

## Producing Video for the Web Streaming Media East, 2010

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## Agenda

- Production
  - 9:00 – 9:30 ● Setting the scene (background and clothing)
  - 9:30 – 10:00 ● Lighting
  - 10:00 – 10:20 ● Shooting for streaming
- Editing/Preprocessing
  - 10:40 – 10:50 ● Choosing your targets
  - 10:50 – 11:00 ● Avoiding/correcting aspect ratio issues
  - 11:00 – 11:10 ● De-interlacing
- 11:10 – 12:00 ● Encoding

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## Setting the Scene

- What's different b/t streaming and analog?
- High level goals for choosing a background
- Best practices
- Choosing a background for in-house
- Choosing a background for on-location
- Conclusion and checklist

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## Background - What's Different?



- Contrast issues:
  - Very similar between analog and streaming - need to separate subject from background
- Other issues:
  - Backgrounds with motion can severely degrade compressed video quality
  - Poorly chosen backgrounds (well lit, reflective blank walls) can "create" noise

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## What do I Care About When Choosing a Background?



- Provide contrast with talent
  - Obviously relates to clothing worn by talent
- Avoid color and contrast extremes
- Choose one that compresses well
  - No motion
  - Low detail
  - No wide open spaces (embrace clutter)
  - No highly saturated colors

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## Contrast



- |                                               |                       |
|-----------------------------------------------|-----------------------|
| • Good contrast                               | • Bad contrast        |
| • Deloitte - dark grey suit, light blue back  | • P&G - blue/blue     |
| • Cranky Geeks - brown suit, black background | • Price - black/black |
| • HP - grey shirt, dark background            | • NIST - black/black  |
| • HP - blue shirt, brown background           | • Real - blue/blue    |
| • Amex - light blue shirt, grey background    |                       |

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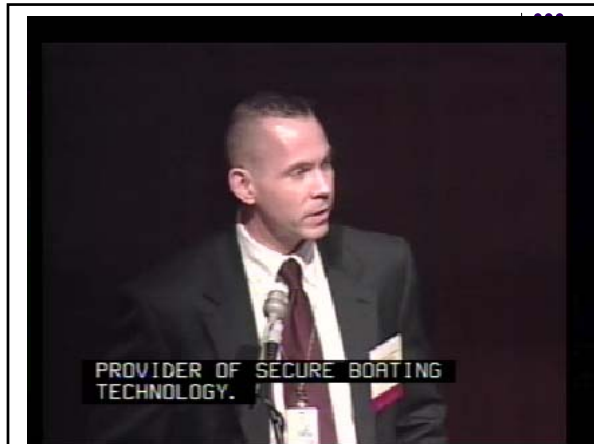
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## Avoid Color/Contrast Extremes

- Brightness extremes hard for camera/codecs to preserve
- Color extremes make it tough to maintain contrast

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## Avoid Motion

- NAB
- Avoid
  - Trees/leaves
  - Traffic
  - Walking/playing
  - Handheld camera



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## Avoid Wide Open Spaces



- DON'T - Use flat, well-lit, light color backgrounds without some "clutter".
- DO
  - Add "clutter" to the background to contain artifacts
  - Darken background to
    - Reduce detail
    - Reduce reflection



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## Avoid Highly Saturated Colors

- DON'T use highly saturated colors – Which tend to create motion in the background
- DO - Use more muted colors



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## Avoid Fine Patterns



- DON'T - use backgrounds with fine patterns and/or decorative lighting.
- DO - use a simple background with little visible detail



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## Backgrounds for people of color

- Significant diversity in actual color
- Rules seem about the same
- Light tans, light and dark blues
- Soft background
- Good backlight cures most problems



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## Creating the Perfect In-House Background

- Simple is better
  - Flat black works well
  - MS got fancy and lost contrast
- Be Flexible
  - Curtain system with multiple simple backgrounds



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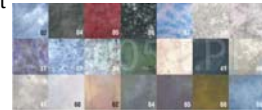
## Building the Perfect Background - Office

- 1 stand (~ \$100 US)
- 2-3 backgrounds (~\$130 US)
  - Flat black
  - Dark grey
  - Light blue
- Under \$250, you're set



Condition: New  
Quantity: 15 available  
Price: **US \$75.00**  
Shipping: **US \$25.00**  
Standard Flat Rate Shipping Service

Add To Cart



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## Building the Perfect Background - On Location

- Need "on location" feel
  - Curtains and portable backdrops out
- How to create compressible set?

