Volume 18 • THE COMPUTER MUSIC AND DIGITAL AUDIO SERIES

COOKING WITH CSOUND

PART 1: WOODWIND AND BRASS RECIPES

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A-R Editions, Inc.

Middleton, Wisconsin

```
...
; [revise the instrument design as follows:]
kfreq   =       ifreq + kvib

kpctdur  phasor    1.0/p3                              ; current time (in percentage of total duration)
kfreq    table     100*kpctdur, ifrtabl, 0             ; frequency from frequency table
kfreq    =         kfreq + kvib

...
; [revise the end of the instrument design as follows:]
asig    =       (awt1+awt2+awt3+awt4)*iamp/inorm

asig     =       (awt1 + awt2 + awt3 + awt4)*adynam/inorm
```

In the score each event of instrument 104 will have a slur function table that accompanies it. Select the slur function table number in p14, and load the function table at the same time as the note. Parameter field 8 of instrument 104 is not used for setting the pitch, but instead it determines which wavetables to use (typically, set it with one of the highest pitches in the slur). As in dynamic.sco, select the amplitudes for the dynamic changes in p4, p6, and p7, and the time for the change from amplitude 1 to amplitude 2 in p5. The following score demonstrates function table slurs on the first phrase of the bassoon solo in Stravinsky's *The Rite of Spring.*

```
; slur.sco - use with season.orc (in the season subdirectory on the CD-ROM)
; Igor Stravinsky, The Rite of Spring, opening bassoon solo

;bar 1-----------------------------------------------------------------------------------------------------------------
;p1      p2        p3        p4        p5        p6        p7        p8        p9        p10       p11       p12       p13
;       start     dur       ampl      time1     amp2      amp3      Hertz     vibr      att       dec       br        inst
i103    1.000     3.2       10000     .15       8000      6000      523.2     1.000     0.030     0.350     7         7

;fn      start     points    gen       time/pitch etc.
f355    4.100     128       -17       0  490.50  2  523.20  5  490.50  11  392.4  18  327  26  490.5  36  436

;p1      p2        p3        p4        p5        p6        p7        p8        p9        p10       p11       p12       p13       p14
;       start     dur       ampl      time1     amp2      amp3      Hertz     vibr      att       dec       br        ins       ftab
i104    4.100     3.55      6000      0.0563    8000      4000      392.4     1.000     0.030     0.100     6         7         355

;fn      start     points    gen       time/pitch etc.
f356    7.550     128       -17       0  523.20  12  490.5  15  523.2  19  490.5  29  392.4  42  327  54  490.5  68  436

;p1      p2        p3        p4        p5        p6        p7        p8        p9        p10       p11       p12       p13       p14
;       start     dur       ampl      time1     amp2      amp3      Hertz     vibr      att       dec       br        ins       ftab
i104    7.550     2.85      5000      0.1692    7000      6000      490.50    1.000     0.030     0.100     6         7         356

;Second eighth note bar 2----------------------------------------------------------------------------------------------
;p1      p2        p3        p4        p5        p6        p7        p8        p9        p10       p11       p12       p13
;       start     dur       ampl      til        amp2      amp3      Hertz     vibr      att       dec       br        inst
i103    10.300    0.500     5000      0.5       4000      3500      523.200   1.000     0.040     0.150     7         7

...
```

Grace Notes

Grace notes are a special kind of slur. In grace.sco (use with season.orc) we give the slurred example with only the grace notes slurred (see Figure 9.9). This solves the timbre problem but the slurs are not as smooth.

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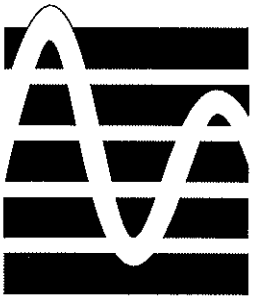


ONE

Introduction

Did you ever dream of writing an orchestra piece? Can you imagine the orchestra playing accurately in just intonation, 31-tone equal temperament, or any other tuning system you choose? How about an orchestra of 100 ring-modulated tubas?

