I. **Delivery**

A. **Hardware**

1. **Personal computer**
   a) Intel PC (MPC compliant)
   b) Macintosh (68000, 68020 or greater, PowerPC)
   c) Display (resolution, bit depth)
   d) CD-ROM speed
   e) MPEG
   f) 3D acceleration
   g) MIDI
   h) Connectivity (network, modem, ISDN...)
2. **Kiosks**
   a) Display
   b) Sound system
   c) Storage and/or connectivity
   d) Keyboard/keypad
   e) Pointer (trackball/touchscreen)
   f) "Hardened" enclosure
3. **Game console**
   a) Nintendo, Sega, Atari, Sony, 3DO
   b) game controller
   c) CD-ROM or cartridge
   d) Portable LCD display, or TV hookup
4. **PDA (Palmtops)**
   a) Newton, Magic Cap, GEOS, H-P
   b) Handwriting recognition and/or keyboard
   c) Connectivity (wired, wireless)
5. **"Adult" consumer player**
   a) CD-I
      (1) MPEG expansion
6. **Network computer**
   a) Oracle (Newton/ARM)
   b) Sun (Java processors)
   c) Bandai/Pippin
      (1) Storage
      (2) Keyboard/remote/controller
      (3) Connectivity
7. **Set-top box (ITV)**
   a) Multiple, incompatible, experimental units

B. **Software**

1. **Run-time executable**
   a) Embedded in content file
      (1) Director Projector, HyperCard Standalone
   b) Separate application
      (1) Proprietary player
         (a) Acrobat Reader, HyperCard Player

(2) Open-standard player
(a) Web browsers
c) Plug-in based on open API
(1) Director Shockwave for Netscape Navigator

2. Virtual machine

a) KMP (ScriptX)
b) Java

3. Compiled native code

II. Production

A. Media acquisition and editing

1. Text

a) Capture

(1) Optical Character Recognition software

b) Text editors

(1) No formatting, no word-wrap
(2) BBEdit, Alpha

c) Word processing

(1) Extensive formatting, bordering on DTP
(2) MS Word, WordPerfect, Write Now, MacWrite...

d) File formats

(1) ASCII (= text only or plain text) files (type: TEXT, ext: txt)
(2) Various proprietary word processing file formats.
(3) RTF (= Rich Text Format) interchange format (type: TEXT, ext: rtf)

2. 2D stills

a) Raster graphics

(1) Scanning
(a) Hardware: multimedia requires relatively low-res, high color depth
(b) Standalone applications
(c) Photoshop Acquire plug-ins
(2) Painting
(a) Optimized for the creation of new images
(b) Fractal Painter
(3) Photoediting
(a) Optimized for manipulating existing images
(b) Adobe Photoshop
(4) Compositing
(a) Optimized for collaging images from varied sources
i) Of greater relevance to print media work (very large source files)
(b) Live Picture, Macromedia XRes, Specular Collage.

b) Vector graphics

(1) Autotracing
(a) Convert scanned images to editable geometry
(b) Adobe Streamline
(2) Illustration
(a) Create new images out of Bezier curves (the geometry underlying PostScript)
(b) Adobe Illustrator, Macromedia FreeHand

(c) For multimedia, these images generally are rasterized for final delivery
i) Adobe ScreenReady

c) File formats

(1) Raster-only
(a) MacPaint, Mac-only format (type: PNTG)
(b) TIFF (= Tagged Image File Format) widespread, flexible format (type: TIFF, ext: tif)
(c) GIF (= Graphic Interchange Format) widespread online, WWW format (type: GIF , ext: gif)
(d) JPEG (= Joint Photographic Experts Group) lossy-compressed format, also used for WWW (type: JFIF or JPEG, ext: jpg)

(2) Vector-only
(a) DXF (= Drawing Exchange Format) widespread CAD format

(3) Vector and raster combined
(a) EPS (= Encapsulated Postscript) widespread DTP format (type: EPSF, ext: eps)
(b) Pict, Mac-only format (type: PICT, ext: pct)

