Metric-Driven Design Verification
An Engineer’s and Executive’s Guide to First Pass Success
Hamilton B. Carter
Shankar Hemmady

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## Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Authors</td>
<td>xi</td>
</tr>
<tr>
<td>Dedications</td>
<td>xiii</td>
</tr>
<tr>
<td>Preface</td>
<td>xv</td>
</tr>
<tr>
<td>Introduction</td>
<td>xix</td>
</tr>
<tr>
<td>Contributing Authors in Order of Appearance</td>
<td>xxi</td>
</tr>
<tr>
<td>PART I ANALYZING AND DRIVING VERIFICATION: AN EXECUTIVE’S GUIDE</td>
<td>1</td>
</tr>
<tr>
<td>Chapter 1 The Verification Crisis</td>
<td>3</td>
</tr>
<tr>
<td>Chapter 2 Automated Metric-Driven Processes</td>
<td>13</td>
</tr>
<tr>
<td>Introduction</td>
<td>13</td>
</tr>
<tr>
<td>The Process Model</td>
<td>15</td>
</tr>
<tr>
<td>The Automated Metric-Driven Process Model</td>
<td>16</td>
</tr>
<tr>
<td>Project Management Using Metric-Driven Data</td>
<td>28</td>
</tr>
<tr>
<td>What Are Metrics For?</td>
<td>29</td>
</tr>
<tr>
<td>Tactical and Strategic Metrics</td>
<td>29</td>
</tr>
<tr>
<td>Summary</td>
<td>30</td>
</tr>
<tr>
<td>Chapter 3 Roles in a Verification Project</td>
<td>31</td>
</tr>
<tr>
<td>Introduction</td>
<td>31</td>
</tr>
<tr>
<td>The Executive</td>
<td>31</td>
</tr>
<tr>
<td>Marketing</td>
<td>33</td>
</tr>
<tr>
<td>Design Manager</td>
<td>34</td>
</tr>
<tr>
<td>Verification Manager</td>
<td>34</td>
</tr>
<tr>
<td>Verification Architect/Methodologist</td>
<td>35</td>
</tr>
<tr>
<td>Design/System Architect</td>
<td>36</td>
</tr>
<tr>
<td>Verification Engineer</td>
<td>37</td>
</tr>
<tr>
<td>Design Engineer</td>
<td>38</td>
</tr>
<tr>
<td>Regressions Coordinator</td>
<td>39</td>
</tr>
<tr>
<td>Debug Coordinator</td>
<td>39</td>
</tr>
<tr>
<td>Summary</td>
<td>40</td>
</tr>
<tr>
<td>Chapter 4 Overview of a Verification Project</td>
<td>41</td>
</tr>
<tr>
<td>Introduction</td>
<td>41</td>
</tr>
<tr>
<td>Summary</td>
<td>49</td>
</tr>
</tbody>
</table>
Table of Contents

Chapter 5 Verification Technologies 51
  Introduction 51
  Metric-Driven Process Automation Tools 52
  Modeling and Architectural Exploration 58
  Assertion-Based Verification 63
  Simulation-Based Verification 70
  Mixed-Signal Verification 73
  Acceleration/Emulation-Based Verification 75
  Summary 78

PART II MANAGING THE VERIFICATION PROCESS 79

Chapter 6 Verification Planning 81
  Introduction 81
  Chapter Overview 83
  Verification Planning 86
  Summary 105

Chapter 7 Capturing Metrics 107
  Introduction 107
  The Universal Metrics Methodology 109

Chapter 8 Regression Management 113
  Introduction 113
  Early Regression Management Tasks 114
  Regression Management 114
  Linking the Regression and Revision Management Systems 115
  Bring-Up Regressions 116
  Integration Regressions 119
  Design Quality Regressions 121
  Managing Regression Resources and Engineering
    Effectiveness 122
  Regression-Centric Metrics 123
  How Many Metrics Are Too Many? 125
  Summary 127

Chapter 9 Revision Control and Change Integration 129
  Introduction 129
  The Benefits of Revision Control 131
  Metric-Driven Revision Control 132
  Summary 139

Chapter 10 Debug 141
  Introduction 141
# PART III EXECUTING THE VERIFICATION PROCESS 155

## Chapter 11 Coverage Metrics 157
- Introduction 157

## Chapter 12 Modeling and Architectural Verification 163
- Introduction 163
- How to Plan 164
- Tracking to Closure 165
- Reusing Architectural Verification Environments 165
- Summary 166

## Chapter 13 Assertion-Based Verification 167
- Introduction 167
- How to Plan 170
- Tracking to Closure 175
- Opportunities for Reuse 177
- Summary 179

## Chapter 14 Dynamic Simulation-Based Verification 181
- Introduction 181
- How to Plan 183
- Taxonomy of Simulation-Based Verification 187
- Tracking to Closure 191
- Summary 196

## Chapter 15 System Verification 197
- Introduction 197
- Coverification Defined 199
- Advancing SoC Verification 201
- List of Challenges 202
- ARM926 PrimeXsys Platform Design 205
- Closing the Gap 207
- DMA Diagnostic Program 208
- Connecting the DMA Diagnostic to the Verification Environment 212
- Connecting the Main() Function in C 215
- Writing Stubs 216
- Creating Sequences and Coverage 217
- Conclusion 219
- References 220
Chapter 16 Mixed Analog and Digital Verification 221
   Abstract 222
   Introduction 222
   Traditional Mixed-Signal Verification 223
   Verification Planning 225
   Analog Mixed-Signal Verification Kit 229
   Conclusion 233
   Reference 234