Let some of your fantasies take off. We hope that you'll use this book as a point of departure for music making and experimentation. This book contains a collection of ready-to-use instrument designs for woodwind and brass instruments that allow you to begin composing immediately. Synthetic instruments can perform without regard for physical limitations, such as intonation, range breaks, and fingerings. Performers often ignore dynamic markings, but the computer gives you exactly what you specify. Synthetic designs also overcome economic constraints: for example, you can have 100 tubas and your personal symphony orchestra in your computer. Csound is a programming language for sound generation and allows much more flexibility in creating hybrid instruments than a synthesizer. If you want a tone to crossfade from a trumpet to a clarinet to a sax, you can get it.

This chapter addresses what different readers can expect to get out of the book. Chapter 2 gives an overview of Csound and outlines the naming conventions for the accompanying files. Chapter 3 describes the Csound instrument design for the winds.

Chapters 4 and 5 describe the physical properties, spectral responses, and normal pitch ranges of the woodwind and brass instruments. For each woodwind and brass instrument, we also give a short musical excerpt and its implementation. Chapter 4 concludes with a transcription of the opening of Igor Stravinsky's *The Rite of Spring,* using primarily the woodwind instruments, and Chapter 5 contains Lydia Ayers's *Paté* and *Brassoufflé,* as well as a brass transcription of Antonio Vivaldi's *Four Seasons.*

Chapter 6 contains a variety of global effects in Csound, and Chapter 7 applies the same effects note by note. These change the

character of the instrument. For convenience, we have integrated these standard effects with the wind instrument design. Chapter 7 ends with a short composition, *Appetizer,* which demonstrates how much timbral variety is possible with just one instrument (the flute) using a multi- effect processor.

Chapter 8 shows various ways of representing pitch in Csound, including custom tunings. A table of standard tunings provides a starting point. Finally, Chapter 9 gives some suggestions for seasoning touches that can give more polish and expression to a composition.

We have completed several pieces in an international feast of flavors drawing on resources in this collection. *Appetizer* is a one-minute algorithmic piece in the Indonesian *slendro* tuning system using multiple effects on the flute. Several flavors of *Paté* blend the brass in various tunings, whereas *Brassoufflé* bakes a brass chorale in a *utonality* of 19.

WHO SHOULD USE THIS BOOK

We wrote the book for an audience ranging from near-novice computer musicians to computer music experts, with composers our main intended audience. Computer music newcomers and MIDI users can learn from the working designs, which they can modify as they gradually become more proficient in Csound and synthesis. The designs can run in real time since they use only a small amount of computation. The book provides composers and researchers with a set of ready-to-use designs that can be built upon. The book is structured so that it is especially useful for self-study and research. We have chosen the Csound language because it is easy to understand, and it is relatively straightforward to translate the designs into other languages such as Cmix, Cmusic, Music4C, Kyma, Common Music, and Max.

THE RECIPES

We designed the recipes in this book as black boxes that you can use directly from the orchestra (.orc) and score (.sco) files. We also include effects and have already integrated them into the wind instrument design. To add effects to other instruments, you can copy code from insert (.ins) files and paste it into your instrument in the places indicated.

WHY WE WROTE THIS BOOK

A systematic collection of instrument designs has long been the El Dorado of the computer music community. Here is what James Moorer, the pioneering computer music researcher at Stanford and later director of the audio project at Lucasfilm, said about it in *Computer Music Journal* (Roads 1982):

> There is another musical project we have talked about but have never done. It is an enormous project, the fabled "Lexicon of Analyzed Tones." One could make the argument that cataloging orchestral instruments is an obsolete sort of thing to do. However, I could make the counterclaim that the orchestral instruments give us immediately a wide variety of musically interesting timbres. I would like to see someone go through the entire pitch range of each orchestral instrument at several dynamics and articulation styles and analyze and categorize each tone. . . . This lexicon would be the kind of Rosetta stone for computer music we have all been looking for. Most of the computer musician's time is spent looking for sounds, and the lexicon would help to reduce that effort.

