatible with the concept of native musicians.

> "The *maqam* phenomenon is a form which is represented by a fixed tonal-spatial organization peculiar to the respective mode. The singular feature of this form is that which is not built upon motifs, their elaboration, variation and development, but through a number of melodic passages of different length which realize one or more tone-levels in space and thus establish the various phases in the development of a *maqam*" [Touma 1980: 40-41].

These tone-levels gradually move upwards from the lower to the higher registers, until the climax is reached. A tone-

level comprises one or two melodic axes. In every maqam, the pivotal tone is encircled by neighboring tones and is sustained for a duration determinated by the musician. The first and last tone-level of a *maqam* are centered on the first degree of the mode.

> "The succession of the central tones of the tone-level can be reduced to the contour of an arc: C F Eb F G C' G F Eb C". [Touma 1989: 43].

> "The *maqam Bayati* is one of the most commonly performed maqamat of Arabian music, being equally popular with singers and instrumentalists. It is not restricted to any particular musical genre, and occurs in religious and secular, folk and art music." [Its expressive character is] "happiness and joy, feminity and authentic Arabitude" [Touma 1980: 6].

It is possible that *Bayati* is an ethnic designation,

> "after the Turkish tribe *Bayat* placed in Azerbaijan, or after the Kurdish tribes, *al Bayat*, that still live in the Jabal Himrin area of Iraq" [Touma 1980: 7-8].

> "The maqam Bayati is mentioned on the writings of Arabic musical theorists from the 15th century onwards" [Touma 1980: 7].

Its tones are: *D-Eb-F-G-A-Bb-C-D,* in a two-octave register, with *Eb* being higher: the interval *D-Eb* measures ca. 150 Cents. The traditional names of the degrees are: *Dugah, Sigah, Jahargah, Nuwa, Husseini, Ajam, Kurdan and Muhayyar* [Touma 1980: 8]. The intervals are the whole, three-quarter, and half tones.

There exist many old theoretical contributions about such scales: Al-Farabi describes first in the 10th century the division of the octave into 24 intervals. [Touma 1980: 45-51]. However, a *maqam* is much more than a scale: the *maqam* series builds up the principal modus of the genre *Bayati*. All modes of the genre have as characteristic final formula one whole and two three quarter tones (e.g. G F Eb D) [Touma 1980: 57].

A *taqsim* is an instrumental improvised time image of a *maqam.* The rhythm and the duration of a piece are rather free.

> "A *taqsim* can run to a considerable length when the player extends the tonal-spatial organization and aims at exhausting all the possibilities latent in a particular tonal field. This is especially the case when a taqsim has the function of representing the complete framework of a definite *maqam*" [Touma 1980: 12].

The form consists of a couple of *anfas,* which are separated by long pauses. There is a very specific melodic development in *phases,* which introduces constantly new, always higher tones of the *maqam,* with a plentiful ornamentation centered an *axes.* [Touma 1980: 27-36]. The rhythm and the duration of a piece are rather free. The order and number of phrases in which modal framework is fixed; furthermore, no phrase is ever developed and rendered twice in a strictly identical way.

> "The compositional aspect is demonstrated in the pre-determinated tonal-spatial organization of a fixed number of tone-levels without repetitions, while the improvisational aspect unfolds itself freely in the rhythmic-temporal scheme" [Touma 1989: 41-47].

> "The theorists of the early and the late Middle Ages do not discuss the term *taqsim*. It may be assumed that the expression was too well known to require an explanation, or that the theorists ignore it because it belonged to the domain of musical practice" [Touma 1980: 12-13].

It would be ideal for a computer simulation to follow the supposed logical process of a real improvisation or, at least, to imitate this process as exactly as possible.

The most general approach to a language and its natural use considers commonly two aspects of it: a *static* one (a level of *competence*) and a *dynamic* one (a level of *performance*). Therefore, a computer program involves mainly

a collection of music morphological data (an "out of time" material) and a system of syntactic rules for their use "in time".

Here are the basic parts of my two programs:

1. The INTRODUCTORY- segment:
    1.1. The declaration part (routines, variables etc.);
    1.2. The data depot (a sort of catalogue of data in numerical format: form schemata, tone pitches and lengths, scales, functions).
    2. The WORK - segment (the main part of the program):
    2.1. The procedures to choose, read schema and data;
    2.2. The procedures to "work": to select the work routines, to modify the original data, to combine them;
    2.3. The procedures to link the strings of obtained data and temporarily store them.
    3. The FINAL - segment:
    3.1. The translation of the numerical data into visual (notes) / audible (sounds) signals;
    3.2. The output of their signals as music data.

