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»» **BOOK REVIEW** MEL SCRIPTING FOR MAYA ANIMATORS

DECEMBER 2005

game developer

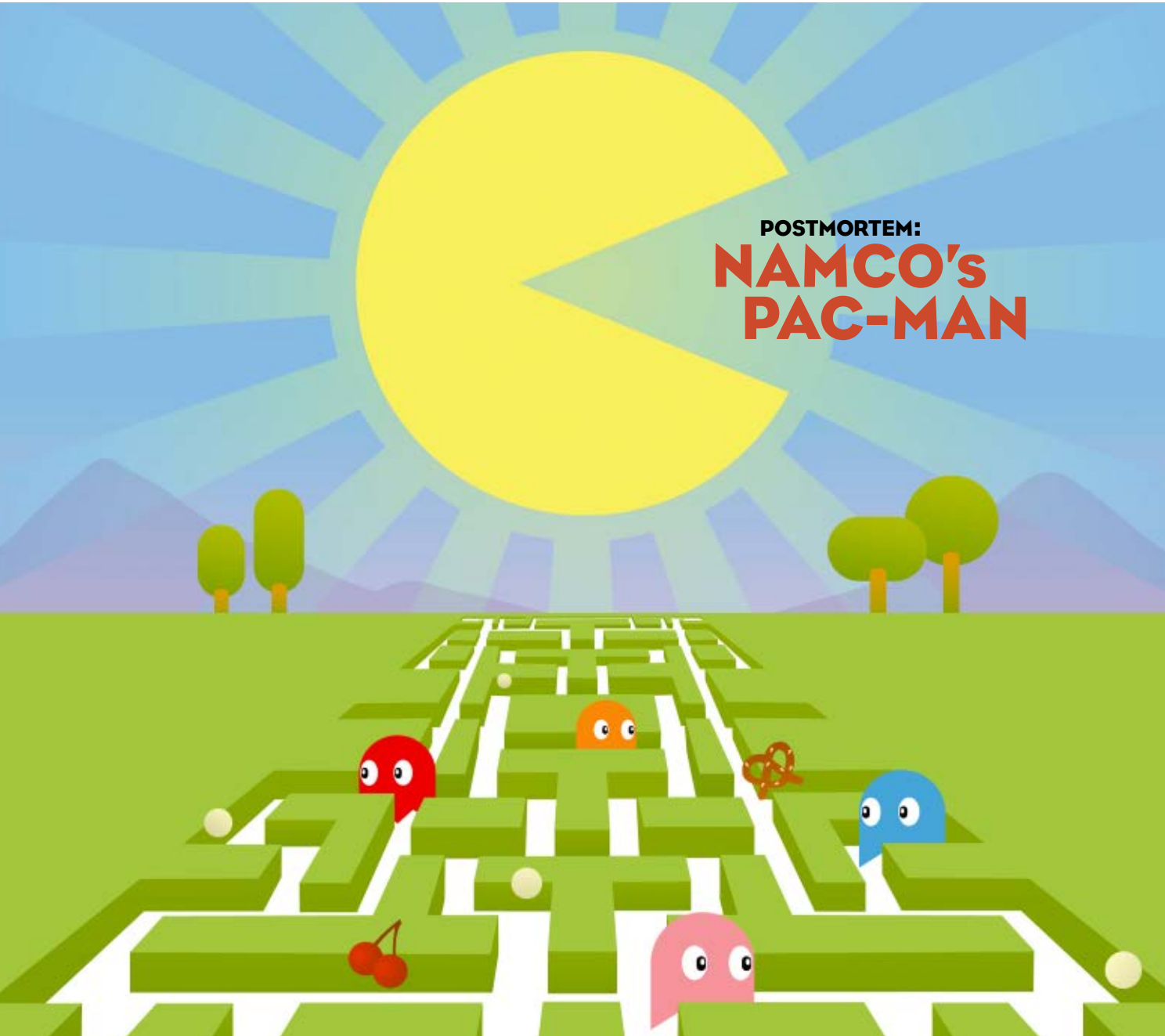
THE LEADING GAME INDUSTRY MAGAZINE

»» **TOO HOT FOR YOU**
COMPARING RATINGS
AS GAMES MATURE

»» **FUTURE OF FLOW**
ART PIPELINES FOR
NEXT-GEN CONSOLES

»» **GAIJIN ATTACK**
BUSINESS SMARTS FOR
EASTERN PROMISE

POSTMORTEM:
NAMCO'S
PAC-MAN



Havok games

➤ Xbox360 Games

Amped 3
NBA Live 06
Condemned: Criminal Origins
The Elder Scrolls IV: Oblivion
The Outfit
Perfect Dark Zero
Saint's Row

*and 40+ more next-gen
titles in development...*

➤ Current Gen Games

Swat 4
Half-Life 2
Halo 2
Mercenaries
Medal of Honor: Pacific Assault
Medal of Honor: European Assault
Max Payne 2
Mortal Kombat: Shaolin Monks
AstroBoy
Full Spectrum Warrior
Brothers in Arms: Road to Hill 30
Brothers in Arms: Earned in Blood
Tom Clancy's Ghost Recon 2
The Matrix: Path of Neo
Marvel Nemesis
Painkiller
FEAR
Tom Clancy's Rainbow 6: Lockdown
Darkwatch
Destroy All Humans

and the list goes on...

Supposed Competitor

Uhhh . . . one PC game.
Can you even name it?

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POSTMORTEM

26 DESIGNING PAC-MAN

Twenty-five years have passed since the dawn of PAC-MAN. Though the game and its lovable hero represent the first iconic presence in games, the PAC-MAN symbol continues to emerge on new platforms, offering new iterations of the original gameplay. Now, 25 years since its birth, seems an appropriate time to catch up with Toru Iwatani, PAC-MAN's creator, to get a long-overdue postmortem of the original game. As a bonus, *Game Developer's* editors have written a third-party postmortem of the entire franchise, trying to pin down PAC-MAN's continuing appeal.

By Toru Iwatani and Simon Carless

DEPARTMENTS

2 GAME PLAN *By Simon Carless*
Clyde Says Hi

4 HEADS UP DISPLAY
Austin Games Conference, Serious Games Summit, and more

7 SKUNK WORKS *By Tom Carroll and Kelby Fuchs*
MEL Scripting for Maya Animators, second edition

48 A THOUSAND WORDS
Electronic Arts' JAMES BOND 007: FROM RUSSIA WITH LOVE

COVER ART: DEREK YU

FEATURES

11 RATED AND WILLING

As video game violence turns more and more heads as a hot-button issue, it has become clear that the majority of the anti-video game lobby, and indeed a portion of the development community, is under-informed about just how the ratings systems work for games. In this feature, we dissect the ratings systems across four major territories—the U.S., the U.K., Germany, and Australia—to give a better impression of how the ratings board work to keep games in the right hands.

By Paul Hyman



11

19 ART PIPELINE PHILOSOPHIES FOR THE NEXT GENERATION: A TECHNICAL ART DIRECTOR'S PERSPECTIVE

As the next generation of systems unroll, game development will change forever. Fears of bigger budgets, larger teams and dispersed control could run wild, but as with any industry, the key for each individual is to work smarter, not harder. Rod Green outlines some techniques for next generation art pipelines that could save time and money as your team takes that big step into the next generation.

By Rod Green



19

COLUMNS

32 BUSINESS LEVEL *By Bill Swartz*
Navigating Japan

[BUSINESS]

33 THE INNER PRODUCT *By Mick West*
Practical Hash IDs

[PROGRAMMING]

36 PIXEL PUSHER *By Steve Theodore*
Anatomy for Animators Part II

[ART]

38 AURAL FIXATION *By Alexander Brandon*
Minimal Themes

[SOUND]

39 GAME SHUI *By Noah Falstein*
Rules of Interest

[DESIGN]



CLYDE SAYS HI

A LITTLE YELLOW PILL-CHOMPING GUY HAS BEEN featured in video games for an almost unbelievable quarter of a century. As you might have spotted from the cover, this esteemed personage would be PAC-MAN, whose immense arcade success in 1980 helped to kick-start the modern video game craze.

To pay tribute, we've managed to get a special postmortem for the original PAC-MAN written by its creator, Namco's Toru Iwatani. Iwatani talks lovingly about his goals when designing the title, the trials and tribulations of development, influences, and the title's effect on the gaming landscape. To back this up, the *Game Developer* editors have weighed in with our own postmortem of the PAC-MAN franchise in the 25 years since it started. What went wonderfully right? What went horribly wrong? We take an objective look (pg. 26).

RATE MY GAME?

This month's feature from Paul Hyman (pg. 11) looks in detail at video game ratings, following a not-insignificant amount of controversy in the mainstream press over how games are rated in North America. Rather than snapping to any decisions, we thought it would be a good idea to investigate exactly how other major countries rate games and determine what we can learn from their practices. Rating authorities in the U.S., the U.K., Australia, and Germany discuss how they each make their decisions and what factors they deem particularly important. That makes this article a must-read for any developers who want to understand how games are treated by rating boards, as well as the amount of effort that actually goes into making sure that video games are geared toward the right audience.

NEXT-GEN RELATIONS

Our two other guest developer articles for this month focus on vastly differing, but equally fascinating areas of the game business.

Former BioWare senior artist Rod Green presents a well thought-out feature on next-generation art pipelines, written from a technical art director's point of view (pg. 19). Is your art pipeline ready to deal with the massive amounts of extra data coursing through it as we segue into the next hardware generation? Green explains, both philosophically and practically, some of the most important points to bear in mind.

Second, Mastiff's "head woof" Bill Swartz, an Activision Japan veteran, takes the opportunity in a Business Level column to muse on why many Western publishers and businesspeople are convinced that Japan is an entirely culturally alien landscape, and how this affects the way business gets done in the East. Swartz does a good job of explaining why we should listen carefully, look sharp, and in particular, hire a good interpreter, to avoid tragic loss of nuance.

KAISER SOZE

Elsewhere in the magazine, this month's art page, A Thousand Words, looks to Electronic Arts' FROM RUSSIA WITH LOVE, replete with a suave Sean Connery and slinky new Bond girls. In addition, the Heads Up Display news section rounds up two important recent shows—the Austin Game Conference and Serious Games Summit—in case you missed out and would like to know what all the fuss is about.

JACKSON VS. ANCEL

Talking of fuss, a lot of the pre-Christmas critical interest we're seeing is focused on Ubisoft's PETER JACKSON'S KING KONG. But there's something in here that's worth remarking on further. In recent interviews, Jackson has clearly outlined that he asked to work on the game with Ubisoft because of Michel Ancel's work on the earlier, under-exposed title BEYOND GOOD & EVIL.

We needn't tell you why this is a great thing for video games—creators in other media wanting to work with individual creators for reasons of quality and meshing style, rather than wanting to work with companies and corporate entities for strict reasons of business is quite a step forward. Wonders will never cease.

Hopefully, as particular game development teams delineate themselves in certain genres and with certain game styles, we'll see even more of this cherry-picking from film to game and game to film, since, well, doesn't it sound like it will actually result in better quality end products? Beating the movie license curse never seemed so simple. ❖

Simon Carless, editor

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- Newton's Third Law of PhysX



[momentum]



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AUSTIN SWEET ON MMOS

WHY CAN'T WE BE MORE LIKE SOUTH KOREA?

That sentiment pretty much summarizes the hot talk at this year's Austin Games Conference. In addition to two days' worth of connected mini conferences on game writers and women in games, the main event was tightly themed to

LINEAGE II turns a sizeable profit in Korea for developer NCsoft.



cover massively multiplayer online games.

The show contained four distinct tracks dedicated to MMOs: Online Business & Production, Online Multiplayer Design, Online Multiplayer Tech and Online Multiplayer Services and Support. Even the keynote addresses, delivered by John Smedley, president of Sony Online Entertainment, on the first day and Dr. Richard Bartle, teaching fellow at University of

Essex and co-creator of the first MUD game, hummed along to the pervasive MMO tune.

Because online, persistent world games are not typically pressured into keeping step with next-generation technology—at least not to the degree that console games are—the sessions at the AGC tended toward

business aspects of managing the games, such as billing methodology. The few technological issues that were addressed by and large related to mobile connectivity only, or how to keep players connected to both their games and other players when not stationed in front of a computer.

For MMO developers, a key field of study is the Korean market. Due almost entirely to cultural differences, online games thrive in Korea in a way that currently isn't recreated in North America or Europe. Nonetheless, the majority of speakers at the AGC ached to find some nugget from Asia that might translate into Western development tactics.

"In Korea, we don't use retail because there is no retail channel. One of the things that drives the U.S. retail market is consoles. Until a year ago, consoles were illegal in Korea," explained Robert Garriott, CEO of NCsoft North America, whose LINEAGE series is enormously successful overseas. "In Korea, a retail channel will have to develop. In the U.S., just the way the markets have developed, retail is critical. Retail will continue to be critical."

Yet to what extent retail is truly critical for western MMOGs' success remains unanswered. Hopefully, the Texas-based conference will address such questions in 2006.

—Jill Duffy

"I think there's a good chance prices [for MMOGs] will go up. \$15 is not a price point. I don't think our player base is affected by the price. If it's a good game, they will pay \$20. If it's a good game, they'll pay \$25."

—Robert Garriott, CEO, NCsoft North America

"Innovation isn't really innovation unless it's intuitive and that's what we want from developers."

—Paul Nakayama, producer, Amp'd Mobile

"Why is your documentation so bad? ... You push it off on the people who write 'Dummies' books. You push it off on the players. You push it off on the guys in customer support. Those of you who have MMOs, you have the opportunity to update your documentation every day. ... Put it in writing the way your game actually plays and not the way you wanted it to play three months before launch."

—Steve Jackson, president and editor-in-chief of Steve Jackson Games, ranting about MMO developers' failure to write clear documentation

"There's a difference between a game being for a subject matter expert and a game built for a person."

—Jessica Mulligan, consultant [and former ASHERON'S CALL developer] on the barriers to attracting new players

"It's not suits I object to, it's suits who call the creative shots."

—Dr. Richard Bartle, teaching fellow at University of Essex and co-creator of the first MUD game

"We don't need to charge [MMOG] customers subscriptions in order to make money."

—John Smedley, president, Sony Online Entertainment

"The big barrier [to making a profit from an MMOG] is subscription itself. We offer 40 to 80 hours of entertainment for \$20 a month. You can't find a better rate for entertainment."

—John Needham, CFO, Sony Online Entertainment

NINTENDO DS

RANK	GENRE	UNIT SHARE
1	Action	47%
2	Strategy	16%
3	Family Entertainment	12%
4	Other Games/Compilations	9%
5	Racing	8%

TOP 5 PORTABLE GENRES

COURTESY OF NPD LTD.; RANKED BY TOTAL U.S. UNIT SHARE, SEPTEMBER 2005

SONY PSP

RANK	GENRE	UNIT SHARE
1	Sports	30%
2	Racing	28%
3	Action	22%
4	Role-Playing	7%
5	Family Entertainment	7%

SGS GETS SERIOUS

THE SERIOUS GAMES SUMMIT D.C. 2005, WHICH FOCUSED ON GAMES

created for training, health, government, military, education, and other uses, was held on October 31 and November 1, in Washington, D.C., at the Crystal Gateway Marriott, and attendee reactions and overall conference spirit seemed buoyant, as the nascent area of serious gaming continues to develop into essentially a sub-industry of its own.

More than 70 sessions dealing with all facets of serious games were covered at the conference, and the keynotes were particularly diverse, with Peter Perla the Director for Interactive Research, Center for Naval Analyses, kicking off the conference with his look at the concept of "wargaming science." Perla, whom noted author and game designer Larry Bond has called "the leading wargaming expert in the United States" is the author of important reference tome *The Art of Wargaming* (Naval Institute Press). Perla started his lecture by noting that a colleague at the Naval War College, though a noted eccentric who suggested that the Department of Defense pursue research using pigeon brains as the basis of robotic control systems, had challenged Perla to write a second volume of his book, called *The Science of Wargaming*. This brought up an important point for Perla, as he recalled his internal response to this request: "Wargaming isn't a science—it's an art, it's a craft, but it's not a science."