This book is part of the enormous project Moorer describes. While collecting our own instrument designs, we saw J.-P. Gather's *Amsterdam Catalogue of Csound Computer Instruments,* which contains Csound implementations of designs described in Dodge (1985), Risset and Matthews (1969), and other books. In his foreword, Gather quoted Moore et al. (1983) as follows:

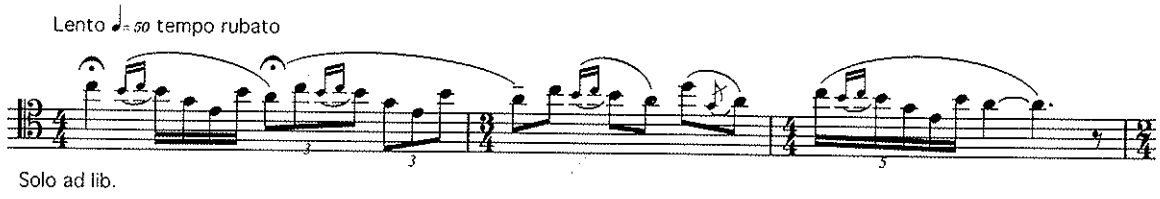
> Computer music as a field has been likened to a building with a sign on it saying "Best Eats in Town." Many people go into this building expecting to find an elegant restaurant with a parchment menu, formidable wine list, and pleasant, efficient, even charming service. What they find instead, to their surprise, is a shiny, enormous, extremely modern kitchen, with abundant supplies of every kind of foodstuff in voluminous, refrigerated storage. Indeed, the "Best Eats in Town" are available here, but only for those willing to learn to cook!

This image caught our imagination and inspired us to make our collection available to others. We have attempted to make our work a complement to Richard Boulanger's definitive *The Csound Book* and J.-P. Gather's catalog. We have bottled up our favorite sauces and chutneys and provided recipes for our favorite dishes. We invite you into our kitchen, and hope that you will enjoy cooking with us.

shape the dynamics of the slur. (See the discussion in "Dynamic Changes" under "Dynamic and Amplitude Levels" earlier in this chapter.) It is possible to use this design for a single note (just put one frequency in the table at time 0), but it is easier to use instrument 15 or 103.

Figure 9.8 (the bassoon solo at the opening of *The Rite of Spring*) demonstrates the strengths and weaknesses of this technique. The wide skips in some phrases make the phrases sound like a computer is playing them. However, some of the phrases in a smaller range sound better than the original bassoon example.

Figure 9.8 Slurs in the bassoon solo from the opening to Igor Stravinsky's *The Rite of Spring*.



Instrument 104 in season.orc is the wavetable wind instrument with function table slurs and dynamic changes. To add slurs to another instrument design, insert the files slur.ins and slura.ins as shown below.

```
; season.orc (in the season subdirectory on the CD-ROM)
...
;-------------------------------------------------------------------------------------------------------------------
instr 104                          ; general wavetable wind instrument with dynamic changes and function table slurs
...
; [revise the instrument design as follows:]
;-------------------------------------------------------------; initial variables
idur    =       p3                                            ; duration
iamp1   =       p4                                            ; initial amplitude
...
itablno table   p10, 3                                        ; select first wavetable number for this
                                                              ; instrument (in table 3)

iamp1   =       p4                                            ; initial amplitude
p5      =       (p5 < = 0 ? 0.01 : p5)                        ; keep values between 0 and 1
p5      =       (p5 < = 1 ? 0.99 : p5)
itime1  =       p5*p3                                         ; time from initial to middle amplitude
itime2  =       p3 - itime1                                   ; time from middle to ending amplitude
iamp2   =       p6                                            ; intermediate amplitude
iamp3   =       p7                                            ; ending amplitude
adynam  linseg  iamp1, itime1, iamp2, itime2, iamp3, 1, iamp3 ; overall dynamic change
ifreq   =       p8                                            ; highest pitch in Hertz
ivibd   =       abs(p9*ifreq/100.0)                           ; vibrato depth relative to fundamental frequency
iatt    =       p10                                           ; attack time
idec    =       p11                                           ; decay time
ibrite  tablei  p12, 2                                        ; low-pass filter cutoff frequency
itablno table   p13, 3                                        ; select first wavetable number for this
                                                              ; instrument (in table 3)
ifrtabl =       p14                                           ; function table number for slur
```