Chapter 17 Design for Test 235
   Introduction 236
   Motivation 238
   A Unified DFT Verification Methodology 239
   Planning 240
   Executing 241
   Automating 243
   Test Case 245
   Benefits 248
   Future Work 249
   Conclusions 249
   References 250

PART IV CASE STUDIES AND COMMENTARIES 253

Metric-Driven Design Verification: Why Is My Customer a Better Verification Engineer Than Me? 255
   Abstract 255
   Introduction 256
   Section 1: The Elusive Intended Functionality 257
   Section 2: The Ever-Shrinking Schedule 265
   Section 3: Writing a Metric-Driven Verification Plan 270
   Section 4: Implementing the Metric-Driven Verification Plan 274
   Conclusion 277

Metric-Driven Methodology Speeds the Verification of a Complex Network Processor 279
   The Task Looked to be Complex 280
   Discovering Project Predictability 281
   A Coverage-Driven Approach, a Metric-Driven Environment 282
   A New Level of Confidence 283

Developing a Coverage-Driven SoC Methodology 285
   Introduction 285
   Verification Background 286
   Current Verification Methodology 289
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To my Parents who removed the word “cannot” from my vocabulary!

Hamilton Carter

To Seema, Shona, & Anand who make each and every moment a special one!

Shankar Hemmady
Preface

With the alarming number of first pass silicon functional failures, it has become necessary for all levels of engineering companies to understand the verification process. This book is organized to address all verification stakeholders at all levels of the engineering organization. The book is targeted at three somewhat distinct audiences:

- **Executives.** The people with their jobs on the line for increasing shareholder value.
- **Project, design, and verification managers.** The people responsible for making sure each design goes out on time and perfect!
- **Verification and design engineers.** The innovators responsible for making sure that the project actually succeeds.

The book is divided into three parts corresponding to its three audiences. The level of technical depth increases as the book proceeds.

*Part 1* gives an overview of the functional verification process. It also includes descriptions of the tools that are used in this flow and the people that enable it all. After outlining functional verification, Part I describes how the proper application of metric-driven techniques can enable more productive, more predictable and higher quality verification projects. Part I is targeted at the executive. It is designed to enable executives to ask appropriate educated questions to accurately measure and control the flow of a project.

*Part 1* also holds value for project managers and verification engineers. It provides an overall view of the entire chip design process from a verification perspective. The chapters on a typical verification project and the overview of verification technologies will be of use to entry level verification engineers as well. This part of the book also provides a unique viewpoint on why management is asking for process data and how that data might be used.
Part II describes the various process flows used in verification. It delves into how these flows can be automated, and what metrics can be measured to accurately gauge the progress of each process. Part II is targeted at design and verification project managers. The emphasis is on how to use metrics within the context of standardized processes to react effectively to bumps in the project’s execution.

Part III’s audience is the design and verification engineering team. It focuses on the actual verification processes to be implemented and executed. This section of the book is divided with respect to the various verification technologies. Each chapter on a given technology is further subdivided into sections on how to plan effectively, and how to track metrics to closure.

Entire books have been written on implementing verification using the technologies discussed in Part III. We will not reiterate what those excellent volumes have already stated, nor do we intend to reinvent the wheel (yet, we are engineers after all). Implementation details will be discussed when they will make the metric-driven techniques discussed more effective.

Part IV contains various case studies and commentaries from experts in the metric-driven verification field.

The various parts of the book can also be described as a progression of process abstractions. The layers of abstractions are “Observational Processes,” “Container Processes,” and “Implementation Processes.”

Observational Processes

Part I looks at the verification process from an observational point of view. The various aspects of a project that should be observed are described to the reader along with informal suggestions about how to strategically manage a verification project based on these observations.
Container Processes

Part II looks at processes that are necessary regardless of the verification technology you are using; processes such as regression management, revision control, and debug. Part II describes how to implement these processes using metric-driven methodologies. It also discusses the inter-relations of these processes.

Implementation Processes

Part III describes each of the verification technologies and explores how a metric-driven methodology can be used to enhance the productivity, predictability, and quality offered by each of these technologies.

Finally, Part IV leaves the world of abstraction altogether and presents several concrete case studies that illustrate metric-driven processes in action. In addition to these case studies are several commentaries offered by industry experts in metric-driven methodologies.
Introduction

Legend has it that 2300 years ago, Euclid walked the beaches of Egypt with his students. They were exploring the fundamentals of a new field: geometry. Each day, Euclid would draw a new problem in the sandy shores of the Mediterranean Sea. He’d ask his students to reflect on each problem and discover what they could. One day he sketched a diagram that would come to be known as Euclid’s 42nd Problem.

One of his particularly bright students worked on the diagram and came back with a simple formula:

$$a^2 + b^2 = c^2$$

This formula became so famous that it is now known simply by its discoverer’s name: the Pythagorean Formula.
Pythagoras thirsted for knowledge and spent most of his life traveling the various countries of the ancient Hellenic world searching for it. In his travels, he encountered many cultures and gleaned valuable knowledge from each of them applying it to the burgeoning new field of geometry.

Today we’re witnessing the birth of another new field, Metric-Driven Verification. Like Euclid, we hope to layout templates that not only illustrate the basics of this promising new field, but also inspire the reader to make even greater discoveries. Like Pythagoras, we have traveled the world searching for the best applications of this knowledge.

This book contains more than our basic understanding of the principles of metric-driven verification. The book also contains examples and experiences gleaned from many industry experts in verification and design. All of these are presented in their entirety in Part IV.

The last three chapters of Part III are about emerging technologies in the field of metric-driven verification:

- System verification
- Mixed-signal verification
- Verification of DFT hardware

These chapters use a different format. Each chapter contains a complete case study from one of the industry leaders in each of these three emerging areas.
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