Perla went on to discuss possible ways that scientific concepts could be applied to wargaming, and then handed over to BreakAway Games CEO Doug Whatley, whose portion of the keynote concentrated on some of the practical problems of developing serious games. Whatley particularly took care to stress that those making serious games are game developers with sometimes confusing scheduling and naming processes, and it's important that those who are funding serious games "understand our process," in terms of scheduling and framework, sometimes especially alien for those working on government projects. However, Whatley suggested that the sky really is the limit in serious games, as he ended on a happy note, positively glowing about the possible future of the community, and evangelizing: "We can change the world."

The second day's keynote presented a stark contrast to that of the first, with the animated, hyperkinetic Dr. Dave Warner, MD, Ph.D., who is the director of the Institute for Interventional Informatics and an expert in sharable situation awareness and real-time feedback on

important events. The keynote description noted that Warner is "not a serious game developer, but his work on distributed intelligence, cutting edge sensor networks, and virtual reality makes him a shared partner in the quest to change the landscape of learning, healthcare, defense, and beyond." His intense, fascinating,



The United Nations' FOOD FORCE

and amusing talk, which touched on how to better solve real-life humanitarian and communication problems—and had definite relevancy to many of the problems of the serious games market—was enjoyed greatly by all present.

The rest of Serious Games Summit (run by the CMP Game Group, as is *Game Developer*) was a whirlwind of diverse sessions, from the United Nations' discussion of its educational FOOD FORCE game, through Carnegie Mellon University and the New York Fire Department's talk on HAZMAT: HOTZONE and a multitude of other talks. You can read about a number of them in more detail at www.gamasutra.com/sgsdc2005.

—Simon Carless

game developer FRONTLINE AWARD '05

2005 FRONT LINE AWARD FINALISTS

THE 2005 FRONT LINE AWARDS ARE UNDER WAY. A SELECT PANEL OF judges is diligently reviewing the products selected as finalists in the Front Line Awards, an annual evaluation of tools used in game development. The winning products, which are recognized for their excellence in helping game developers do their jobs better, more efficiently, and more gratifyingly, will be announced in the January 2006 issue.

Game Developer congratulates the companies whose products were selected as finalists in the 2005 Front Line Awards.

ART

Zbrush 2, Pixologic
FX Composer, Nvidia
ClayTools system for 3DS Max [v.1.1] and Maya [v1.0], SensAble Technologies
Modo 102, Luxology
Maya 7, Alias (recently acquired by Autodesk)
3D Studio Max 8, Autodesk

AUDIO

ISACT version 1.60, Creative Labs
Miles Sound System,
Rad Game Tools
Lipsync SDK 3.0, Annosoft
Harmony Hard Drive,
DeWolfe Music
CRI ADX, CRI Middleware

BOOKS

GPU Gems 2, Matt Pharr (ed.), Addison-Wesley
A Theory of Fun for Game Design, by Raph Koster, Paraglyph Press
Audio for Games: Planning, Process, and Production, by Alexander Brandon, New Rider Press
The Game Localization Handbook: Localization Production Pitfalls, by Heather Maxwell Chandler, Charles River Media
Introduction to Game Development, Steven Rabin (ed.), Charles River Media

ENGINES

Virtools Dev 3.0, Virtools
Source, Valve
Unreal Engine 3, Epic Games Inc.
BigWorld MMO Technology Suite V1.6, BigWorld Pty Ltd
Gamebryo 2, Emergent Technologies

HARDWARE

Razer Copperhead, Razer
Quadro FX 4500, Nvidia
SpacePilot, 3Dconnexion
MX40 Motion Capture System, Vicon
DX1 Input System, Ergodex

MIDDLEWARE

SpeedTreeRT/v1.7, Interactive Data Visualization (IDV)
Gameface, Anark
AGEIA PhysX SDK, AGEIA Technologies
Tira Jump Product Suite, Tira Wireless
DemonWare Netcode, DemonWare

PROGRAMMING

Intel VTune Performance Analyzer, Intel Corporation
ReplayDIRECTOR v2.0, Replay Solutions
Perforce SCM 2005, Perforce Software
ProDG for PSP, SN Systems
SlickEdit 10, SlickEdit

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MEL SCRIPTING FOR MAYA ANIMATORS **Second Edition**

BY TOM CARROLL AND KELBY FUCHS

INNOVATOR DALE DAUTEN ONCE said, "It's time to re-appreciate the original software: paper."

This leads us to a discussion of the ups (many) and the downs (few) of the second edition of *MEL Scripting for Maya Animators*, a 529-page stack of "original software," so to speak. Written by Mark R. Wilkins and Chris Kazmier, this new edition is—as was the first edition—the very best of an extremely small number of books that even attempt to cover the subject of scripting animation.

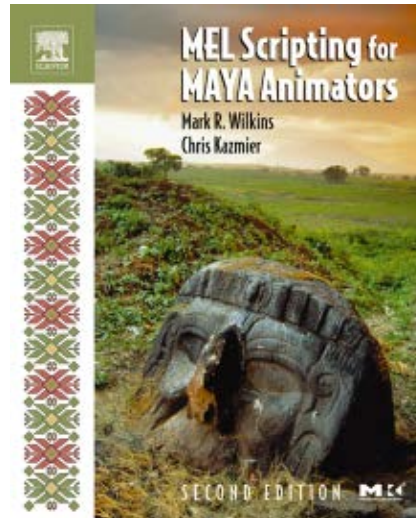
For those who may be new to the field, MEL, which stands for Maya Embedded Language, is the scripting language used within Maya. MEL allows the user to automate any operation that can be accomplished through Maya's GUI; some of those operations can be extended through MEL in ways that aren't possible using the GUI alone.

This review looks at Wilkins and Kazmier's book in two takes.

TOM CARROLL

While I aspire to be a Maya technical artist, I am certainly not there yet. Because I have a day job that doesn't require me to use Maya deeply and daily, and because I have a family, my day-to-day exposure to MEL scripting is limited. Picking up the second edition of *MEL Scripting*, however, allowed me to see how far I could push myself in a relatively short period of time—about three weeks. As they say, the results were heartening.

I never used the first edition of this book (though my co-author did), so my impressions are limited to the updated version. Luckily for a neophyte like me, the book starts out with an explanation of the basics. Wilkins and Kazmier have built a foundation for a broad audience,



These exercises are outlined in clear language, step by step, usually with one or two accompanying visuals to help ensure the reader is achieving the desired results.

By the time I reached Chapter 3 ("Using Expressions"), I was ready for more substantial exercises. I had already built a foundation for my MEL learning that would permit me to systematically add knowledge: the location and function of the Command Line, the Command Shell, and the Script Editor; how to create a MEL script, run it, and verify the result(s); and how to capture MEL commands from the interface and add them to my existing scripts. Chapter 3 expanded this knowledge by introducing the concept of expressions (an expression is a script that calculates values for one or more attributes in the scene). "Example 1: Eyes" then showed how to use an expression to determine whether a pair of eyes tracks an object in a coordinated or uncoordinated way, and another expression to make the pupils of those eyes dilate or constrict in relation to an outside variable (in this case, light).

As with the other examples, this one was very well thought out. It was designed to teach specifics as a means to open up a wider world of general principles. In fact, one of the more successful aspects of using this book is that it helps you to learn (or re-learn) about Maya in a bigger, more diverse way than you may have before.

KELBY FUCHS

I have been creating video games for more than seven years as a technical artist, and I've always enjoyed helping others get a handle on new software, asset pipelines, and improved workflow techniques. I don't have a computer science degree, but I did take a MEL scripting course in college. Luckily, during my college years, paired with a buddy from computer science who

and the first brick is the admission that Maya works very hard to hide much of what's "going on under the hood" from the casual user.

The authors take great pains to explain where pertinent features, graphs, and editors are found, and to paint a picture of the interconnectivity of Maya's various networked nodes. The average Maya modeler or animator knows this about as well as an amateur astronomer knows the dark side of the moon. Wilkins and Kazmier also explain that some aspects of Maya can't even be manipulated at all unless they are accessed through scripting.

By the end of Chapter 1 ("Maya Under the Hood"), I was fairly comfortable with the authors' approach. The style is inclusive. The authors stop to clarify specialized terminology, and the written word is supplemented from time to time with appropriate figures.

READER ENGAGEMENT

Specific exercises, which the reader is expected to complete, are included to augment what the authors are teaching.

BOOK REVIEW



STATS

TITLE
MEL Scripting for Maya Animators, Second Edition

AUTHORS
By Mark R. Wilkins and Chris Kazmier

PRICE
\$49.95, paperback

PUBLISHER INFORMATION
Elsevier
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ISBN: 0120887932

excelled in programming, I was able to get a grip on complex terminology as well as some of the core concepts that I would need to carry with me into my career.

My copy of the first edition of *MEL Scripting* is now a mass of dog-eared pages, copiously highlighted and enveloped in sticky notes. The book was a major stepping-stone into the world of scripting for me. With very clear explanations of programming concepts and easy-to-follow examples, it has remained within arms' reach.

I found the concepts of global and local variables and procedures extremely helpful. Issues of scope within scripts created hindrances for me initially, but I can now use them to my advantage.

The new second edition embellishes on the first book in many ways and includes new sections for fixing programming bottlenecks and additions to the user interface. It quickly gets you

into how Maya works and the many features and actions you have control over. The authors frame this technical material with handles most artists should be able to grasp.

This book is filled with great examples of simple procedures that even a scripting lightweight can comprehend. It's helpful to read through the preface to understand whom the specific chapters are directed toward.

For instance, the section in Chapter 3 that asks the reader to set up eyes to focus on one object or two uncoordinatedly was fun because it got me thinking of some other complex rig configurations that I could make. Also, setting up simple particle expressions to control particle flow in Chapter 5 ("Problem Solving with MEL Scripting") gave me a sense of the amount of control and ability to automate complex repetitive tasks I can now take advantage of in a routine manner.

helpful as new users encounter the inevitable // Error: line #: Syntax Error // that's so frustrating to interpret.

Many of the teaching examples use particles, which can be fun to play with. For instance, Chapter 5 has an example that shows how to automate setup for Spiral Particles. It makes it easy to see how MEL can greatly increase your productivity. Chapter 14 ("Custom Dialog Boxes") has another example in which you create a window interface to control your script or parameters. What animator doesn't want to make a control interface of his or her own? While the book's dependence on particles for some examples was fun and productive, it's important to remember that, at least in my experience, particles for games are often generated with tools developed outside of Maya.

BEST USE

While *MEL Scripting* is an excellent resource, I find it a little difficult to use like a desk reference. It might help if there were a robust cross-reference section that listed terminology common to the field even if not specifically used in this book.

If you have the first edition of *MEL Scripting for Maya Animators*, you might not need to purchase the second unless you're fluent in scripting and specifically need help with optimizing character rigs, fixing programming bottlenecks, or advanced user interface techniques. If you're just getting started or are advanced enough to want the second edition's beefed up content, there's an empty spot for this book next to your monitor right now. But make sure there is enough space for a few pads of sticky notes and a couple of highlighting markers. You'll want to ink this one up. ❖

TOM CARROLL is an environment artist.

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SYNTACTIC MATTERS

Though syntax is explained in Chapter 3, I would like to see a reference chart that listed simple examples and complex commands. Maya syntax can be very challenging because the order can vary in form when written in an expression as opposed to a MEL script. For beginners, deciphering the proper use of syntax is often difficult to grasp. A few pages dedicated to the format of allowed words, special characters, and structure of MEL commands with the appropriate parameters in the correct order would help novices tremendously.

For instance: when should `{ }` be used instead of `[]` or `[]?` Also, why is Maya so picky about the direction of a slash, like backslash as opposed to forward slash, when dealing with texture or reference paths? And most important is the use of backtick versus a single quote mark when storing command results into a string (for example, string `$sphereName= `sphere``). A reference page would be

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RATED AND WILLING

WHERE GAME RATING
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» THE RECENT CONTROVERSY OVER THE HOT COFFEE MOD FOR

Rockstar's *GRAND THEFT AUTO: SAN ANDREAS*, and its subsequent temporary re-rating by the ESRB from M (mature) to A0 (adults only) has only intensified the focus on how video games are rated in the U.S. But in the British Isles, as we'll discover, game raters scratched their heads and wondered what all the fuss was about. This fact alone showcases the cultural and procedural game ratings system differences among different territories of the world.

We at *Game Developer* investigated and tried to compare the video game rating systems of four countries—the U.S., the U.K., Germany, and Australia. Each territory deals with games in a slightly different way, both in terms of how they are screened and how the government or voluntary bodies combine to allow the rating of titles, making for some fascinating comparison points. There's no empirical *right* or *wrong* when it comes to game rating—just the seldom-raised opportunity to look at multiple data points, and see how different territories hope to rate and compare vastly differing gameplay experiences for countries and people that are culturally different.

FULL DISCLOSURE, U.S.A.

The New York City-based Entertainment Software Rating Board (ESRB), a self-regulatory body established by the Entertainment Software Association trade organization in 1994,

issues a rating to more than 1,000 games each year, a formidable task to be sure. That's practically every video game released to retail in the U.S. minus a few sold strictly online. Because of this volume, and the fact that games can sometimes take tens of hours to beat, the ESRB doesn't attempt to play the games all the way through in order to determine their content.

"We depend on full disclosure of all pertinent content by the games' publishers," says Patricia Vance, the ESRB's president, "and that's done through an extensive written questionnaire that documents everything that's relevant to our rating system."

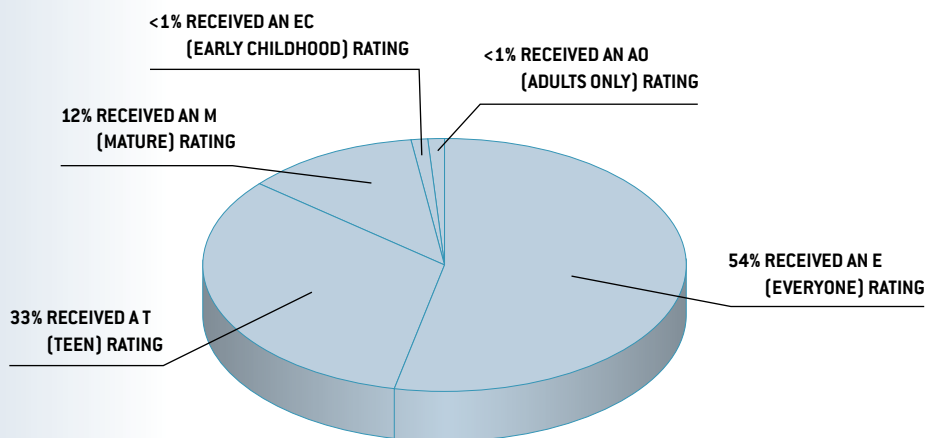
"Pertinent content" isn't the easiest concept to get one's head around, but it can mean, for example, not only the degree of violence of an act but also how much control the player has over that violence. In other words, after shooting a character, can the player continue to shoot that person after he or she is dead? And what is the effect if the player continues to shoot? Such details, which the ESRB says are totally pertinent to the overall intensity of the experience, are covered by the organization's lengthy questionnaire.

"We are actually quite specific about what we mean by 'pertinent content' in our submission materials," Vance notes. "Even if you were to interpret 'pertinent' differently than we do, it would be hard to misinterpret it when you're filling out the submission forms. We also include information about how to

PAUL HYMAN was the editor-in-chief of *CMP Media's GamePower* and currently writes a weekly column on the game industry for *The Hollywood Reporter*. He's covered gaming for more than a dozen years. Email him at phyman@gdmag.com.