This is surely only a very simplified formula, because in fact, a sharp difference between *static* and *dynamic* sections is not possible. So it is necessary e.g. to store musical material together with its qualities and special capabilities to be combined. The segment 1 (The INTRODUCTORY - segment) appears only once, at the start of the program, with the function of initialization. The segments 2 and 3 (the WORK and the FINAL segments) appear in an endless loop.

The declaration segment (1.1.) depends on the computer language conventions. The data segment (1.2.) can theoretically be very large, as a musical archive: it should comprise all important structures of the musical language in question. However, practically it must be as concentrated as

possible, because the dimension of the program and the duration of the selection and reading of the material depend on its volume.

The first part of the main segment (2.1.) works following a *clever random* principle. The data (a schema, a mode, and some musical formulae) is randomly chosen and read, then actually worked (in part 2.2.: changed, repeated, and combined). The corresponding procedures are randomly selected and they work according to couples of "if/then conditions" and statistical principles. The result of each work phase must be proved and eventually rejected if not compatible, then another procedure chosen.

When one tends to other goals, the corresponding routines may be introduced into segment 2 (e.g. in the *bucium*-program, where each of the procedures of this segment may be experimentally controlled through an interactive modus, and there is supplementary ethnological information for a pedagogical purpose).

As in the case of the "music archive", it is not possible here either, to use many rules for working the material. Only the most typical procedures must be selected and clearly formulated, and the relation between variables and constants must also be reasonable (e.g.: In the case of the *maqam*-program, I had to formulate only one rule to embellish the melodic basic line, because the time to calculate the new tones became critical). An optimal (and sometimes tricky) strategy decides the quality of the result.

The obtained data strings must be linked, stored (2.3.), then directed to the output segment (3.1.).

The last part (3.2.) permits the data to be seen (on the screen or printer) and heard (through computer loudspeaker or with the help of a synthesizer or sound card). Special procedures must "translate" the musical data first into an optimal format for storing and working them, and then reformulate them back to a comprehensible form. In principle simple, this segment poses problems of graphic format, MIDI

controls etc.

The simulation of the Improvisation by computer requires specific quantity and quality of musical data, which highly stimulates the refinement of analysis methods. An adequate musical analysis to this goal must be: complete, precise, algorithmic. That is, because in this case the analysis must be *prescriptive*, not only *descriptive*, as is usually the case. In addition, it must describe not only how to play just a musical piece (as in a score of classical music), but how to play all possible pieces of that musical language. *Herewith the simulation will act like a sure method to prove the correctness of the music analysis: approximate or false analysis may lead to absurd results.*

One must not reduce the analysis to some important aspects, or formulate general estimations. There is not only a question of nuances, but of new qualities. In fact, the common degree of knowledge of a musical material, expressed through a usual musical analytical description (where, e.g. the "well known" ideas are no longer repeated), is not sufficient for a simulation. (Let me give an example. Formulations like this are in our case not acceptable: "this interval is sometimes a little bigger than a half-tone" or "the rhythm is completely free" or "there are some changes in *tempo".* These all are quotations from usual analytical texts.) All tone levels and durations must be precise in frequency and in time units. So it may be sometimes necessary to repeat the analysis and to refine it.

Otherwise, the computer can calculate and "play" all kinds of pitch and time relationships much more exactly then a normal European staff notation could show them, even with supplementary signs. All that would be only *the first level* of the analysis, and its precision would generate correct but mechanical data.

The second level is very important: not only that it is possible to accept all kinds of flexible solutions and fuzzy structures (of course with the condition that the boundaries of the flexibility are explicitly given), but the computer stimulates the study of self-conditioning couples of parameters, normally

ignored. (So e.g. the pitch of a tone may fluctuate between these limits, and can be associated with a longer duration only if that tone occupies the last place in a melodic formula).

The music analysis must be *generative* too: that is *the third level*. The specific basic unit (or units) of that musical language must be determined, in a way which is very much like a linguistic research method. The analysis data must be chained and organized in that way, to imitate the algorithm of real “improvisation/creation” of a music piece, that is, *its systematic construction and evolution in time*. Therefore, not only each music element must be statistically measured, but also each pair of elements (and not only of neighboring elements). The result must then be "enriched" or "humanized" through some "mistakes, impurities, noise" (that is, through some randomly deviations from the rules). That would be *the forth level*.

All this is only rarely contained in a usual analysis. However, the analysis of the *maqam bayati* by H. H. Touma, even if not intended for a computer simulation, was ideal for such a purpose. Maybe here it was something transmitted from the tradition of Arabian medieval analysis methods and descriptions, which were always in a way prescriptive too.

