

# Contents

**Foreword: New Music and Science** *xi*

*John Chowning*

**Preface to the Second Edition** *xv*

**Acknowledgments** *xxi*

**Preface to the Original Edition** *xxiii*

---

## I Digital Audio *1*

---

1 *History of Digital Audio* *3*

2 *Basics of Sound Signals* *13*

3 *Theory of Sampling* *23*

*Curtis Roads with John M. Strawn*

4 *Sample Quantization, Conversion, and Audio Formats* *39*

---

## II Introduction to Sound Synthesis *55*

---

5 *History of Digital Sound Synthesis* *57*

6 *Wavetable Lookup Synthesis* *65*

7 *Time-Varying Waveform Synthesis* *73*

8 *Software Synthesis* *77*

---

**III Sound Synthesis 93**

- 
- 9 Sampling 95**
  - 10 Additive Synthesis 115**
  - 11 Multiple Wavetable Synthesis 143**
  - 12 Wave Terrain Synthesis 151**
  - 13 Granular Synthesis 161**
  - 14 Subtractive Synthesis 187**
  - 15 Modulation I: RM, SSM, and AM 221**
  - 16 Modulation II: FM, PM, PD, and GM 241**
  - 17 Waveshaping Synthesis 273**
  - 18 Physical Modeling Synthesis 285**
  - 19 Virtual Analog 327**
  - 20 Formant Synthesis 345**
  - 21 Pulsar Synthesis 365**
  - 22 Waveform Segment Synthesis 389**
  - 23 Concatenative Synthesis 401**  
*Bob L. T. Sturm with Curtis Roads*
  - 24 Graphic Sound Synthesis 413**
  - 25 Noise, Chaotic, and Stochastic Synthesis 427**
- 

---

**IV Mixing and Signal Processing 443**

- 
- 26 Sound Mixing 445**
  - 27 Dynamic Range Processing 469**
  - 28 Digital Filtering 483**  
*Bob L. T. Sturm with Curtis Roads*

<b>29</b>	<b><i>Convolution</i></b>	511
		<i>Curtis Roads with Bob L. T. Sturm</i>
<b>30</b>	<b><i>Time Delay Effects</i></b>	531
<b>31</b>	<b><i>Pitch-Time Changing</i></b>	543
<b>32</b>	<b><i>Sound Spatialization</i></b>	559
<b>33</b>	<b><i>Reverberation</i></b>	603

---

**V Sound Analysis** 631

---

<b>34</b>	<b><i>Pitch Estimation</i></b>	633
<b>35</b>	<b><i>Rhythm Recognition and Automatic Transcription</i></b>	661
<b>36</b>	<b><i>Introduction to Spectrum Analysis</i></b>	681
<b>37</b>	<b><i>Spectrum Analysis by Fourier Methods</i></b>	701
<b>38</b>	<b><i>Spectrum Analysis by Alternative Methods</i></b>	739
<b>39</b>	<b><i>Spectrum Analysis by Atomic Decomposition</i></b>	769
		<i>Bob L. T. Sturm</i>

---

**VI The Musician's Interface** 783

---

<b>40</b>	<b><i>Musical Input Devices</i></b>	785
<b>41</b>	<b><i>Interactive Performance Software</i></b>	825
<b>42</b>	<b><i>Sequence Editors</i></b>	857
<b>43</b>	<b><i>Sound Editors, DAWs, and Audio Middleware</i></b>	873
<b>44</b>	<b><i>Spectrum Editors</i></b>	889
<b>45</b>	<b><i>Common Music Notation Editors</i></b>	907
<b>46</b>	<b><i>Unconventional Score Editors</i></b>	929
<b>47</b>	<b><i>Instrument and Patch Editors</i></b>	947
<b>48</b>	<b><i>Languages for Sound Synthesis</i></b>	963

**49 Languages for Composition** 983

**50 Algorithmic Composition** 995

---

**VII Interconnections** 1029

---

**51 MIDI** 1031

**52 Open Sound Control** 1077

*Curtis Roads and Matthew J. Wright*

**Appendix A: Machine Learning** 1087

*Bob L. Sturm with Curtis Roads*

**References** 1099

**Index** 1233