RATED AND WILLING

UNITED STATES



NOTE: The statistics represent the ratings of games as they appeared on the shelf. Percentages based on 1,036 games rated in 2004.

ESRB, UNITED STATES

URL

www.esrb.org

LOCATION

New York

AFFILIATION

Entertainment Software Association (the ESA established the ESRB in 1994)

RATINGS

eC (early childhood)

E (everyone)

E10+ (everyone 10 and older)

T (teen)

M (mature/over 17)

AO (adults only/over 18)

review content and how to prepare it for submission. If publishers still have questions, there's contact information on our web site to reach the people in our ratings department with whom they're probably already familiar."

In addition to the questionnaires, the ESRB expects to receive lyric sheets and highlighted scripts, if appropriate, along with videos that give a good idea of the game's context, story line, objectives, mission, options, typical gameplay, and especially, the most extreme violence, language, suggestiveness, and sexual content.

While Hollywood raters have the luxury of viewing completed movies, the ESRB does its job while the developers continue to remove bugs, link missions, and spiff up the final product. So, if the board believes it needs more information about a game, it will sometimes request a build of the title in its current state so that its staff can further evaluate the game in question.

Once the submission is deemed complete, the ESRB draws from its pool of part-time, independent adult raters who have no other ties to the industry but are willing to work two or three hours per week viewing content. Based on the feedback of at least three raters—but sometimes as many as nine—the ESRB looks for a consensus upon which to base its final rating.

Critics point out that it would be easy for publishers to fudge their submissions, perhaps leaving out references to violence in order to earn a less severe rating. But the ESRB holds firm (with consequences) that there's no incentive whatsoever to such shenanigans. If offensive portions of a game are discovered after it ships, the ESRB requires publishers to have the game re-rated, re-stickered, possibly recalled, with all advertising changed appropriately.

"It's extremely costly for a company to do that," Vance notes. "Not only are the corrective actions expensive, but there may also be penalties and fines associated with nondisclosure."

The ESRB has modified those ratings over the years, adding descriptors to better help consumers understand the rating system, and making the ratings and descriptors more prominent on the game boxes. Most recently, a new rating—E10+, for everyone 10 and older—was added "because we felt

that consumers, particularly the under-14-year-olds, were demanding a new category for those in-between years. And there was plenty of product that met those requirements, meaning not suitable for age 6 but not yet at the T rating [for everyone 13 and older]," says Vance. "Our goal is to keep the system current."

Vance acknowledges that the next generation of game consoles and more advanced technology will definitely change the face of the industry, thereby affecting the ratings system. "I certainly think the online environment is a challenging one for us," she notes, "especially when gamers can generate their own content, say, through mods. That's an area where parents need to be more vigilant, and one that I'm not so sure we can do much about."

Developers have queried the rating system on occasion, saying that there is a place for mature games, but that large retailers refuse to sell anything with an AO (for 18 years and older) rating. Vance, however, believes that what happens in the marketplace should not be blamed on the ESRB, refusing to let herself or the organization be held responsible for such outcomes.

"That's the marketplace making up its own mind, not us. We're just here to accurately label product. If retailers choose not to sell AO product for whatever reasons—because they don't think it will sell, or they don't think their customers want them to carry it, or it doesn't fit in with their family-friendly image—that's their decision. Not ours."

VOLUNTARY AND GOVERNMENTAL, U.K.

In 1993, one year before the birth of the ESRB, the U.K.'s Entertainment Leisure Software Publishers Association (ELSPA) and the Video Standards Council (VSC) created the ELSPA system, which makes it necessary for all ELSPA members to submit their games for ratings. Just as in the U.S., it's a voluntary system which is enforced by most video game retailers who won't sell un-rated games.

Laurie Hall is secretary-general of the VSC, the standards body that administers the ELSPA system and represents the country's game publishers as well as more than 10,000 retail

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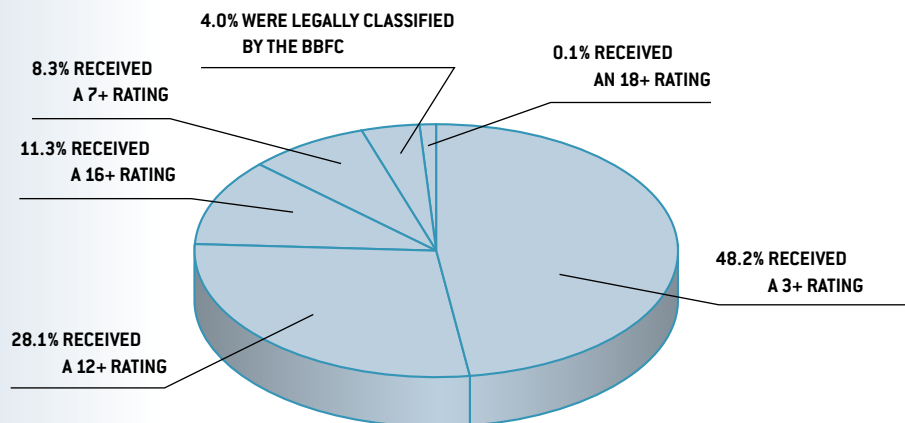
XBOX 360

VIDIA

XBOX

RATED AND WILLING

UNITED KINGDOM



NOTE: The games dealt with by the BBFC are games that have lost classification exemption in the U.K. and have been legally classified. Percentages based on all games rated from April 2003 to June 2005.

outlets. Between 1994 and 2003, Hall and his team have rated well over 7,000 games.

As with the ESRB system, the VSC depends on “the help and guidance of the game publishers who answer a series of questions which then throws up an age rating,” says Hall. “So far, we haven’t had any examples of abuse or anyone deliberately hiding things from us.”

The games that receive the most mature ratings—for ages 15 and up and for 18 and up—are examined by the VSC before those ratings are applied. “That’s to make sure that the game has been rated correctly at that higher, more sensitive level,” Hall notes.

Unlike at the ESRB, the VSC uses professional raters who examine the games in detail using cheat codes provided by the publishers. Their typical workload is approximately 200 games annually.

“What they are looking for is to make sure that the game hasn’t crossed the line from being in the voluntary category to the mandatory category where the game needs to be submitted to the British Board of Film Classification [BBFC],” explains Hall; or, as stated on VSC’s web site (www.videostandards.org.uk): “Before a game can be rated under the voluntary system, it must be established that the game is exempt from legal classification in the U.K.”

According to British law, games containing gross violence and/or sexual content need to be submitted to the BBFC, a government body, for legal age classification. Only two or three percent of the games published—so-called “extreme games”—receive this treatment. In fact, the ELSPA system was developed specifically to deal with the overwhelming majority of games that would otherwise have had no rating at all.

“The penalties are quite draconian for a game publisher or retailer getting it wrong and selling a game that should have gone to the BBFC but didn’t,” Hall warns. “Under the law, the fine can be unlimited, plus up to six months in jail. And so, everyone tends to follow the rules. It tends to concentrate the mind.”

In 2001, the Interactive Software Federation of Europe [ISFE] met in Brussels to tackle the issue of the growing number of

national rating systems. At the time, there were already four rating systems in Europe, and the ISFE feared that confusion would erupt if every country created its own system.

“You can imagine what a game box would look like if it needed to carry 10 or 15 different age ratings on it,” says Hall. The ISFE’s solution was the Pan-European Game Information System [PEGI], a single video game rating system that is now administered by both the U.K.’s VSC and The Netherlands Institute for the Classification of Audiovisual Media. The number of countries using the system has grown from 16 to 20, with the notable exception of Germany.

“There had been a shooting in a school there and, just as in the U.S., a computer game was blamed,” explains Hall. “Legislation was passed that all video games in Germany had to be rated by their government, which is still the case.”

As with the ELSPA system, any game publisher requesting a 16+ or an 18+ rating must have its game examined before it gets rated. Games self-rated for ages 3, 7, and 12+ are examined retrospectively.

While the PEGI members agreed on how they would rate games, there will probably never be agreement on what is objectionable and what isn’t in the various member countries. For instance, the U.K. seems particularly concerned about bad language, more so than on the continent, but sexual content gets just a middling reaction, which is still more than in the Scandinavian countries which are extremely liberal in that regard. But when it comes to violence, the U.K. and other southern European countries are fairly accepting of it in their games, whereas Scandinavia is much more restrictive. The solution has been the use of “descriptors” on packaging. If a game gets an age 16 rating because of language, a mother in the U.K. who sees the “language descriptor” might prevent her child from buying it, but a mother in France, who isn’t particularly bothered by such language, may have no hesitations about buying it for her 12-year-old.

“The same sort of cultural differences popped up with the so-called Hot Coffee issue with GTA,” recalls Hall. “I know the scene depicting a sex act caused a great stir in America. Even Hillary

ELSPA, UNITED KINGDOM

URL

<http://elspa.co.uk> and www.videostandards.org.uk

LOCATION

London

RATINGS

3+
7+
12+
16+

BBFC RATINGS

15
18



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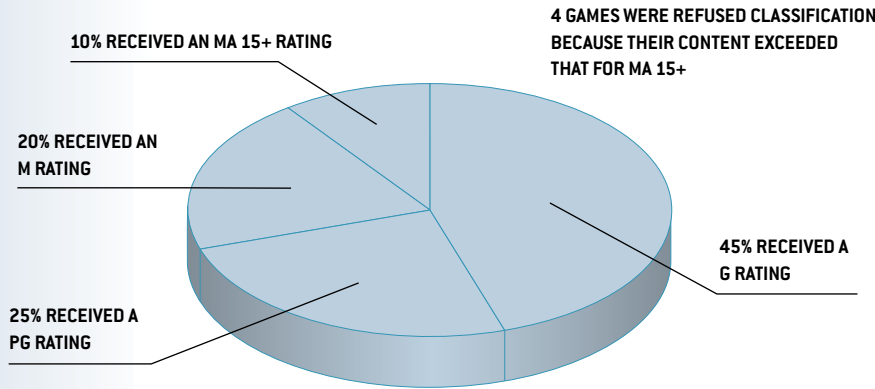


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RATED AND WILLING

AUSTRALIA



NOTE: Percentages based on 718 games rated in 1994. More recent statistics were not available.

CLASSIFICATION BOARD, AUSTRALIA

URL

www.oflc.gov.au

LOCATION

Sydney

AFFILIATION

Government of Australia

RATINGS

G

PG

M

MA15+

(not suitable for people under 15)

SAMPLE OF BANNED GAMES

BMX XXX

MANHUNT

NARC (2005 update)

Clinton got involved. But we looked at it and it seemed relatively trivial. Did we change the rating? No, because it was already rated 18 for violence, which is the highest it can go. Would we have raised it if we could? I think not; as I said, that sort of thing is considered mild over here."

UNDER GOVERNMENT SCRUTINY, AUSTRALIA

There's no such thing as a voluntary video game rating system in Australia. Under national law, no video game can be sold or rented unless it has been rated by the Classification Board (formally known as The Office of Film & Literature Classification), an independent statutory authority.

Australia applies a comparatively simple system containing just four ratings or "classifications:" General (G) for very mild content, Parental Guidance Recommended (PG) for mild content, Recommended for Mature Audiences (M) for moderate content, and Not Suitable For People Under 15 (MA15+) for strong content.

Although films can be rated as R18+, any game with content stronger than an MA15+ is simply refused classification and cannot be sold or rented in Australia. What usually happens is that publishers modify these titles for the Australian market in order to receive an MA15+ rating.

After paying a fee, publishers provide a "comprehensive and detailed synopsis and description of gameplay sufficient to allow the Board to work its way through the entire game if it needs to," says Des Clark, director of the Classification Board. If the game contains content that is likely to receive an M or MA15+ rating, that content must be provided on videotape or demonstrated to the Board by the publisher.

"The recorded or demonstrated sequences of M or MA15+ content are given very close scrutiny, as is the content of G and PG games," adds Clark. "As the Australian government is committed to protecting children from things that may harm them, we take classification of games at all levels extremely seriously."

Ratings are based on an "impact test"—from very mild impact to strong impact—for each of several classifiable elements,

including themes, violence, sex, language, drug use, and nudity. "The impact test means that we need to consider not only the impact of the individual elements but also the cumulative impact of the overall production," says Clark.

The review board can contain as many as 20 people who have 20 working days to create a report that outlines their decisions. The publisher is then given a classification certificate plus a copy of the report, if requested.

"In my opinion, the fact that Board members are recruited to be broadly representative of the Australian community ... and the fact that the mechanisms by which classification decisions are made are clearly laid out in legal instruments contribute very strongly to the success of our system," says Clark.

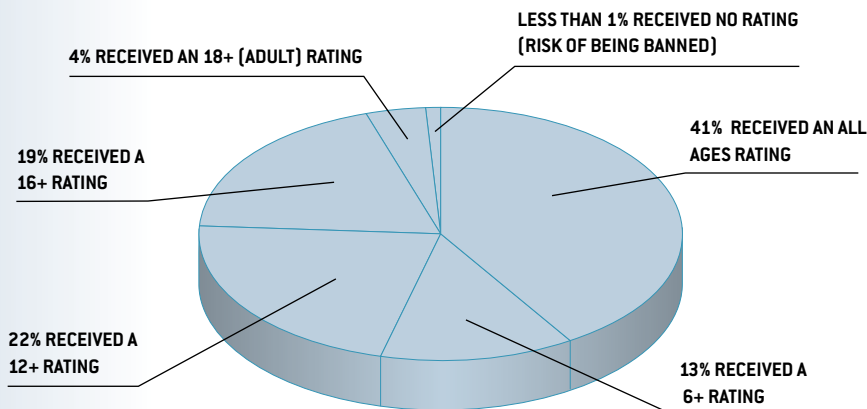
Because the Board rates not only video games but also movies, DVDs, and videos, its biggest challenge these days is to deal with the increasing volume of content being released onto the Australian market. The solution has been twofold: to increase the size of the Board itself and to create so-called authorized assessors.

The assessors are employees of publishers who are trained by the government to review the games themselves and make recommendations to the Board in comprehensive reports for games they believe deserve G, PG, or M classifications. In addition, they must supply the M content to the Board either on videotape or through some other means. The Board reads the report and either accepts the recommended rating, calls for more information, or repeats the classification process. Members of the board must view and classify MA15+ games themselves.

Occasionally, the Board plays the games up for review in their entirety, but not often. "Due to the massive volume of content in many games, it's usually not possible," Clark explains. "Government policy requires the cost of classification services to be recovered from applicants. Because of the time it would take, if the Board were to play every game through, the cost burden on applicants would be huge, not to mention the potential for delays."

That means the system relies on applicants to submit complete information, which, in Australia, is their legal obligation.

GERMANY



NOTE: Percentages based on 2,152 products presented to USK in 2004.

"If they do not ... if content is found [after the game's release] to be at the M or MA15+ level and would, therefore, cause a higher classification, the Board revokes the game's certification," warns Clark. "That is what happened here with the Hot Coffee modification of *GRAND THEFT AUTO: SAN ANDREAS*. So it is extremely important that the Australian distributors are made aware of all content by the developers so it can be provided to the Board."

EXTREME VIOLENCE IS VERBOTEN, GERMANY

The two-year-old German Juvenile Protecting Law states that every video game must have an age rating on it, or it can only be sold to adults. Unlike in the U.S., adult games (with M and A ratings) seem to have no stigma attached to them since they are readily available for purchase by adults at German retailers. That is, unless they have been banned completely, likely due to excessive violence, or use of forbidden symbols, such as the swastika.

"Developers can create any game they want to, just as long as they take into consideration that there is a rating system for the protection of minors," says Jurgen Hilde. Hilde is the Permanent Representative of the Supreme Youth Authorities of the Lander at the USK (Unterhaltungssoftware Selbstkontrolle), Germany's software rating body.

