

Contents

I	OVERVIEW	9
1	OVERVIEW	11
1.1	Introduction	11
1.2	What you should get from this course	11
1.3	Level of detail	12
1.4	Ways of breaking down the problem	12
1.5	Generality vs Special case	13
1.6	Philosophy of exposition	13
II	DESIGN	15
2	Graphical Design (static)	19
2.1	What is a design Problem?	19
2.2	Direction of Attention	20
2.3	Avoiding Information Overload	21
2.4	Video Restrictions	21
2.5	Color Selection	22
2.5.1	Make it work in Black and White	22
2.5.2	Context	22
2.5.3	Distance Cues	22
2.5.4	Not too many	23
2.5.5	Consistency	23
2.6	2D/3D Considerations	23
2.7	Making things stand out from background	24
2.8	Character Sets	24
2.9	Realism vs. Abstraction	24
2.10	How its REALLY Done	25

3	Graphical Design (dynamic)	27
3.1	Stylistic Evolution	27
3.2	Speed and Timing	27
3.3	Interpolation	28
3.4	Incorporation of 'classic' techniques	28
3.4.1	Squash/stretch	28
3.4.2	Overlapped motion	28
3.5	Perceptions of speed	29
3.6	Character Animation	29
III	SCIENCE	31
4	Visual Metaphors (Design)	35
4.1	Color	35
4.1.1	For Dimensional Analysis	36
4.1.2	Solid, Liquid, Gas	37
4.1.3	Electric charge	38
4.1.4	Electric and Magnetic Fields	38
4.1.5	Electric Potential, Magnetic Potential, Flux	38
4.1.6	Temperature	39
4.1.7	Invisible Light	39
4.1.8	Frequencies	39
4.1.9	Relativity coordinate systems	40
4.1.10	Wave/Particle Duality	40
4.2	Literal vs. Schematic	40
4.2.1	Literal	40
4.2.2	Schematic	41
4.3	Recurring themes	41
4.3.1	Atoms	41
4.3.2	The Teapot	42
4.3.3	Parchment	43
4.3.4	Shadowed Circuit Diagrams	43
4.3.5	Molecular Dynamics	43
5	Visual Metaphors (Physics)	45
5.1	Algebraic Ballet	45
5.1.1	Term labeling	45
5.1.2	Balancing Act	46
5.1.3	Cancelling	46
5.1.4	Recalling old results	47
5.1.5	Substitution	47

CONTENTS**3**

5.1.6	Varying parameters	48
5.1.7	Simplicity	48
5.1.8	Jokes	48
5.1.9	Calculus	48
5.2	Calculus	49
5.2.1	Limits	49
5.2.2	Symbolic derivative machine	49
5.2.3	Geometric derivative machine	50
5.2.4	Colors of Areas	51
5.3	Inertia	51
5.4	Newton's Laws	51
5.5	Vectors vs. Scalars	51
5.6	Vector Fields	52
5.6.1	Representation	52
5.6.2	Dynamic Fields	55
5.6.3	Special Problems with Electromagnetic Fields	56
5.6.4	Remaining problems and ideas for further work	56
5.7	Vector Calculus	57
5.7.1	Derivatives	57
5.7.2	Line Integrals	57
5.7.3	Surface Integrals	57
5.8	Wave interference	57
5.9	Thermodynamics	58
5.9.1	Ideal gasses	58
5.9.2	Non-ideal gas, Lennard-Jones potential	58
5.9.3	PVT diagrams	58
5.9.4	Piston engines	58
5.9.5	Heat flow diagrams	58
5.10	Relativity	59
5.10.1	Michaelson-Morley experiment	59
5.10.2	Cartoons	59
5.10.3	Space-Time Diagrams	59
5.11	Quantum Mechanics	60
6	Mathematical Models	61
6.1	Falling body	61
6.2	Momentum transfer in pool balls	61
6.3	Vector Field Sources	63
6.3.1	Static Electric Fields	63
6.3.2	Magnetic Dipole Field	63
6.4	Field Lines	66
6.4.1	Stepping Along	66

6.5	Sum of potentials	68
6.6	Swirl of particles down drain	68
6.7	EM wave ripples in field lines (140)	68
6.8	Spiraling electron (149)	68
6.9	Fourier synthesis (151)	68
6.10	Water (22)	68
6.11	Wave (22)	68
6.12	Galaxy contraction (20)	68
6.13	Surface Charge on Conductor	68
6.14	Ripple Tank Simulation	69
6.15	Hydrogen Wave Orbitals	69
6.16	PVT Diagram	70
6.17	Kepler orbits	71
6.18	Ideal Gas	72
6.18.1	General Simulation Strategy	72
6.18.2	Next Interesting Event	73
6.18.3	Advancing Time	75
6.18.4	Collisions	75
6.18.5	Initial Conditions	76
6.18.6	Equal Time Steps	76
6.18.7	Statistical Oscillations	76
6.19	Central Force Laws	77
6.20	Gravitational Force	78
6.21	Lennard-Jones Potential	79