3. 3D stills

a) Modeling

(1) hardware: 3D digitizers
(2) Create geometric descriptions (models) of objects to be used in the composition of scenes.
(3) Types of geometry
(a) Planar polygons
i) Faster to render, favored for real-time 3D games on low-end platforms
ii) Will appear increasingly crude as the viewer approaches. For greater efficiency, different versions of the object at different polygon resolutions are required.
(b) Curved surfaces
i) Easier to edit (few control points instead of many vertices)
ii) Retain their appearance at all magnifications

b) Rendering

(1) Create images from geometry (models), environment (lighting, atmospherics), and material (textures) information.
(2) The algorithms used for rendering can be ranked by the increasing realism of the images they create (and increasing computational effort):
(a) wireframe
(b) hidden-line removal
(c) flat shading
(d) smooth shading (Gouraud)
(e) smooth shading with specular highlights (Phong)
(f) ray tracing (optically-correct rendering of shadowing, reflection and refraction)
(g) radiosity (energy calculation for the correct rendering of diffuse illumination)
(3) Additional algorithms can be used in various combinations to increase the effectiveness of the images produced:
(a) Depth cueing
(b) Texturing or mapping
i) Surface
ii) Solid
iii) Environment (reflection)
iv) Transparency
v) Bump

vi) Displacement
(c) Cast shadows
(d) Self-shadowing
(e) Haze/fog
(f) Glow/radiance
(g) Depth of focus
(h) Motion blur

(4) Most modeling programs provide some rendering features as well. A few 3D programs provide only rendering (RenderMan) or rendering and animation (Electric Image). All objects used to create scenes in the latter programs must be imported from outside sources.

c) Special-purpose software

(1) Landscape rendering: Metatools Bryce, Virtual Reality Labs VistaPro
(2) Human figures: Fractal Poser

d) File formats

(1) Few effective standards, many incompatible proprietary formats
(2) DXF--will generally convert curves to polygons
(3) RIB (= RenderMan Interface Bytestream) includes rendering as well as geometry info (type: TEXT, ext: rib)
(4) 3DMF (= QuickDraw 3D Metafile) includes rendering as well as geometry info (type: 3DMF, ext: b3D for binary and t3D for text encoding)
(5) VRML (= Virtual Reality Modeling Language), WWW format, version 1 based on SGI Open Inventor.

4. Animation

a) Motion capture

(1) Monkey, Flock of Birds, Dataglove, custom harnesses

b) Keyframe-based systems

(1) Director (2D)

c) Path-based systems

(1) ADDmotion (2D); Strata StudioPro, Electric Image (3D)
(a) PixelPutty spiraling paths

d) Advanced features

(1) Hierarchical Linking (Swivel)
(2) Inverse Kinematics (RayDream 4D Studio, Pixel Putty)
(3) Timing Curves (Elastic Reality) and Eases (Director)
(4) Particle Systems (Strata StudioPro)
(5) Dynamics (Alias|Wavefront Dynamation for SGI)
(6) Behaviors (flocking -- Jurassic Park dyno stampede)

e) Morphing and warping

(1) Morph, Elastic Reality, Flo' (2D); Strata StudioPro (3D)
(2) QuickMorph cat & baby demo
(a) Rendered QuickTime MooV

f) File formats

(1) No widespread standards for motion data. Formats for rendered output often same as video formats.
(2) PICS (= Pict sequence), Mac-only format, no timing info (type: PICS)
(3) Flic, Autodesk Animator format used by several PC programs (ext: flc)

5. Video

a) Capture

(1) Built-in video input: Power Mac 7500 and 8500, older AV models.

(2) Targa 1000 and 2000, Radius VideoVision Studio and Telecast

b) Editing

(1) Unbundled software: Adobe Premiere, Avid VideoShop.

(2) Hardware & software combinations: Avid Media Composer, Data Translation Media100

c) Compositing

(1) Adobe After Effects

d) File formats

(1) File formats for digital video are separate from the compression algorithm used (codec). The same codec may be used to compress image data saved in two different file formats.

(a) A range of codecs are available. Choice based on:

i) Image content (live images vs. computer-generated)

ii) Linear playback vs. random access

iii) Compression and decompression speed

iv) Acceptable image degradation, and whether recompression will occur.

(b) Different media: video, sound, music, text, time code, sprite...

(2) QuickTime movie, cross-platform Mac, Win, SGI (type: MooV; ext: mov)

(a) QuickTime VR variant provides precomputed 3D simulations and interactivity

i) Panorama of raydiosity-rendered room

ii) Apple Company Store from QuickTime VR 7/95 CD

iii) White House Tour from QuickTime VR 7/95 CD

(3) Video for Windows movie (ext: avi). Microsoft Active Video?

(4) MPEG (= Motion Pictures Experts Group). This is both a specific file format, used for WWW, and a codec which may be supported by QT or VFW

6. Sound

a) Capture

(1) Built-in analog inputs in all Macintoshes since IIsi and LC, most PC sound cards.