Within the USK, between three and five "video game experts" from a board of 52 are randomly selected to review each submission by a publisher. The process involves a discussion of all aspects of the game, including graphics, contents, gameplay, and other topics that would be relevant in selecting an age rating.

"The main focus is this: Are there any elements in this computer game that would possibly have a negative impact on juveniles of a certain age?" says Hilde. "If the board of experts is convinced that there are risks for a certain age, they rate the game up to the next age category." Criteria for all age ratings are listed on the USK's web site, though the text is in German.

Hilde prides himself on the fact that the USK board handed out almost 2,500 ratings last year, usually within 14 working days, if all the appropriate information was submitted properly. In

order to accomplish this, the board employs three full-time game testers who are tasked with playing the entire game through using cheats and walkthroughs supplied by publishers. Using "save game" options, they construct a presentation to the board of experts.

"These testers must be video game experts with a lot of experience," Hilde explains, "and, of course, they have to be very reliable so that the board is convinced it has all the information it needs to make a proper age rating."

Hilde says he finds the different views that various countries have about the harmful effects of video games interesting.

"In America, sex and bad language seems to be the focus of discussion and, in the case of the Hot Coffee mod and *GRAND THEFT AUTO: SAN ANDREAS*, the wrong content can mean enormous financial loss for a publisher," he notes. "Here in Germany, violence dominates our concerns, and too much violence can get a video game banned."

MIDDLEMAN'S STIGMA

Regardless which country is monitoring the classifications, the raters are unanimous in their advice to game developers and publishers: "Remember, we're on your side!"

"I know they'd much rather not have to deal with us at all," says ELSPA's Laurie Hall, "but we're not the enemy. We are here to make sure they satisfy consumer, retailer, and legal requirements."

The ESRB's Pat Vance stresses that the submission process ought to be taken very seriously. "We're here to protect the publishers and developers as much as we're here to inform their customers," she stresses. "This is not an adversarial relationship, although I often think developers consider us to be their adversary. We're not. We're here to make sure that the content they create is accurately labeled ... so that everyone doesn't find themselves in a situation where there are consumer complaints or where there are surprises that take everybody—including the publishers and developers—down with them." ❖

USK, GERMANY

URL

www.usk.de

LOCATION

Berlin

RATINGS

No Restrictions

6+

12+

16+

Adults Only

SAMPLE OF BANNED GAMES

MANHUNT

QUAKE 1, 2, and 3

RETURN TO CASTLE

WOLFENSTEIN and

WOLFENSTEIN 3D

(English version)

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A TECHNICAL ART DIRECTOR'S PERSPECTIVE

ART PIPELINE PHILOSOPHIES FOR THE NEXT GENERATION

DEVELOPERS WORKING ON THE NEXT GENERATION OF GAMES

have some significant concerns about the ability of existing art pipelines to handle their growing production needs. The number of artists involved in a project is swelling as high as three figures, and the amount of data handled in a game is growing into terabytes.

The core of the problem is the expanding number of artists needed to achieve a constantly rising standard of detail. With any increase in detail, there is a corresponding increase in the nature and number of technical hurdles during development. The trick is to be as efficient as possible with the flow of information between artists and the tools they use. It's an issue I've been addressing for companies with next-generation art needs, such as BioWare.

ART PIPELINE ASSESSMENT

The goal of any art pipeline—the interconnecting software, utilities, processors, and techniques that artists use to design, develop, and submit assets—should always be to make sure the artists on the project are able to work as quickly and efficiently as possible.

A good pipeline should have the following core features:

- fast art iteration
- detailed art tracking
- detailed feedback
- common data formats
- a modular structure with a centralized hub
- robustness.

ROD GREEN has been working in the video game industry for the last six years, contributing to 12 published titles at companies such as BioWare and Atari. Email him at rgreen@gdmag.com.

ART PIPELINE PHILOSOPHIES FOR THE NEXT GENERATION

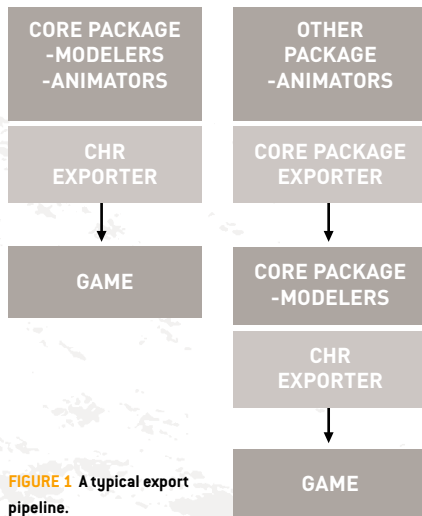


FIGURE 1 A typical export pipeline.



When defining a pipeline, it's best to start with the big picture and then drill down to the specific areas that require more definition. In general terms, all assets go through three major stages:

- design
- creation (which includes the feedback and revision loop)
- submission.

Each stage is made up of two key components: asset creation tools and asset processing tools. The technical art director must carefully define the data flows (export, import, copy, move, archive, check in, check out) and the types of data you anticipate will move through them (such as textures, meshes, animation, hierarchies, materials) before setting up this flow. The thing to most carefully avoid is a back step because of a deficiency in the pipeline.

THIRD-PARTY ART TOOLS

Picking the right tool for the job. There are two major pitfalls that you should try to avoid when picking software to incorporate into your pipeline. First, don't rely on a magic bullet approach when it comes to art tools. Pick a tool that fulfills as many needs as possible, but recognize that it won't be able to do everything. Trying to bend one tool to fit all your needs can cause more trouble than it's worth.

Second, when planning, many teams apathetically "stick with the devil they know" rather than evaluate new tools. Many studios are well aware that the software suite or version they use is substandard, but they stick with it anyway out of fear that they'd have to retrain everyone or that all their tools are built into version X, or that X software vendor is their friend. Or, they simply might not take the time to reevaluate the pipeline between projects.

If one of your vital tools is substandard, start working out a

plan to implement a replacement or updated version. Your pipeline needs to be future-proofed, as much as possible anyway, meaning you should build your art pipeline in a way that best prepares it for future integrations and updates, without having to rewrite all your art tools every time a change is made.

Make sure everyone on the team, including the art tools programmers, evaluates all available tools and their support network before you decide to purchase a new tool. That includes considering tools that might not be conventional. Zbrush is a great example of a tool that was created for one purpose, but as a by-product, was found to perform other tasks very well and became an integral part of many pipelines practically overnight.

As projects progress, there will be points where new solutions are necessary. If the pipeline is set up well, it can limit the time it takes to add new features. For example, the character animators on a project are working in art package X with the modelers, but they discover that art package X's animation systems weren't able to support the animators effectively, thereby reducing their productivity. The obvious solution would be to find another tool to support the animators.

In a typical pipeline, the character exporter (rig and animation) would export from X into one CHR file (see Figure 1). But this would mean that the animation from the new tool needs to be exported to X, then again exported by the modelers with their rig. However, if the exporter were split into the separate components, namely RIG and ANI files (see Figure 2), then all you'd need is an animation exporter for the new tool. Then, the modelers and animators can export independently of each other. This would also mean that, if art package X were found to be less appropriate

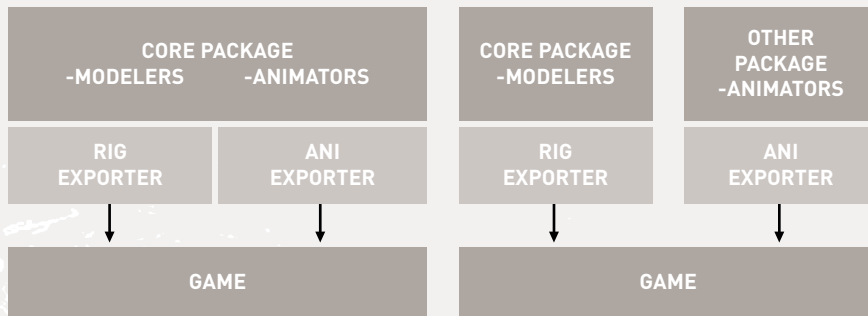


FIGURE 2 An alternative export model.

for modeling at a later date, replacing it would have little to no effect on the animators.

Art data formats. Every tool has its own custom format for storing data, along with a varying array of more universally-supported data formats. Some software companies are very protective and actively make it difficult to use other formats, which can lead to bad or broken exporters and unnecessary data loss; it can even render files from newer

versions incompatible, locking you into a vicious cycle of needing to upgrade frequently and across the board.

Generally, the more ways a package can export data, the better. With any package that has an SDK or a scripting host, such as XSI or Maya, a tools programmer or technical artist can usually extract the data from the software into any format needed. However, this can be quite difficult if the package doesn't give the user access to the data needed. Take a look at Photoshop. If it had initially been restricted to only handling .PSD and .JPG files, it would never have become as popular as it

has, despite how usable and powerful it is. Therefore, try to pick tools that are as open as possible. It'll help you in the long term.

In-house art tools. All development processes suffer from various problems, but if your problems are caused by an inefficient or defective third-party tool (or a task for which no tool yet exists), then the art tools team needs to create an in-house tool. From my perspective as a technical art director, the following steps are vital when considering in-house tool creation.

First, be clear about what the tool will do. Typically, building a new tool requires a staged development process, and therefore, the technical art director should have separate "first implementation" and "ultimate aim" targets for the tool. The first implementation defines the minimum functions to start implementation: rollout and shakedown. The ultimate aim is the goal for the long-term development of the tool—when is it considered complete? The art tools team will then decide where exactly in the pipeline the tool is going to sit. You will also need to consider whether it will be integrated into existing software in the pipeline (script, plug-in) or become a whole separate step in the pipe.

There are advantages and disadvantages to implementing a tool directly into another piece of software either through scripting or the SDK, as explained in the sidebar (see Tool Implementation, page 23).

However, there are of course different levels of software integration. For instance, you could integrate just the UI, but not the core system, thereby getting the advantages of being integrated without the dependency on the software. However, the UI would then need to be rewritten if the tool is changed.

The most powerful and robust tools need to sit on the same layer as other tools of similar function. Generally, keeping a tool abstracted from third-party packages allows you to better control the flow of data and provides more universal access to that new tool (see Figure 3).

MODULAR STRUCTURE, CENTRALIZED HUB

Regardless of whether the tool is integrated or kept as an external application, every tool should be made to be as modular as possible, interconnecting through a central interface. When creating a tool, try to create it with the

DEVELOPMENT STAGE			
3 RD PARTY LAYER		IN-HOUSE LAYER	
1 ST DEGREE TOOLS	2 ND DEGREE TOOLS	1 ST DEGREE TOOLS	2 ND DEGREE TOOLS
PHOTOSHOP	XSI	EFFECTS EDITOR	TEXTURE PROCESSOR
ZBRUSH	MAYA	MATERIAL EDITOR	ANIMATION OPTIMIZATION
SILO	MAX	LIBRARY SYSTEM	TEXTURE COMPRESSOR

FIGURE 3 Contrasting different pipeline layers.

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ART PIPELINE PHILOSOPHIES FOR THE NEXT GENERATION

mindset that it is an independent module that receives and sends data. That way, if any tool needs to be refactored, then you only need to make sure the input and output plugs stay intact, and the internals of the tool can be changed completely.

However, this is not always possible when a change needs to be made to how a tool receives and sends data. In this case, you'd also need to rework the plugs. This shouldn't be a problem if you're careful when planning your data formats. The centralized hub will allow the user to edit and tweak many different aspects of the asset—from animation, materials, and visual effects, to sound queues—in one suite of tools.

A centralized hub doesn't mean, however, that a module can only exist in connection with this hub. As stated previously, each module needs to be independent so it can be integrated into another tool (such as a third-party application), or so that it is able to run completely without direct user input, which makes it automated and thus a viable component in any kind of batch processor system. A modular system, if done right, also cuts down on code duplication by allowing you to easily share tools, functions, and processors with all applications in your pipeline.

INTERFACE AND PROTOTYPE DEVELOPMENT

As a designer of a tool, it's a good idea to work with the artists who are going to be using the tool in order to create a prototype of the interface and workflow. The artists should also take ownership of how the tool works, judging how intuitive it is to use. On their own, tools programmers might create a tool that's efficient and functional, but also completely unusable for an artist. A tool's interface can be created by a technical artist in a relatively simple visual coding package, such as C# or even HTML, where the workflow can be shelled out and used as a visual template for the programmer to create the actual tool.

Data formats. Make sure you work out where data is going to and from the tool first and then decide how this data is going to be represented in the file. The format should be extendable to allow for additions to the format in the future, and stable. If data is missing or incorrect, the importers and exporters should be able to safely skip the problematic chunk and keep going.

In all development stages of the pipeline, if any data is missing, the tools need to fail gracefully. An engine that crashes without detailed, informative feedback because of a missing secondary resource (textures, sound files, or sub nodes, for example) is going to seriously slow down early development. The feedback should give a clear indication of what resource caused the problem, such as the descriptive "model 'aModel' resource 'aTexture.tga' failed to load!" and not something generic like, "missing resource!"

It's also a good idea to unify all your tools to support one proprietary format so that you only need to manage one set of file writers and readers. Also, try to keep the data as open as possible. ASCII is great for this but can be very slow for reading and writing. Using a binary format is fine, as long as there are very good editors and inspectors for the format.

Shakedown. When developing proprietary

tools, allow adequate time for shakedown. Don't expect that the tool will be fully functional the first time it's released to the art team. It will have bugs, it will need adjustments to the UI, and it will require additional features. If you skip the shakedown step and force a tool into full development too early, then you risk burning your users, frustrating them with obvious problems to the point that they become reluctant to provide feedback on genuine unknown issues.

Update mechanisms. Many companies overlook the inclusion of an update mechanism for the tools they create. But it's a good idea to create one automatic mechanism for all art tools so that everything becomes synchronized, thereby providing everyone on the team with the latest versions of the tools at the same time. If you do this and allow the update mechanism itself to become part of the art pipeline, you should also consider allocating resources to develop and support it.

DATA FLOW FOR NEXT-GEN ASSETS

Tracking. In working with next-generation assets, you need a system that lets you monitor the progress of an asset through to completion, as well as link to the feedback given during development. This system should also keep a list of links to reference and source material, such as high-resolution meshes, concept artwork, books, and web sites—a bibliography for the assets. The bibliography could be built into your asset library system or attached to a customized bug tracker package.

Processing. At different stages in the pipeline, there will be tools that change (or process) the input data before passing it onto the next step such as an animation optimizer. This is typically some kind of refining or formatting step, which often results in a redundant asset.

Redundancy. When an asset gets processed in the pipeline, the asset typically becomes redundant. The process of collapsing layers of a .PSD in Photoshop is a good example. The .PSD file is the source art and the collapsed image is a processed version. You want to make sure that the pipeline doesn't mix up redundant post-processed data with source data. The best way to achieve this is to use two separate formats for



ART: PROJECT OFFSET

tool implementation

There are advantages and disadvantages to implementing a tool directly into another piece of software, whether through scripting or the SDK.

ADVANTAGES

- 1. Fast tool development time.** You have access to the tools' existing systems—animation, mesh, painting, and UI controls. This means, as a tools developer, you can just plug into these systems and create a functional tool very quickly.
- 2. Fast communication turnaround.** If the artists on the project are already working with this tool, there doesn't need to be any exporting or importing to slow them down.
- 3. One package.** The artists only have to worry about using a single piece of software. If the tool's interface is external to the main package, then the artists might need to switch to that tool, which could potentially slow them down.

DISADVANTAGES

- 1. Software dependent.** If there is a need to upgrade or change the underlying package, then the art tools team will have to consider refactoring or rewriting the tool.
- 2. Limited by the package.** The SDK or the scripting host might not expose enough of the information needed or may become slow because of inefficient underlying code that can't be changed.
- 3. Limited accessibility for external tools.** When integrating a tool into another piece of software, you're restricted by the accessibility that software allows. If the tool is external you have complete control to access that tool without having to establish a connection to a host program.