IV ENGINEERING 81

7	Software Tools	85
7.1	Command Language Interpreter	86
7.1.1	External Appearance	86
7.1.2	Internal Processing	86
7.1.3	Command Grouping	87
7.2	Modelling	88
7.2.1	Geometric Modeling	89
7.2.2	Texture Pattern Generation	89
7.3	Rendering - Low Level	90
7.3.1	General Operation of Rendering Programs	91
7.3.2	Special Purpose Renderers	91
7.3.3	General Purpose Renderers	93
7.4	Rendering - High Level	95
7.4.1	Techniques	95

7.4.2	Space Simulation Global Scheduler	96
7.5	Animation	97
7.5.1	Levels of animation software	97
7.5.2	Techniques	98
7.5.3	Tools	99
7.6	ARTIC	104
7.6.1	Desired Functionality	104
7.6.2	Basic Token Processor	105
7.6.3	Transparent commands	107
7.6.4	Subassemblies	108
7.6.5	Review	109
7.6.6	Levels	110
7.6.7	OPAC command	114
7.6.8	Symbolic parameters	116
7.6.9	Review	118
7.6.10	Animation tables	119
7.6.11	Table look up of parameters	125
7.6.12	Algebraic Expression Evaluator	126
7.6.13	The right way to do the above.	128
7.6.14	Cleanup commands	128
7.6.15	Special purpose versions	129
7.6.16	Wrap-up	132
8	Scene Implementation	135
8.1	Data location	135
8.1.1	Physical Data	135
8.1.2	File naming conventions	136
8.1.3	Directory Allocation	138
8.1.4	Shape Libraries	138
8.2	Transformation Tree Design	139
8.2.1	Algebraic Ballets	139
8.2.2	Post facto regrouping and splitting	140
8.2.3	Variable naming	140
8.3	Timing design	140
8.3.1	Starting point	140
8.3.2	Spacing	141
8.4	Image rendering tricks	141
8.4.1	Modeling	141
8.4.2	Rendering	145
8.4.3	Anti-Aliasing	147

9	Video	149
9.1	Generating a Video Signal	149
9.1.1	Properties of the NTSC video signal	149
9.1.2	RGB to NTSC Conversion	150
9.1.3	Synchronizing Computer Display to NTSC	150
9.1.4	Connecting signal	151
9.2	Designing for Video	151
9.3	SMPTE Timecode	152
9.4	Operation of 1" videotape machine	152
9.4.1	time base corrector	152
9.4.2	Dynamic Tracking	153
9.4.3	Recording	153
9.4.4	Preparing tape	153
9.4.5	Computer Connection	153
9.5	Automating the Recording Process	154
10	Production Logistics	157
10.1	The production cycle	157
10.1.1	Make-files and exposure sheets	157
10.1.2	Making the frames	158
10.1.3	Disk space monitoring	158
10.1.4	Allocation of space on videotape	158
10.1.5	Checking tape	159
10.1.6	Deleting frames	159
10.2	Parallel processing	159
10.2.1	Detaching Picture System	160
10.2.2	Virtual Frame buffer	160
10.2.3	Dividing Up the Work	160
10.2.4	Life in multiple processing mode	161
10.3	Final Delivery	162
V	UNDERVIEW	163
11	UNDERVIEW	165
11.1	Multiple Program Structure	165
11.2	Unifying Techniques	165
11.2.1	Frame Buffer Synergy	165
11.2.2	The Command Language Interpreter	166
11.2.3	Data Format Standardization	166
11.3	Flexibility	166
11.4	Various tradeoffs	167

11.4.1	General vs Special case	167
11.4.2	Clean vs Dirty implementation	168
11.4.3	Anarchy vs. Beaurocracy	168
11.4.4	Interpreters vs. Compiled Code	168
11.4.5	Menus vs. Keyboard Commands	168
11.4.6	Editors vs. Filters	168
11.5	Mistakes	169
11.5.1	Obsolete scenes	169
11.5.2	Mistakes in animation	169
11.5.3	Funny stories	169
11.5.4	Inconsistant colors	169
11.6	Dead ends	170
11.6.1	Automatic storyboard generator	170
11.6.2	Movie table editing commands	170