(2) Digital inputs (Avid Digidesign Audiomedia II)

(3) MIDI data capture from various controller types (keyboards, drum pads, etc.). MIDI interface required for most computers.

b) Sound Editing

(1) Unbundled software: Macromedia SoundEdit, Macromedia Deck

(2) Hardware & software combinations: Avid Digidesign Pro Tools

c) Music (MIDI) Editing

(1) Sequencer software: Opcode Vision, Mark of the Unicorn Performer, Steinberg Cubase

d) Speech Synthesis

(1) Apple Text-to-Speech system software

e) File formats

(1) Snd resource, Mac-only system sounds (type: snd)

(2) AIFF (= Audio Interchange File Format), cross-platform Mac, Win, SGI (type: AIFF, ext: aif)

(3) au and μ-law, originally UNIX formats (various platforms), often used for WWW

(4) WAV, Windows format, occasionally used for WWW

(5) MIDI, widespread cross-platform standard. General MIDI also specifies a standard set of instruments and their channel assignments.

B. Authoring and programming

1. Multimedia Authoring

a) Different editing interface "metaphors"

(1) Card stack or book; Timeline or score; Flow chart; Map

(2) The interface metaphor indicates how the multimedia author should think of his/her work when using a specific editing program.

(a) The specifics of the editing metaphor do not immediately affect the look of the presentations created with the editing program. However, presentations created with the same editor often bear subtle similarities.

b) Multimedia editing environments

(1) "Slide show" editors: Director Overview, MediaMaker, Astound.

(2) Timeline

(a) Director

(3) Stack/Book editors: HyperCard, SuperCard. ToolBook.

(4) Flowchart: Authorware, Icon Author (Metatools Interactive).

(5) Map: Apple Media Tool. Storyspace. MAEstro, KMS.

(6) Objects: mTropolis

2. Programming

a) Language "levels" and trade-offs

(1) Lowest level: machine language

(a) All of the other languages must ultimately translate to this before executing

(2) Assembly language

(3) Weakly-structured languages: early BASIC and FORTRAN

(4) Structured procedural languages: Pascal, Modula, C, Ada

(5) Functional languages: LISP, LOGO

(6) Logic programming: Prolog

(7) Object-oriented languages & language extensions: SmallTalk, C++, Object Pascal

(8) Highest level: "scripting languages"

(a) Least general in purpose (apply only to a specific niche)

i) Specific platform

(1) Macintosh: AppleScript; UNIX: shells; Amiga: AREXX

ii) Specific application

(1) Multimedia/Hypermedia: HyperTalk, SuperTalk, Lingo; Spreadsheets: WingZ HyperScript; Databases: 4GLs (Fourth Generation Languages).

(b) Most powerful (complex actions specified by few/simple instructions)

(c) Generally least efficient (require more storage space, yield slower execution speed)

b) Programming process

(1) Define *specifications* (what the program should do, and on which items)

(2) Organize the items that the program will work on (*data structures*)

(3) Break the specs into simple steps (*algorithm*)

(4) Lookup *commands* that will do each step

(5) Determine appropriate *parameters*

(6) Test and debug

(a) Execute program lines selectively (*step, comment/uncomment*)

(b) Stop program to examine its state (*breakpoints*)

(c) Display parts of the program as they execute (*trace*)

(d) Display variable values at key moments in the program to ensure they are valid

c) Programming tools

(1) Text editor

(2) Interpreter and/or Compiler
(3) Debugger
(4) Computer-Aided Software Engineering (CASE) tools for *version control, interface design*, etc.

d) Multimedia programming environments

(1) HyperTalk & relatives (HyperCard/SuperCard/Plus)
(2) Lingo (Director)
(3) Oracle Power Objects
(4) Apple Media Tool Programming Environment
(5) Script X

C. Formatting and Premastering

1. Processing for lower bandwidth/storage/processing

a) Graphics processing

(1) Color reduction (with common palette), cropping, resizing, lossy/lossless compression

b) Sound processing

(1) Downsampling, mix down

c) 3D processing

(1) Polygon reduction

d) Video processing

(1) Frame rate reduction, plus still-image techniques

2. Port/recompile executable(s) for any additional platforms

a) E.G., re-open movie in Director for Windows, create Wintel version of Projector

3. Preparation for CD-ROM delivery

a) Source Storage

(1) Reformat for specific allocation block sizes
(a) Alternatively, use virtual volumes
(2) Defragment, optionally optimize

b) Premastering

(1) Select CD specification(s) (Yellow Book, CD-I, etc.)
(2) Select File System(s) (HFS, ISO 9660, etc.)
(3) Create directory for each file system
(a) Check file naming compliance, directory nesting
(b) Optionally, hide non-Mac files from Finder
(4) Optimize track layout, if available
(5) Test throughput
(6) Burn a one-off

III. System Administration

A. Storage and backup

B. Networking and communications

C. Project management

1. Asset tracking
2. Scheduling
3. Version control

D. Standard business apps