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each type, such as .PSD (layered and high resolution) and filetype X (flattened, down sampled and compressed). If you decide to use one common format, then you'll need to make sure the processed files are kept away from the location of the source files. In a manual process, the file-saving location is at the discretion of the artists. However, if you support the source file type in your art tools and do the processing step automatically behind the scenes, then the artist won't ever get the source and processed files mixed together. All they work with and see are the source files; the rest of the pipeline deals with only the processed files.

Submission. When an asset is submitted into any queue for testing or processing, you'll need a system to manage the status of this submission and any failure in the submission step. The system should send accurate and informative feedback to the artist or developer—via email or lodged bug—as to why the asset failed the submission, and update the asset's status in the task tracker system. The artist will know what needs to be fixed and will be aware that the submitted asset is problematic, without having to wait for someone to scream at them for submitting a busted asset into the pipeline.

Asset validity. There should also be a system created to provide instant feedback on the validity of an asset. This sanity check acts like a firewall to block assets that are invalid before they get into the art pipeline and tie up resources. This system is also very helpful for the artists to understand why their asset is invalid from a technical standpoint by providing instant feedback. The more detailed feedback the system provides, the more helpful it will be to educating the artists about the technical constraints of the game.

The sanity check system should never automatically make changes to an asset without the artist's specific authorization. The system should behave like an impassive adjudicator of the assets, reporting problems to another tool that can attempt to make a repair, if authorized. Any system that automatically makes changes to an asset will confuse and frustrate artists because they don't know why the changes are being made.

FLOW OF COMMUNICATION

Connecting artists. There should be a system and structure that allows artists to communicate with each other easily, such as the Visor tool in Maya or Alienbrain. This system should include an infrastructure to share assets, resources, techniques, and references. Typically, a library system, a really big database with a set of tools to navigate and filter entries, works best. Facilitating communication among artists is a critical component when creating a pipeline for larger art teams.

Departmental communication. Notification systems to tell other departments that an asset is ready and the ability to get untested assets from the art department are mandatory features of a good art pipeline. Sometimes, departments such as sound and design don't need the final gold stamped asset from the art department but are happy with something just recently exported from an artist. Also, a department will often request the most recent version of an asset, but cannot wait the hours or days it will take for it to filter through to the latest build. This component also links into the "feedback/critique" and the "asset tracking" components of the pipeline.

Connecting companies (outsourced). If you plan to utilize external studios or freelancers during development, you need to shape the pipeline to support the tracking and flow of assets to and from those studios. Keep your outsourced studios in mind too when designing any proprietary tools and systems. Typically, if you treat each artist in your development team as though they are external (thereby treating the local network like an external network), when you come to synchronizing tools with artists outside of your studio, you will already have the infrastructure to support it.

Facilitating feedback and critiques. Finally, all pipelines need to incorporate a system to manage the feedback and bug-tracking of an asset. You should keep track of exactly why assets failed certain steps in the pipeline and required reworking. If you plan to outsource any part of development, then the feedback and critiquing system needs to be able to provide limited access to users outside the studio. It also needs methods through which the external studio can request more detailed information on why the asset failed, or more general development questions about the asset. Typically, this component of the pipeline is managed by a bug- or task-tracker, which is a good fit.

THE POLISHED PIPE

The best thing any technical art director of a next-generation title—and for anyone working with the assets that the art team provides—can do for his or her art team is implement a well thought out pipeline. The goal of any pipeline is to enable and facilitate, not hinder, art production. Artists will appreciate all the measures put into the pipeline's design that help them communicate with one another, track the progress and stability of assets, and update their tools as necessary.

The more structured and smooth the pipeline, the quicker and more efficiently your art team will work and iterate, increasing the level of quality of the work the team produces. ❖

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TORU IWATANI'S RHAPSODY IN YELLOW



THE ORIGINAL CONCEPT FOR PAC-MAN WAS THE RESULT OF

my desire to create a game that everyone could enjoy. With a female target audience in mind, I wanted to create a game based on eating (which is why the name comes from the Japanese onomatopoeic word pakupaku, the sound one makes when opening and closing one's mouth while eating). When I was thinking about this, I was at a restaurant and noticed a pizza with a slice missing. I thought, "This is it!"

This was the inspiration, and it became the shape and general concept for PAC-MAN. Around this time, game amusement centers were saturated with games where killing aliens was the main objective. Lots of these games had great concepts that were fun to play, but I felt that none of these were equally accessible to women. Games at the time lacked variety—these types of games had a rather brutal image and a largely male audience. I wanted to liven up the game amusement centers by bringing female gamers, as well as couples, to the scene.

I was inspired by several of Atari's games in this regard; they had some innovative concepts which taught me a lot about design. I had no doubt that the concept for PAC-MAN would appeal to women, even though I didn't spend a lot of time seeking their opinion on the ideas. After all, even in the fashion and jewelry design industry, you have male designers creating items for women. I was confident that my creation was something that women would find appealing, so I just used my own intuition.

When drafting the original proposal for the game, I kept PAC-MAN to myself. When I finally showed the proposal to my boss and colleagues, the response I got wasn't all that

TORU IWATANI joined Namco in 1977 and took charge of the game and visual design of 1980's industry-defining title PAC-MAN. Since then, he produced more than 50 arcade and video games, such as POINT BLANK, ALPINE RACER, and TIME CRISIS. Send feedback about this article to editors@gdmag.com.

DESIGN PAC-MAN



ING

GAME DATA

DEVELOPER

Namco

PUBLISHER

Namco (Japan) Midway (U.S.)

PLATFORM

Arcade

RELEASE DATE

April 3, 1980 (Japan)

NUMBER OF DEVELOPERS

5

DEVELOPMENT TIME

15 months

ARCADE HARDWARE

Z80 main CPU, Custom 3 channel 4-bit WSG sound chip





overwhelming. I had already created three other games prior to PAC-MAN, so I was already known to be a game designer among my colleagues. As a result, most people were able to look beyond this different kind of concept and let me explore the game's possibilities.

WHAT WENT RIGHT

1 LOW-PRESSURE ENVIRONMENT. When we were making PAC-MAN 25 years ago, we didn't have the same budget constraints or deadlines that most developers encounter today. Without this kind of external pressure, we were able to create something we were all very satisfied with in an environment that supported creation. Even so, we weren't able to include absolutely everything we wanted, even in 1980!

2 SMALL TEAM VALUES. Unlike the large-scale projects most developers work on today, our team consisted of a mere five members, so it was easy to control workflow.

Communication problems and team chemistry were not an issue, since we were all so close. In order to effectively manage a large project, everyone on the team needs to think somewhat along the same lines—to work toward a common goal. If you leave out the communication aspect, your team will fall apart. The process of making games today is much more complicated than it was in the PAC-MAN days, so we were able to thrive with a very lean development team.

3 SIMPLE DESIGN. We succeeded in making the game simple. When we were trying to bring out the exciting and fun elements in the game, we mostly used a trial-and-error approach. When working on the design though, we had to remind ourselves not to sacrifice the

game's simplicity, since it was the one basic idea we had agreed upon when we began work. We wanted to make a game that would appeal to all levels of players and all genders, and included settings that would adjust the overall difficulty over time, such as attack waves and run delay zones for the ghosts. We put a great deal of effort into including these settings so it would be challenging for a wide range of players. It took a significant amount of time for us to playtest and to fine tune the various factors to reach the right level of balance.

WHAT WENT WRONG

1 HARD SELL. Since so many of the popular games at the time were similar, we had some trouble explaining the basic game concept to both our colleagues at Namco and the general public. It was especially difficult for us to explain the concept of how PAC-MAN, who spends most of his time avoiding ghosts, is able to turn the tables and chase the ghosts after eating a power cookie. Internally, we received a lot of suggestions on how we could improve the game and make it

easier for players to understand. For example, the president of the company requested that we change the color of all the ghosts to red, even though they all had independent AI routines and personalities. Fortunately, the game explained itself when people saw or played it, so our concerns about confusing players were largely unfounded.

2 ARTIFICIAL INTELLIGENCE. The one area of the game I would have liked to refine more if given the time is its artificial intelligence. I am pleased with the AI that exists in the game, but I would have liked to implement a system where the difficulty of the AI is automatically controlled. I anticipated that having a set difficulty curve would not be enough to cover the entire range of people that would play it. We wanted to have a system in which the computer could tell whether a beginner or an expert player is at the controls, based on the time it took the player to make a mistake. A record of these mistakes could be kept on the system, so it could automatically adjust the level of the AI in real time. We just didn't have enough time in our 15 month production schedule to implement that system. We also considered a few additional game features, such as gates that would trap the ghosts, but these also had to be sacrificed in order for us to finish on time.

3 TECHNICAL DIFFICULTIES. For the most part, we didn't run into too many technical problems during development. The developers on our team were all quite good, and as mentioned, we chose to keep the game simple in order to avoid potential technological issues. I think ultimately, we were able to create a simple game solely because there were techniques we didn't know about, through which we actually could have realized a more complex design. In that sense, it was better that we didn't know about them! The one technical problem we did encounter was with the animation. We ran into a few issues animating the non-game scenes, but managed to still create something compelling with a lot of personality. We had always wanted to create an animation style that people could chuckle at, since we wanted it to appeal to multiple audiences. We knew that in order for the game to become a successful franchise, we needed a main character that was positive and upbeat, and would make players smile while they played. The



PAC-MAN'S original Japanese name was PUCK-MAN.



PAC-MAN creator Toru Iwatani and friends.

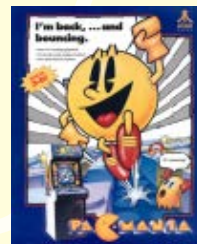
same goes for the ghosts—the game needed an enemy, but we wanted something with a cute design. Fortunately, we were able to work around this one technical constraint with some excellent programmers to make PAC-MAN come alive.

important to have a service-oriented mindset. Additionally, developers should believe in themselves and strive for their goals, knowing that they can succeed at anything with bravery, energy, and a sense of mission.

PAC TO THE FUTURE

I'm delighted that PAC-MAN has gained such popularity worldwide. We knew we had a high quality product after we finished the game when we realized there was nothing that could possibly be added or removed to make it better, aside from the minor issues I mentioned. Even still, we were uncertain as to how successful the game would be overall. We had no idea that it would become such a big hit around the world. Even after its success in Japan, we didn't anticipate the overwhelming reaction from overseas. Even young players today know PAC-MAN due to its consistent presence on consoles generation after generation, but most of all, I have the simple game design and adorable characteristics of PAC-MAN himself to thank for this success.

As the developer of PAC-MAN, I was able to get to know a lot of people that I otherwise would not have had the opportunity to meet. These people are all very important to me and I feel fortunate to have worked on such a special game. All of us who worked on PAC-MAN learned some important lessons that can apply to any game developer. First, it is important to make a game that your target player will enjoy, and not just a game that you would like to play. In that respect, it's



PAC-MANIA brought the PAC-MAN franchise to isometric 3D.

EDITOR POSTMORTEM:

PAC-MAN FRANCHISE

THOUGH TORU IWATANI'S IMPRESSIONS OF HIS WORK CREATING the original Pac-Man game are vital and fascinating, they obviously don't tell the whole story. Twenty-five years and countless titles later, Namco continues to grow and expand the PAC-MAN franchise. But clearly, just as there were ups and downs in creating the original arcade game, there have been similar pluses and minuses in the creation and nurturing of PAC-MAN's legacy. *Game Developer* decided to take a close look at a quarter century of PAC-MAN games and come up with its own objective list of What Went Right and What Went Wrong in terms of the little yellow guy's growth. These, then, are our independent impressions of how the franchise has fared, and what Namco still has to work on before PAC-MAN inevitably takes over the world some time later this century.

WHAT WENT RIGHT

- 1 PAC-MAN: THE FIRST GAMING ICON?** PAC-MAN, many would argue, was the first ever gaming icon—a recognizable video

game character that was embraced by millions, even transcending video game media in his appeal. Why such a breakthrough? Well, prior to Pac's genesis, early video games often didn't even have characters at all—rather, the protagonists were spaceships or paddles. Even those that did include characters were largely disparate from the illustrations and designs upon which they were based.

But PAC-MAN's simple, cute, yet compelling character design allowed him to be easily identified, both in pixelated digital and stylized drawn form. As a result of the smash success of the first PAC-MAN game, Pac's likeness made its way to everything from lunchboxes to Saturday morning animated series, and pervaded early '80s culture far more than anyone could reasonably have expected. The crowning example of this is probably Buckner & Garcia's number eight hit in the U.S. charts, "Pac-Man Fever"—novelty songs are one of the best signs that you have a genuine phenomenon on your hands.

But since then, cultural awareness of PAC-MAN hasn't really let

SIMON CARLESS

is the editor of Game Developer. Reach him at scarless@gdmag.com.



DESIGNING PAC-MAN



Namco's forthcoming PAC-MAN WORLD 3.

up, showing that recognition of and love for the little yellow puck isn't just a fad. Apex Twin, Weird Al Yankovic, and Argentinean concept rock group Patricio Rey y Sus Redonditos de Ricota have also recorded PAC-MAN-related musical numbers. And as recently as this year, Namco reached a settlement with hip-hop star Lil' Flip over his sampling of PAC-MAN sound effects for his hit "Game Over." Also in the recent past, PAC-MAN music and gameplay themes were used for a subtle North American Volkswagen commercial in which the car picked up pellets and fruit, ending on PAC-MAN's classic game over sound. The fact that the game itself was not specifically mentioned, but Volkswagen still felt confident in riffing off the sounds and themes surrounding PAC-MAN shows the true profile of the franchise within contemporary culture.



2 SEQUEL-BUILDING BY ITERATION. For a time, the PAC-MAN series evolved not in over-ambitious leaps, but in baby steps, refining the already proven model of the original, whose chase-and-be-chased 2D gameplay was a major innovation that spawned any number of clone titles by rival arcade game creators. Namco's careful nurturing of the series is evident in the love many players still have for some of the earlier PAC-MAN sequels. This is particularly true for MS. PAC-MAN, the first, and most successful iteration of this type, and still one of the most beloved titles.

In fact, the game was not made by Namco at all, but by the small American firm General Computer Corporation as an add-on to the original PAC-MAN arcade board. But it's to Namco's (and U.S. licensee Midway's) credit that they appreciated the improved gameplay and even more female-friendly nature of the pseudo-sequel and brought it within the fold as an official part of the PAC-MAN franchise. This iteration-like sequel model worked well for a time, and there were some fun twists which still preserved the addictive original gameplay, including the 1987 isometric PAC-MANIA and the enjoyable extension MS. PAC-MAN MAZE MADNESS (2000), each with its own charms achieved through working off the original's innovations.

3 INTELLIGENT EXPANSION OF GAMEPLAY. While PAC-MAN has sometimes had trouble expanding past its 2D maze-based roots, some franchise extensions have worked particularly well, especially when they consider carefully what the essential nature

of PAC-MAN's appeal is and base the gameplay on those points. In particular, Namco's recent collaboration with Nintendo's Shigeru Miyamoto and excursions onto the Nintendo DS system have been fruitful in terms of serving up fresh ideas for our little yellow friend.

Specifically, Miyamoto's experiments for PAC-MAN VERSUS, which pits a PAC-MAN-controlling player on the GameCube against players controlling ghosts on multiple Game Boy Advances, doesn't change the nature of the game's design much on paper. But what it does change is the way people play and interact with the game, which makes it feel fresh and fun. On a similar note, PAC-PIX for the Nintendo DS starts with a charming set up—the ability to draw your own PAC-MAN with the DS's stylus and then control which way it moves onscreen to gobble up the ghosts, a perfect idea for a franchise evolution. In similar form, PAC 'N ROLL for the DS is another smart extension—the innovation of control by rolling PAC-MAN with a stylus is the most compelling part of the experience and helps remind us of the viscerally direct control of the arcade original.