The methods of working the *bucium* or *maqam* material were completely different in the main segment of the two programs. Even for the three areas of Carpathian *bucium* music three sets of specific procedures must be defined, because the stylistic differences between these areas are important. Only a very general frame could be common to all cases. This shows how different the improvisation techniques may be and helps distinguish and define them: the *bucium* music is based on *combinations and variations of some typical cells of each region according to a rough schema*, but the *maqam* music is based on a *complex ornamentation of a basic progressive melodic structure*. In the first case, a *step-by-step texture* was in the main required; in the second case, the *reiterated processing of a complex basic line*.

The loudspeaker of an IBM-computer cannot give any

idea about timbre and color of the sound. The usual thesaurus of sounds of a synthesizer, if editable, allows a better approach to the real sonority. The full consideration of this very important musical dimension could be realized in a future work phase through working with digital sound records. For the moment, the research has been focused on form building.

Conclusions:

The computer simulation is *an approximation process*. Almost any step and any procedure is a compromise between the degree of knowledge of the music material, the programming strategy, the technical possibilities of the computer etc., and may be improved. This first version of my two programs is indeed imperfect in comparison with my intentions, especially in the case of the *maqam.* Nevertheless, such an experience helps formulate some typical problems and questions of the research in ethnomusicology in an acute form. Moreover, to put questions is always more interesting and creative than to try to give definitive answers.

Here are some of these questions:

To generate *valid pieces of a musical language* all the relevant data must be stored in an archive of that language. How should an archive be optimally organized: in a simple linear order (such as the words in a vocabulary) or highly organized (e.g. about grammatical, stylistic categories)?

Must all the data be stored or only the principal forms, with indications as to how this data may be varied (such as a vocabulary of all words in comparison with a vocabulary, which stores only the fundamental thesaurus of a language and the rules of variation of these units)? The archive problem is fundamentally a *search-and-find* problem: the duration of the find process may be shorter in the second case, but the material must be classified beforehand and the search exactly directed. One can find an object more quickly in “a case with more drawers”, but there must be perfect order in those drawers.

How a musical piece could be constructed into a simulation process: “horizontally”, step-by-step (with a proof of

validity of each step) or “vertically”, through “filling” an already verified schema?

How must the material be selected for this schema and worked: randomly, and eventually, if the result is not satisfactory, rejected (filtered), or must the search be from the start so oriented, that the result is surely satisfactory? Each method is in principle valuable and offers some advantages and drawbacks. I used both of them. The random brings more diversity and work speed, but also “good and bad surprises”, also less control of the results. “More exact rules” means better and surer results, but less variety and a longer and more complicated work.

Is it possible to simulate every musical language by computer? It seems it is not possible to simulate an inhomogeneous or instable language. Even in our two cases, it was possible to simulate only the kernel of each language, and not all the marginal forms. For allowing an imitation, a language must be *well defined, homogenous, coherent,* and *flexible*; actually, it must be *a language*. Could that mean, not all musical genres possess their own language?

The musical result of a computer simulation must be, in the best case, not at all distinguishable from a natural music piece. What does a perfect simulation actually mean? Here some compromises must be considered. The music pieces generated by computer *may be very close to an ideal case, but not differentiated between themselves* (a “narrow distribution”). Alternatively, on the contrary, they may be *rich in differences* (a “large distribution”), but *some of them quite far from the model*. The two cases may occur in the musical practice too, and the occasional failing of some pieces in a field research is actually quite a natural process. The study of a traditional music genre, which is advanced in the direction of dissolution, shows that sometimes the "good pieces" are lucky exceptions. So one must consider (statistically) the *normal accident*, the *normal mistake* too, that is, *the normal deviation from a model, whose perfection would be unnatural.*

But why simulate music at all? (That should be the very first question!) The simulation of the functioning of e.g. an

airplane is already a commonly used method to experiment and to prove some ideas. Nevertheless, this is a “creation”, not an “imitation”, and the experimentation is certainly economically motivated. Referring to music, I think it depends on what one wishes to imitate. To imitate perfectly something natural (an ethnomusical genre, which is *a natural musical language that is accepted by a large group of people*) is comparable with the study of the natural phenomenon. It means actually to appropriate some essential natural rules and so, to control them, to train and refine the thinking, to stimulate the creative power. But it is also *a practical method*: it is comparable with playing an instrument instead of describing it. Actually, it means *to do what the ethnomusicology do, but with some modern instruments and research methods*.

And the last question: Who decides if the simulation is really good? Would it be right to let an insider to this musical language validate the results of a simulation? That could be very attractive as an experiment, but the result may not always be conclusive: the insider could be too tolerant or too intolerant (e.g. because the context is not requested). How then could the results of a simulation (and indirectly of the music analysis) be strictly scientifically proved? Maybe… through another computer program?

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English version by Corneliu Dan Georgescu

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