WHAT WENT WRONG

1 A DIFFICULT TRANSITION TO 3D. PAC-MAN's transition into the 3D world, and in particular the world of 3D gameplay, has not been an easy one. While it has been established that departing from the original PAC-MAN design can yield good results, the PAC-MAN WORLD games, while enjoyable on a basic level and relatively commercially successful, ultimately place PAC-MAN in a 3D platforming space alongside the likes of MARIO 64, RATCHET & CLANK, and CRASH BANDICOOT.

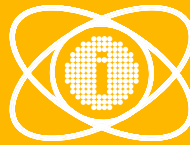
This, needless to say, is a difficult area to compete in, and since PAC-MAN traditionally operates in a restrictive 2D maze medium (as opposed to, say, Mario, whose 3D adventures would be much easier to envision even if MARIO 64 did not exist), it's not as simple to place him in a freeform three-dimensional world, and so his 3D excursions, like those of other early arcade icons, feel a tad limited. As a result, the 3D PAC-MAN games have lacked much of the critical adoration given to competing titles and don't tend to register high on the list of must-play games for hardcore gamers, although their gameplay ends up working out well for the casual mainstream market.

2 LACK OF DIRECT CREATOR INVOLVEMENT. PAC-MAN's much-loved creator Toru Iwatani was indisputably the visionary behind the first PAC-MAN title, and continues to work at Namco 25 years later. He was at the helm of Namco's games division all those years ago, designing the company's first-ever arcade title GEE BEE and two sequels, before making PAC-MAN. After the completion of one further title, LIBBLE RABBLE, he stepped out of the development sphere and into Namco's administration.

Though Iwatani continues to contribute to the company's overall direction and creative think-tank, he has not directly designed a PAC-MAN game since the original. When asked at Game Developers Conference 2004 what one element he would add to the original game, he said, essentially, that he would add nothing. The game was so simple that adding anything extra to it would be too much, and taking anything away would break the gameplay.

This may help explain both why Iwatani has not worked directly on the series since its inception, and why it has sometimes been difficult to transition the game into the next generation. Although Namco has done a fine job of continuing

CONTINUED ON PG 47



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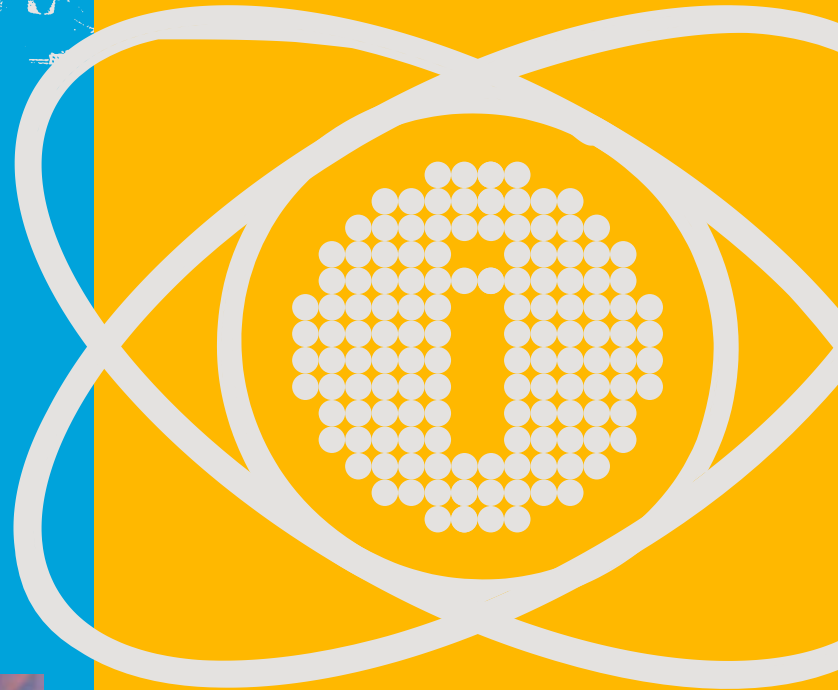
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BILL SWARTZ

❖ BUSINESS LEVEL

NAVIGATING JAPAN

❖ IF YOU'RE IN THE VIDEO GAME INDUSTRY, DEALING WITH JAPAN

is right up there on the list of inevitabilities with death and taxes. Many industry veterans, whether in development, business, or as employees of Japanese companies, come away from their first exposure dazed and confused. This does not have to happen. Let me share a few myths and offer some related advice.

MYTH AND METHOD

Myth: The Japanese are one people, and Japan is special and different.

These notions got rolling during the Meiji period (1868–1912), when the Japanese government made pounding them into the nation's head a priority. Japan is a diverse country full of different groups, cliques, and values. The who, where, and why of those differences are far more important to understanding a situation than the mere fact of Japanese-ness. As for Japan being special and different, yes, it is—so is every nation. That doesn't make it unique in any larger sense. Common sense goes as far in Japan as anywhere else.

Myth: Yes means maybe, maybe means no, no means never.

This comes from a mixture of bad translation and consensus-based decision making. Japanese is not an ounce less direct than English. For example, "I'll think about it" ("kangaetokimasu") is simply a polite idiom which actually means "no." The term, used in context, is not subtle or ambiguous but could throw you for a loop if translated literally. If you use a translator, use a good one. And if you are not sure what someone is saying or sense they aren't following you, ask questions to confirm understanding.

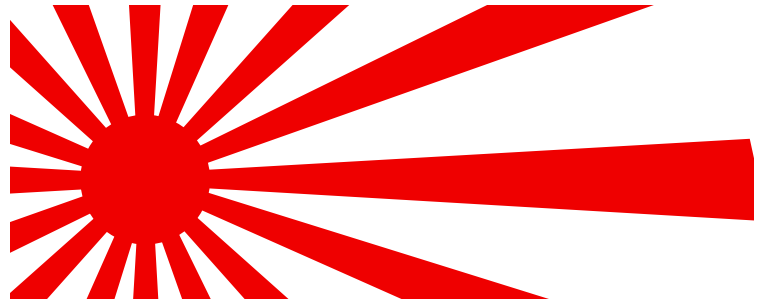
The consensus-based decision aspect is a little more complex. One fairly consistent feature of Japanese businesses, especially older ones, is a disbursement of responsibility. The person you are talking to may want to say yes, but does not alone have the authority to commit the organization and may be embarrassed by this, or may assume you understand his position. The solution is, if someone promises they'll do something, confirm key points, who, what, and when. It's not rude, and it will prevent much heart-ache later.

Myth: Japanese business works without lawyers.

To quote Mark Twain: Lies, damn lies and statistics. Yes, there are very few attorneys in Japan, and a bar pass rate of about three percent keeps it that way, at least for now. However, most companies have a legal section filled with non-attorneys, many with undergraduate law degrees, who take on exactly the role filled by lawyers in the U.S. or Europe. For all practical purposes, you'll be dealing with lawyers. Just remember that actual knowledge of the law in these legal departments varies widely.

Myth: Contracts don't matter in Japan. Its all about oral promises.

Again, it depends on the person and relationship. There are certainly people who, when handed 20 pages in a language they don't read and asked to sign, "for form," will. There are others who don't keep their promises, written or



verbal. My advice: Create a contract where every line is meaningful, review the contract carefully with the other party, and when everyone feels comfortable, sign. No paper will protect you from everything, but a meaningful and well reviewed contract is your best shot at staying on the same page as your partners.

Myths: Business is done in English in Japan. Doing business in Japan in English is a problem.

Yes and no to both. English conversation is certainly a specialized skill in Japan, a country which in 2000 was proud to finally do better than Afghanistan, Cambodia, and Laos, and finish 18th out of 21 Asian countries in the Test of English as a Foreign Language. But it's hard to go through junior high, high school, and college without at least six years of English instruction. The disconnect probably comes from a system that teaches English to be passively read, maybe written, but rarely spoken or heard.

I suggest that if you need to communicate but don't share a spoken language, try writing—just be sure to write clearly and concisely.

Myth: A production pathway is a production pathway, and a milestone is a milestone.

Both the U.S. and Europe have large export software industries producing applications in just about every field. Japan's only major software export is video games. The relative lack of a surrounding software industry has allowed Japanese game production to develop somewhat distinct practices. For example, even now, basic design often happens during production (put something on the screen, then figure it out), milestone definitions differ (Japanese beta is typically U.S. alpha) and schedules are loose, even by our industry's standards.

My advice: Work with the reality. You want your project to use U.S. milestones? Want lots of pre-production design? Define the milestones carefully, educate and lead the team, and most will be happy to oblige. Got a good team you really trust to work without supervision? That's fine, but understand from the start the level of documentation you will get. Most importantly, get good people and teams with strong track records. No amount of communication or awareness will get good work from a weak team, but a strong team will usually find a way to work under the most challenging circumstances.

WHITE RABBIT

Dealing with Japan, whether it's a brief brush or a lifetime affair, does not have to be the Alice-in-Wonderland experience many in the industry report. Just do your job well, use the common sense and the good practices you would anywhere else, stay flexible, and enjoy the ride. ❖

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MICK WEST

» THE INNER PRODUCT

PRACTICAL HASH IDS

Using a 32-bit CRC hash as a unique identifier for game resources

GAME ASSETS FREQUENTLY NEED TO BE referenced indirectly by the engine, by code, and by scripts. The simplest way to do this is to use the name of the object. However, this method is very inefficient and otherwise problematic.

Let's re-examine the practice of using a 32-bit hash of the name as a unique ID and explore some ways of integrating this into your code and tool pipeline.

PREMATURE OPTIMIZATION?

This article is about an optimization. Optimizations are typically done at the end of a project. *The Art of Computer Programming* author Donald Knuth famously quotes British knight and computer scientist Tony Hoare saying, "premature optimization is the root of all evil," but prefaces this with an important caveat, "about 97 percent of the time."

The 32-bit hash optimization is a case that belongs among that three percent (or more, opinions vary) best done early. It's such a fundamental change that it affects many aspects of the game engine code and data structures. It's not an optimization you do at the end to speed things up, but rather one you do at the start because it enables you to do more right from the early stages of development.

THE NEED FOR ASSET IDS

A game contains a very large number of assets, including meshes, textures, animations, skeletons, scripts, sounds, effects, triggers, events, NPCs, and various other miscellaneous resources, objects, and entities.

These assets all need some way of being referenced, either as part of some internal linkage (a mesh will reference

the textures it needs) or as some intentional reference on the part of the designer ("play the Man_jump_01a animation" or "blow up building City04_Bank01," for example).

These references need to be resolved at run time, as this gives you a much more dynamic development environment than statically linking everything together at compile time. Assets can be changed independently and re-loaded. Small sections of the game data can be recompiled quickly without having to recompile everything. (See Sean Barrett's "Late Binding Data," February 2005.)

The assets will nearly always have a name. Textures have the file name of the original .PSD, .PNG, or .TIFF. Scenes exported from 3D Studio Max or a similar package will have a name associated with each object in the scene.

So the simplest way to reference an asset is to just use the string containing the name. This has a great advantage in that it's very straightforward. But, there are several disadvantages, too.

PROBLEMS WITH STRINGS

First, using the string that contains the name takes up a surprising amount of memory. Asset names are often quite long, especially if paths are included. If every mesh has to reference every texture it uses by name, then that can add up to an unnecessarily large amount of memory.

Second, comparing two strings takes a lot longer than comparing two numbers, so this solution is slow. Quite often asset names will have long common prefixes, meaning you get a lot of false partial positives if you are looking up the string in a table. Plus the length of the string means you need to perform a large number of memory accesses, which can be very slow on architectures with expensive data reads, such as the PlayStation 2.

Third, it does not fit into data structures nicely. The strings are of random length, making it difficult to form neat data

structure around them.

And finally, having a large number of strings visible in the data might be something of a security concern. Plot spoilers might be deduced from the names of assets ("Hey, what's this 'MDL_SPIDERWOMAN'? Sweet!"). And if you want to stop people from hacking left-over content in your game (like the infamous Hot Coffee mod in *GRAND THEFT AUTO: SAN ANDREAS*), then you're better off not giving them a load of clues.

USE THE HASH VALUE

Instead of using the string itself, one approach is to use a hash value of the string. A hash value is a number calculated by mangling the bits of the string together using some algorithm to produce a fixed number of bits. There are various hash algorithms that produce various sized outputs. Algorithms such as SHA, MD5, or RIPEMD-160 produce hash values of 128 or 160 bits in length (16–20 bytes) and so don't really help us very much.

The string hash algorithm that best fits our needs here is CRC-32, which takes a string and gives you a 32-bit value. The algorithm is specifically designed so that small differences in a string produce very large differences in the output. This is very important, since you don't want string such as "ANIM_10002" and "ANIM_20001" to result in the same hash value (as they would if you did a traditional checksum where you added or XORed the bytes or words together).

Using the hash in place of the string immediately removes the problems that I've already mentioned. Comparisons are now very fast, since you only need to compare two 32-bit values. Memory accesses are reduced to a bare minimum. Data structures can now have a nice, neat, single 32-bit word to store the reference rather than a variable length, memory-hogging string.

Using a hash has other benefits. Since it's a hash value, you can use it as a very

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LISTING 1

```
// crc_hashes.h
#ifndef __CRC_HASHES_H__
#define __CRC_HASHES_H__

#define CRC_MDL_MECH01_LARGE 0x4854987A
#define CRC_MDL_MECH02_LARGE 0x374FAAD2
#define CRC_ANM_FOX_JUMP 0xF003C8A8
// add additional crcs here ...
#endif
```

A header file containing all the hash values.

fast index into a hash table simply by lopping off however many bits you need—for an 8K table, just use the bottom 12 bits. Or even easier, you can pick 12 bits out of the middle of the word to match the power of 2 alignment that your table is on (so, if your hash table

index is 8 bytes per entry, then just mask off bits 14 through 3, and you've got the offset into your hash table index).

Another useful technique applies when game assets need to have pointers to each other. By using a 32-bit hash you can write out a data structure identical to that used in the game, but with the hash values in the memory location usually occupied by the pointers. Then when the asset needs to be loaded and bound into the game, you simply replace the hashes with the appropriate pointers. This removes the need for building data structures from parsed data, and can greatly speed up the loading process, while still giving you the flexibility of late-binding data.

FEAR OF COLLISIONS

So why don't people use hashes for IDs? Well the first thing people think when

presented with this idea is "what if there's a collision?"

A collision is when two strings have the same hash value. Since with a 32-bit hash value there are only about 4 billion possible hashes, if you throw enough strings in, you will eventually find two that have the same hash value.

The probability that any two strings will have the same hash value is 1:4,294,967,296 (about 1 in 4 billion). With a larger number of strings, the probability rises. At about 65,000 strings there is an approximately even chance that there will be a collision—at least one pair of distinct strings will have the same CRC-32 hash value.

For a practical example, I did a check for collisions on 89,000 unique strings culled from some random dump of a dictionary, and there was only one collision. The strings "bellys" and "cochleariform" both have the same CRC32 (0x5D1F90F6). Later when checking a list of 216,000 strings, I only got seven collisions.

Remember there is a big difference between finding a collision somewhere in a large set of strings, and the possibility of a new string causing a collision. If you've already got 89,000 strings with no collisions, and you add one more, the chances that there will now be a collision are $89001/2^{32}$ or about 1 in 50,000.

So depending on how many IDs you actually use, you are going to have to deal with collisions very rarely.

DETECTING AND HANDLING COLLISIONS

But collisions will occur, and at some point you will need to detect collisions, and then deal with them.

To detect collisions, you need to keep an automated central database of all the strings and hashes that are used. This database is solely used during development, so it doesn't require any overhead in the actual game. It need not be complex. Just a simple list will usually suffice, and you don't need to worry about removing unused entries—just purge it whenever you do a full rebuild.

When you find a collision, the simplest way to deal with it is to change the string. Now I know that this sounds like a rather

hacked-in solution, but it's really not going to happen very often. You'll perhaps have to change a string once a month towards the end of the project, and not at all during the first half of the project, when the number of unique strings is still very low.

USING HASHES IN CODE

The other reason that people don't use hashes is that they can't read them. A simple implementation of this system would involve someone running a CRC-32 program on the string, and then manually typing in the checksum into the code where the asset was being referenced. Instead of typing

"LoadAsset("MDL_ENEMY_GUNSHIP")", you type LoadAsset(0x23C55C3A). Nasty. Ideally the user (in this case the programmer or designer) should never have to see these hexadecimal strings. The entire process should be automated to make it both easier to read and less prone to errors. (I've cut and pasted the wrong hash value a few times in the past.)

When dealing with compiled data such as meshes, animations, textures, and so on, this is relatively straightforward. You just compile the strings into hashes when you compile the data into whatever engine specific format you need.

When you need to reference an asset from C/C++ code, the story is somewhat different. Here are four ways of doing this, in the order I first considered using them.

1. *Just use the hash values directly.* Not a very good option. You'll type them in wrong, and there's no easy way of figuring out if it's the right hash value. You can improve things slightly by adding a comment next to the hash value, but it's still a messy and fragile method.

2. *Use #defines.* In this system, you add all your strings to a header file (say `crc_hashes.h`), with a line for each possible string (see Listing 1). Then in the code you just use the `CRC_` symbols. This initially seems like a reasonable option, but suffers from the huge downside that you have to include `crc_hashes.h` in every single file that uses a hash value. This effectively means that whenever you add a new hash, you need to re-compile a significant portion of the game.

LISTING 2

```
inline uint32 check_hash(uint32 id, const char *name)
{
    assert(id == crc32(name));
    return id;
}

#ifdef DEBUG
#define HASHCHECK(id, name) check_hash(id, name)
#else
#define HASHCHECK(id, name) id
#endif
```

A macro for checking your hashes at run time in debug mode.

RESOURCES

A description of the CRC-32 algorithm
<http://en.wikipedia.org/wiki/CRC32>

A practical and public domain implementations of CRC32
<http://www.csbruce.com/~csbruce/software/crc32.c>

3. Use a macro that checks the hash value, but is compiled out in “ship” mode. (See Listing 2, page 34.) With this you enter in both the string and the hash value directly into the code (see the example in Listing 3).

This ensures your hash values match your strings. In ship mode it will compile away to leave just the hash value itself. This works well enough, and it’s relatively straightforward to set up a hot key your editor to automatically generate the hash, and the call to HASH(), and insert them in the code, so you don’t ever have to deal with the hash value directly.

However there are still problems. First, you’ve still got the hash value there in the code, leaving you open to cut-and-paste problems. Second, the check is at run-time, so if it’s an obscure bit of code (maybe it only runs at the end of the game), then the check might not fire until a few weeks after you add it. Third, it’s slow in debug mode since you have to generate a checksum for each string.

As I wrote in another article (“Debug and Release,” October 2005), I don’t think there should be separate debug and release modes, but rather a single “develop” mode, used for both purposes. Having the code check the value of a hash value against a string is slow, and it’s done too many times. The hash value might be used several times per frame, but if it’s right once it’s always going to

be right. You can hack the macro so it only checks once, but you’ve either got to add another check, or write some self-modifying code.

4. Use a custom preprocessor. With this approach everything is automated for you, you simply use the string itself and tag it by placing it as a parameter, a pseudo-function, called HASH(). You then need to introduce a custom build step to your build process that scans your source for calls to HASH(), and replaces them with the correct hash value. (See Listing 3 for a comparison of all these methods.)

The great benefit of this system is that the programmer never has to see (or type) another hex string in order to reference something in the game. Once the system is set up, the programmer can continue to refer to assets by name, and the optimization of using hash values will take place under the hood. The disadvantage is that you have to add a custom build step that generates intermediate files to be compiled. If you already have such a step it’s probably not such a big deal to extend it to include this. But changing your build process is not a trivial task.

Introducing a custom build step runs the risk of making your code less portable. A new platform might not be as flexible in its compiler options. To get around this, you

can define the function HASH() as a function that calculates and returns the checksum of the string passed to it. That way, even if the additional compilation step is missing, the code will still work perfectly (albeit a little slower).

One additional place in your code where the use of these string id hashes needs special consideration is in switch statements. Since the value after a case keyword must be an absolute value, and not the return value of a function, then using the HASHCHECK() method will not work. A custom preprocessing step will work

fine, as the value is automatically inserted and there is no use of macros. However now the fallback method of also defining the HASH() function will not work for switch statements.

OTHER CONSIDERATIONS

By default, CRC-32 is case sensitive. For this use though, it is probably a good idea to make it case insensitive. This is especially true if you are going to use hashes in some kind of script environment used by designers. Since you never really want to have MDL_BigJump01 mean something different from MDL_Bigjump01, then it makes everyone’s life easier. Making your CRC routine case insensitive will also not make it any slower if you use a table-based method (just duplicate the upper case entries with the lower case entries).

If you are using hashes to uniquely identify objects in the game, you might want to reserve some for specific system objects. You could do this by adding a few names like SYSTEM_0001, SYSTEM_0002, etc. Or you can simply reserve the first, say 1,024 values. (0x00000000 through 0x000003FF), and explicitly report them as illegal values in your database. This might seem a little odd, not allowing this range of values for a hash, but only one out over every 4,194,304 possible strings will have a hash value in this range.

Given a hash value from a string A (HASH(A)), and given another string B, then you can calculate HASH(A+B) by calculating HASH(B) using a starting value of HASH(A). This means you can calculate HASH(A+B) without ever knowing the actual contents of the string A. This is very useful if you have assets that have a series of different extensions or other appended strings (for example, MDL_ROBOT_01_ might have MDL_ROBOT_01_LEFT_ARM, MDL_ROBOT_01_LEFT_LEG, etc.). Then you can quickly calculate the hash values of the string with the extensions without having to know the original string. ❖

LISTING 3

```
// hash value directly:
Load(0x334BDCF8);
// hash value with inline comment
Load(0x334BDCF8 /*MDL_MECH01_LARGE*/);
// using #define in a common header file
#include crc_hashes.h
...
Load(CRC_MDL_MECH_01_LARGE);
// Using a macro to check values
Load(HASHCHECK(0x334BDCF8, "MDL_MECH01_LARGE"));
// Using additional preprocessing
Load(HASH("MDL_MECH01_LARGE"));
// The same line after the custom build step:
Load(0x334BDCF8 /*MDL_MECH01_LARGE*/);
```

Showing the different ways of using hash values in code.



STEVE THEODORE

PIXEL PUSHER

ANATOMY FOR ANIMATORS PART II

Spinal Tips

LAST MONTH WE REVIEWED SOME

anatomy for animators, concentrating on the legs and feet. This month, we'll continue with a look at the anatomy of the spinal column, including the body, torso, and neck.

The spine, naturally enough, forms the backbone of any good animation rig. Unfortunately, setting up a character's spine is daunting for a number of reasons, both anatomical and technical. It's obvious just from looking at a skeleton that the spinal column is a pretty complex mechanism, with 33 vertebrae and a complex re-curved S-shape. Luckily for us, most of this complexity can be abstracted into a much simpler set of animation bones. However, it's helpful to have a quick overview of the full system before moving on to a more animation-friendly one.

Veterans of figure drawing know that the spine isn't straight. The basic shape is formed by a sweeping S-curve. The curve isn't just there to make for better looking charcoal sketches; the arch of the back works to increase the ability of the spine to carry weight, just as arches support a bridge better than flat girders. You see this principle at work in the classic *contrapposto* stance, in which the hips and shoulders are canted in opposite directions for support with minimal effort. The same principle also explains the comical forward thrust of a weightlifter's belly in a full snatch (see Figure 1). A good animation spine has to reproduce smoothly flowing curves, so it's important to understand how those curves are integrated into the structure of the body.

THE IMPRESSIVE VOCABULARY SECTION

Anatomists divide the spine into four major areas, each of which forms a distinct curve (see Figure 2).

1. *Sacral*. The sacral section is the foundation, located inside the mass of the pelvis. Technically it counts as five vertebrae, although they're fused together into a single jumbo bone. The sacral vertebrae are basically part of the pelvis and don't move independently; however you can see the extension of the lower curve of the spine in the upper plane of the buttocks. Technically, the base—the real base—of the spine is the coccyx, or tailbone, which doesn't do much in the body except add three vertebrae to the total count.

2. *Lumbar*. The lumbar section is the connector between the hips and the ribcage. It contains five vertebrae and curves forward toward the navel. The lumbar section is where most of the bending and twisting in the spine really takes place; thanks to that, it's also the source of most back pain. The forward curvature of that Herman Miller Aeron chair you got cheap after the dot-com bubble burst is intended to support a natural lumbar arch.

3. *Thoracic*. The thoracic section is the foundation of the ribcage. It curves backward, opposite the arch of the lumbar. Although it contains 12 vertebrae, it's much less mobile than the lumbar section. However, it does actually flex as the body turns and reaches, so it's incorrect to represent the ribcage as a completely solid block, particularly for side-to-side stretches.

4. *Cervical*. The cervical section is the neck, which includes seven vertebrae. Like the lumbar, it actually curves forward in the rest position. Unlike the rest of the spine, though, the vertebrae of the neck are much closer to the center of the neck mass, so it's harder to spot the rhythm of the curve in a static model. However, you can easily see the effects of the curve by observing the neck in action in Figure 3.

HOW MUCH IS ENOUGH?

Regrettably, all this fancy anatomical knowledge doesn't translate directly into a good working animation skeleton without some extra planning. When roughing out a character skeleton, you need to consider the tradeoffs between visual fidelity, ease of animation control, and in-game performance. Generally, more bones will provide better deformation, particularly if you want to really capture that flowing line of action properly.

But a precisely correct, 33-bone spine can create a lot of headaches for the animator and a lot of work for the game engine. Every one of those bones is another opportunity for the animator to accidentally insert a kink into what ought to be a flowing line of action. Thirty-three nested transform matrices represent a lot of math, even for a modern game engine. Therefore, it's unlikely you'll want to build a character with an exact bone-for-bone version of a real human spine.

Exactly how many bones will be enough depends on both the model and the application. Naturally, a high-resolution hero character demands more



FIGURE 1 The curvature of this weightlifter's back is critical to his ability to sustain heavy weights.

STEVE THEODORE started animating on a text-only mainframe renderer and then moved on to work on games such as *HALF-LIFE* and *COUNTER-STRIKE*. He can be reached at stheodore@gdmag.com.

attention than an extra in the non-playable character crowd. A minimal spine ought to include at least one joint for each region of the spine: a sacral joint just above the pelvis, a lumbar joint behind the navel, a thoracic joint behind the sternum, and a cervical joint at the base of the neck.

As you increase the bone count, you'll get smoother deformations and more realistically sinuous motions, though you shouldn't simply distribute the additional bones evenly along the character's trunk. This is a bad fit for the way the body really moves. Most of the flexion of the spine is concentrated in the lumbar area between the hips and the ribcage, so this area should get more joints. The thoracic region (roughly, the ribcage) is about twice as large as the lumbar area, but it should get fewer joints. The sacral area is enclosed by the mass of the pelvis, so there's no point in adding extra bones down there at all. The inadequacies of standard smooth-skinning mean you don't get much visual reward for having more bones than vertices. As a rule of thumb, you probably won't need more bones than you have edge loops in a model's torso.

One minor issue to watch out for when building naturalistic spines is that many animation packages are unhappy with re-curved bone chains. After you've laid down the bones for your spine, remember to check the local axis arrangements before you add the arm or head bones. Be sure that the local axis systems in the spine are lined up so they all respond the same way to pitch or roll inputs. If you're going to use Euler angles for rotation, make sure that the twist of the spine corresponds to the first term of your Euler rotation angle so you get more reliable twists and can use the Euler numbers to drive expressions (for more details on dealing with twists, see "Twist and Shout," April 2004).

SOMEWHERE BETWEEN 4 AND 33

Deciding on the number of spinal bones is relatively simple. The tricky part of building an animation spine is determining how strictly you will follow

the correct anatomical placement of the spinal column. Game animators typically ignore anatomical correctness and place the spine pretty close to the centerline of the body. We're also much more likely to arrange the spine straight up and down, rather than in a biologically proper curve. Film animators, on the other hand, are more likely to use the anatomically proper position and curvature.

The difference evolved mostly out the fact that games have pretty crude deformation tools. Central spine placement is a good defense against the loss of volume when the character bends forward. In film characters, where muscle systems or procedurally driven influence objects are common, the danger of crunching is much less and the attraction of correct anatomy correspondingly greater.

Nowadays, the distance between the two camps is starting to diminish as game characters get more complex. Models with higher vertex counts can produce something closer to the appearance of a real abdominal crunch, instead of the disturbing accordion folds that result from realistic spinal placement on low-poly models. Moreover, we now have the horsepower to spare for volume-preserving fix-up bones in the belly. As it becomes easier to avoid the abdomen problem, the upsides of proper spinal placement—better rhythm in the curve of the body, less counter-animation when twisting the torso, and more realistic separation of the ribcage and pelvic masses—become more attractive.

If you're used to working with central spines, it may be time to start experimenting with a more anatomically correct position. If you want to use an anatomically correct spine, don't make the common mistake of placing it too close to the skin of the back. The visible bumps you see on the human back aren't vertebrae—they're caused by the fin-like extensions called "spinous processes," and they can be several inches from the real pivots of the spinal bones. At the forward most point of the lumbar curve, the pivot point is actually almost at the centerline of the body. So check some

anatomical reference. As always, go with what looks best for your character not with what you read—not even here!

BELLY BONES

With modern vert counts, careful vertex weighting is often all you need to get reasonably good deformation with an anatomically correct spine. However there will be plenty of cases—particularly on characters whose physique or clothing gives them more prominent bellies, where the crunching effect of the rearward spinal placement will become unpleasant.

Usually, a very simple fix-up is usually all that's needed to bring crunch-collapses under control. The easiest fix is to use a single extra bone located behind the navel in the mass of the abdomen. Parent this to the vertebra closest to the navel, and use driven keys to push it forward in the parent bones' local space as the lumbar region flexes.

The key to making this work is never to weight any verts exclusively to the belly bone. Instead, make sure that it has a gentle effect (less than 50 percent on any given vertex) and a soft falloff. Also, take care that it has little or no effect on the solid mass of the ribcage.

Pushing the "belly bone" forward along the local forward axis of its parent vertebra helps counteracts the loss of volume from the

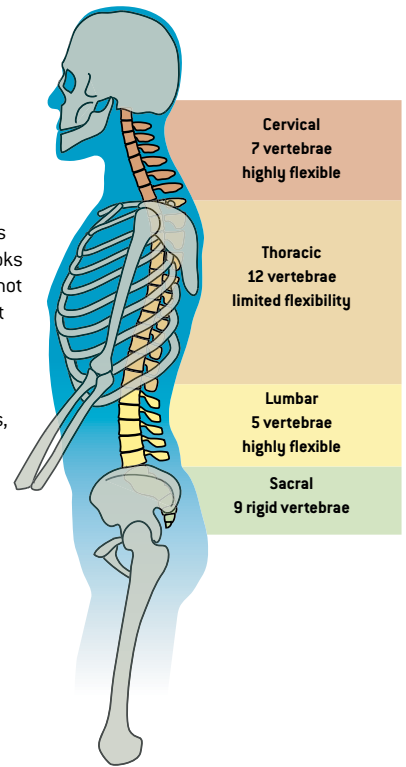


FIGURE 2 The four major regions of the spine are shown.

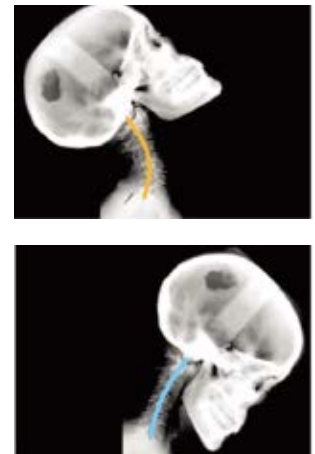


FIGURE 3 Because the rest pose of the cervical vertebrae is curved, raising your head and lowering it produce noticeably different motions.

CONTINUED ON PG 40



ALEXANDER BRANDON

» AURAL FIXATION

MINIMAL THEMES

THIS SPACE IS USUALLY RESERVED FOR advice, tips, and tricks for game audio, but I want to take a different approach this month. In this column, I will offer some constructive criticism that applies primarily to the action adventure genre. *GOD OF WAR*, *HALO 2*, and *FABLE* are all good examples, but for the purposes of this article, I'll be discussing two excellent games—*DOOM 3* and *HALF-LIFE 2*. These games are both utterly beautiful and have effective sound effects, but in my opinion don't make many advances with their soundtrack.

Although they are masterpieces of the genre, *DOOM 3* and *HALF-LIFE 2* just aren't as progressive with their music design, a trend I'm noticing more and more.

FEAR FACTOR

I want to discuss *DOOM 3* first—the latest game in the series that IBM and Hewlett Packard banned from their networks due to lost productivity.

When you start up *DOOM 3*, the CD launch window presents you with a very loud, low, eerie, ambient drone, which certainly sets the mood and lets you know that this is not your dad's *DOOM*. After the Id logo screen completes (which has even more creepy imagery, and a memorable heart palpitation sound effect), you meet the title screen, with music by Chris Vrenna. The initial electronic instrumentation is lilting and foreboding, and brings you that much closer to reliving a new and



DOOM 3 might be even more frightening with a more dynamic soundtrack.

super enhanced version of the original title. Then the guitars kick in.

Rather than present a memorable theme, a rather generic riff was used. I was sorely disappointed.

While Bobby Prince's marriage of power chords and 12 bar blues didn't exactly make the first *DOOM*'s soundtrack pop, at least you could remember the themes.

DOOM was impressive at the time, and a massive step forward for 3D, but was still a rather cute game, and wasn't really about instilling fear in the player. Bobby Prince's soundtrack played on this, and it truly was enjoyable to watch imps explode to the driving rhythm of instrumentation that seems quite quaint by today's standards.

DOOM 3 though, has fear written all over it, and it's difficult to open a door without your heart jumping out of your chest. The game is a triumph of graphic engineering, with some good environmental sounds to boot, so the lackluster soundtrack is even more apparent.

With the extremely rare ambient drone and occasional electronic mini motif, the game is relatively music free. In these frightening moments, music could be used to increase the tension even more. Think of movies like *Alien*, *Vertigo*, and *Terminator 2*. Now imagine them without music—they're not nearly as effective. *DOOM 3* could have used that edge. A few well placed stingers and more use of creepy ambient tension tracks would have gone a long way.

A SOUNDTRACK HALF-LIVED

Then there's *HALF-LIFE 2*. It's a great game, and a constant jaw-dropper, from the clever design mechanics to the incredibly beautiful environments. The game was a huge leap over its predecessor in all respects, save one. The model for music remained exactly the same. There's only the odd action track during the more intense battles (such as one or two points during the airboat sequence), and every so often there is an opening piece that give you a musical sense of the



HALF-LIFE 2's emotional atmosphere would be a good showcase for a strong musical theme.

level's intended theme, along with its chapter title.

This was the model used for the first game as well, and doesn't heighten the drama very much. Having said that, the absence of music is utterly important to games like these, and there really shouldn't be any music at least 30 percent of the time. However, just as with *DOOM*, the soundtrack could have served to bring the player a sense of dread, or foreboding, or simply to enhance the feeling you get when staring out over that gigantic bridge that made you sweat profusely when crossing. I can't say that the game would have sold better if there had been a proper theme, but while playing I was constantly identifying areas that could have benefited from a well-placed stab, or an Absynth drone, or even a theme for Gordon Freeman! The story, while somewhat sparse, made you feel far more heroic, a savior of mankind, and while the voice over communicated that, the music did not.

There's no question that both of these titles deserve credit for making great steps forward in games. And I'm not saying that all games should have music, either. Music isn't a prerequisite. However, games that lift you out of reality, especially those that present drama, deserve an original soundtrack—and games that deliver such intense and incredible experiences as *HALF-LIFE 2* and *DOOM 3* deserve better ones. ❖

ALEXANDER BRANDON has been involved with game audio since 1994 and is currently the audio manager at Midway in San Diego, Calif. You can email him at abrandon@gdmag.com.



RULES OF INTEREST

AT THE UPCOMING GDC IN MARCH 2006, Hal Barwood and I will present an update to The 400 Project, the quest to collect rules of good game design. We don't have 400 rules yet, but we're well on the way, and it's almost time to make the list public. As a preview, here are brief versions of rules from various designers that all address the issue of how to keep players interested in a game.



MONKEY ISLAND II followed the rule: "Players should see their goal before they can achieve it."

My favored description of a good game is "A series of interesting and meaningful choices made by the player in pursuit of a clear and compelling goal." Here's how to make those choices interesting and meaningful to the player.

MAKE CHALLENGES VARY IN MORE THAN DEGREE —E. Daniel Arey, Naughty Dog (JAK AND DAXTER)

Dan Arey warns that a series of challenges that vary only in degree, for example enemies that come in waves of increasing numbers but are otherwise identical, will bore the player. Instead, make enemies that vary the player response in terms of strategy, tactical button presses, timing, reaction, and

opportunity so the game stays fresh and engaging across the entire difficulty ramp-up. This rule is a specific case of an earlier, more general rule "avoid player fatigue," the admonition to avoid the paired threats of boredom and frustration.

DON'T MAKE YOUR OBJECTIVE YOUR PRIMARY THREAT—Brian Upton, Red Storm (RAINBOW 6)

Brian explained that if the main quest for the player is killing an ogre chieftain, the smaller challenges along that quest cannot consist only of defeating weaker ogres. This is also a specific version of the "avoid player fatigue" meta-rule.

MAKE THE PLAYER FEEL SMART—David "Zeb" Cook, Cryptic Studios (CITY OF VILLAINS), Gordon Walton, ex-Three-Sixty Pacific (HARPOON), and others

Many designers suggested this rule; a practical suggestion on how to implement it is to give the player a deliberately imperfect tool or set of characteristics that he or she can improve over the course of the game. For instance, you may start them in an RPG with a weapon that is merely average, and let them find or make one that is perfect for their character, or start them with a sports team that has a few sub-par players. Then let the player "discover" a fix for that problem in a way that lets the player feel smart.

PROVIDE MULTIPLE SOLUTIONS TO PROBLEMS—Warren Spector, ex-Ion Storm (DEUS EX)

This rule suggests a good way to avoid frustrating the player. If there are multiple solutions to a problem, there is less chance of getting caught in a dead end. The different solutions should also take into account the different preferences and abilities of players. One tried and true method is to provide at least one solution that requires fast action and good reflexes, and another that depends more on intellectual prowess.

PLAYERS SHOULD SEE THEIR GOAL BEFORE THEY CAN ACHIEVE IT—Ron Gilbert, ex-LucasArts (SECRET OF MONKEY ISLAND 1 AND 2), Warren Spector, and others

This is another common rule that I first heard Ron state in the old graphic adventure days: "No backwards puzzles." Letting players see (or at least hear about) their goals before they can achieve them builds anticipation and makes the payoff sweeter. Don't give them the key they need before showing them the lock, whether a literal key or a piece of information, a critical tool, artifact, or weapon. One trump to this rule is to give players the key but disguise it or mask its power, only to reveal it at the right moment for effect. Remember Dorothy's ruby slippers!

MAKE CHALLENGES REQUIRE SKILL—Raph Koster, Sony Online (STAR WARS GALAXIES)

Raph Koster expounded on this rule colorfully: "Don't make a task so simple a dead monkey could do it." A trumping domain where this rule is weaker is the tutorial or first level of a game, where tasks should be easy and painfully obvious—but even there it would be good to require at least a modicum of skill.

TUNE FOR PLAYERS AT THE CENTER OF THE SKILL CURVE—Gordon Walton, Sony Online

Gordon Walton clarified that if you tune for power gamers, who may be the vocal minority, you will leave behind the vast silent majority of players. Users of this rule also should take into account the audience for which the game is intended. But even if most of the players of GOREFEST VII: THE BLOODLETING will probably have played GOREFEST VI: THE CRIMSON FLOOD, it makes good economic sense to keep the game accessible to new players who can expand the franchise. ❖

NOAH FALSTEIN is a 25-year veteran of the game industry. His web site, www.theinspircy.com, has a description of The 400 Project, the basis for these columns. Also at that site is a list of the game design rules collected so far and tips on how to use them. Email him at nfalstein@dmag.com.

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PIXEL PUSHER

CONTINUED FROM PG 37

crunching of the abdomen. Moving it up in the bone's local space helps keep the mass of the abdomen from sliding down into the pelvis during the bend. If your engine supports non-uniform scaling at runtime, you can also try some subtle scaling to reflect the drooping of the belly mass (unless, like the author of this column, your character has rock-hard six-pack abs).

Naturally, the belly bone is a great place to add some secondary motion to the soft mass of the belly. If you need hand-animated secondary on top of the automatic volume fix-up, add an animatable child to the automatic belly bone for the manual tweaks.

SKELETAL FUNCTION

The focus of this series is on deformation skeletons, rather than animation rigs, so this isn't the place to delve into the details of rigging spines. It's worth mentioning, though, that using naturalistic spines is a great counterpart to using spline IK rigs, particularly if you're building the spine using more than six or seven bones. Properly built spline rigs do a great job of capturing the fluid lines of a well-built spine. Unlike simple FK rigs, they also keep the number of keyframes to manage to a reasonable minimum. For more detail about the pros and cons of different spinal rigs, check out "Get Some Backbone" (November 2004).

That's about it for the topic of spinal anatomy for animation. Next month we're going to take a break from the anatomy lesson, but we'll return to the boneyard in a few months. In the meantime, take the opportunity to check out some anatomy resources on the web and experiment with some alternative construction methods. It's always a good idea to revisit settled habits once and a while. ✘



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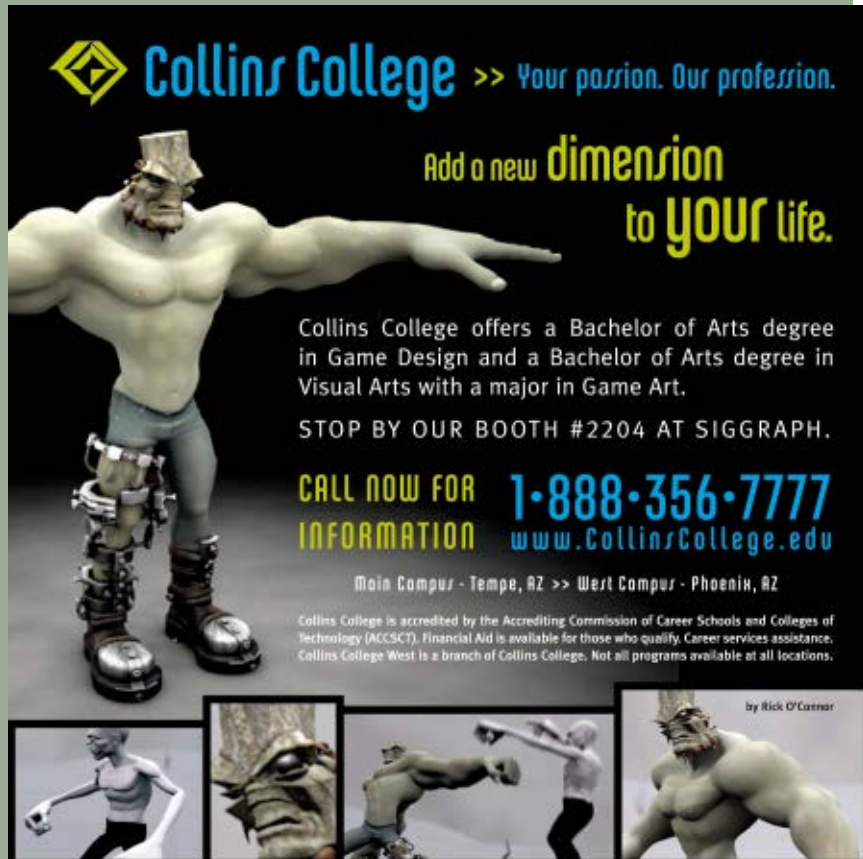
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by Rick O'Connor

ADVERTISER INDEX

3Dconnexion	10
Academy of Art University	45
Ageia	3
Alias Systems	C3
Anark	6
Autodesk	15
Center for Digital Imaging	47
Collins College	44
Columbia College	40
Datascope Recruitment Ltd.	40
Full Sail Real World Education	46
Guerrilla	44
Havok	C2
Integrity Ware Inc.	47
Midway Games	42
The MIT Press	25
Neversoft Entertainment	43
Nintendo of America Inc.	41
Rad Game Tools	C4
Replay Solutions LLC	13
Vancouver Film School	46
Xoreax Software Ltd.	8

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DESIGNING PAC-MAN

CONTINUED FROM PG 30

the high profile of the franchise, and although there have been some critical highlights for the PAC-MAN series, some argue that the lack of a consistent creative overseer has caused the series to lack direction. In fact, with his fun-yet-simple design tactics, one wonders what a second Iwatani-helmed PAC-MAN game might look like.

3 FRANCHISES CAN BE BUMPY. Every franchise has them—from THE LEGEND OF ZELDA's horrid interactive CD-i games through some of CASTLEVANIA's stuttering 3D iterations. Unfortunately, the same is true for the PAC-MAN franchise. Along the 25 years of fun, there have been a few mis-steps. This is particularly true of titles that try to stray too far from PAC-MAN's original maze chase genre. Many humanoid mascot characters have multiple natural extensions; as ambulatory humans, they can be in a platformer, a racing game, a tennis game, a baseball game, all without changing their intrinsic nature or design. PAC-MAN, on the other hand, needs to sprout arms and legs, neither of which are part of his original design, in order to leap out of his 2D maze.

Although these changes can work in video game form (as in PAC-LAND), other extensions can just end up feeling a bridge too far for our plucky friend. A prime example is probably party game PAC-MAN FEVER, which traded off the PAC-MAN name to relatively little interest and unfavorable critical reception, though early, quirky titles such as PROFESSOR PAC-MAN also seemed to take the franchise name down an inappropriate cul-de-sac. The bottom line, as with all franchises: things work less well when their branding or characters are added to genre-based titles that aren't actually enhanced by their presence in terms of gameplay.

PAC IT UP

There's no disputing the pervasiveness of the PAC-MAN iconography, and in that sense, the little yellow fellow's quarter century has been overwhelmingly successful. As journalists and former game developers ourselves, we've been interested by the ways that the PAC-MAN franchise's game designs have grown and morphed over the years, despite the apparent perfection of the original game concept.

Though it's clear that PAC-MAN's genesis has made him a handful during his teenage years, now he's in his 20s and settling down to a life of contented ghost-chomping. And who knows—another golden age of power pill consumption may be just around the corner. Here's to another 25 years of "wokka wokka wokka!" ❖

Brandon Sheffield contributed to this article.



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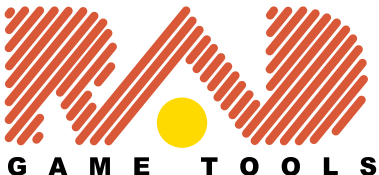
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