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## Building the Perfect Background - On Location

- Avoid contrast extremes
- Avoid complex textures and shapes
- Limit detail with lighting (darken the background)
- Or by blurring the background with camera settings
- Avoid backlighting



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## Background Checklist



- Does the background provide contrast with subject's face, clothing and hair?
- Are there extremes in contrast and/or color
- Is there extraneous detail in lighting or pattern?
- Is it moving?
- Are the colors highly saturated (rich reds and blues)?
- Are there well lit, wide open spaces?
- Are there any light sources like lights or windows?
- Have you tried compressing the footage and viewing the results?

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## What Should Talent Wear?



- What's different between streaming and analog production?
- Feng Shui in clothing and backgrounds
  - Avoid contrast extremes
  - Other issues
- Clothing checklist

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## Clothing - What's Different?



- Must be more sensitive to detail that can produce compression artifacts (jewelry, glasses, hair)
- Similar in other aspects, though compression exacerbates issues
  - Contrast (no black and white)
  - Details (no stripes, herringbones)

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## Poor Clothing Choices



- Minimal contrast with the background
- Back light helps

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## Poor Clothing Choices



- Minimal contrast with the background
- No backlight – blends in

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## Poor Clothing Choices



- Excessive detail
- Avoid tight pinstripes and other patterns

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## Poor Clothing Choices



- Excessive detail
- Avoid tight pinstripes and other patterns

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## Dressing for Streaming Success



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### What to wear

- Solids
- Not too dark or too light
- Contrasts well with the background
- No shiny jewelry

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## Dressing for Streaming Success



Deloitte.  
Industry Perspectives  
2006 Real Estate Capital Markets Industry Outlook

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## Dressing for Streaming Success



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## Clothing Checklist



- Clothing
  - Solid colors - dark blues, grays or browns
  - Avoid white and light blue (which looks like white on camera)
  - Advise in advance to contrast with background, and to bring alternatives (or lighter shirt/darker coat)
- Hair
  - Pulled back (Loose ends get messy after compression)
- Jewelry
  - Some OK, large bling is additional detail and reflective
- Glasses may require special lighting (generally from the side) to avoid glare

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## Lighting - Theory, Practice and Application



- What's different between streaming and analog production
- Overview
- Fundamentals
- Decision time - flat lighting or shadows

s/b 9:30

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## Lighting - What's Different?



- Overall, TV/Movie and streaming are similar, except that:
  - We use cheaper cameras (usually)
  - Compression *decreases* overall contrast ratio, so lighting extremes are not well tolerated
  - Bottom line – highly stylistic shadowed lighting may not work for streaming

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## Overview



- Lighting is the single most important determinant of video quality
  - Low lighting causes gain (noise) in the video, complicating low bitrate compression
- Hierarchy of considerations
  - Ensure lighting is adequate to produce clear, easily compressible image
  - Then worry about style and mood

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## Fundamentals

- Color temperatures
- Hard vs. soft lighting
- Lighting styles
  - Three-point
  - Flat

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## Color Temperatures



- What's the problem?
- Key points:
  - All lights have different color temperature (sun/incand/fluor)
  - Don't mix



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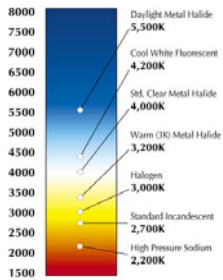
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## Common Color Temperatures



<http://www.patmullins.com/img/colortempchartorig.jpg>

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- Big no-nos
  - Outdoor lighting with any indoor light
  - Fluorescent with any incandescent
- What to do?
  - Disable one light source (e.g. close shades, turn off lights)
  - Change color temperatures with gels

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## Hard vs. Soft Lighting



- Hard lighting
  - Uses incandescent and halogen bulbs
  - Creates shadows and enhances detail
- Soft lighting
  - Minimizes shadows and detail
    - Best for streaming
  - Diffused hard lights
    - Softbox/reflector
  - Fluorescent lights

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## Know Your Lighting Styles



- Three-point
  - Useful for setting mood
  - Hard to set up
  - Heavy shadows tough to compress
- Flat
  - Visually neutral (e.g. boring)
  - Easy to set up
  - Easy to compress

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## Flat or 3-Point - A Quick Survey

| Category                | Flat | 3-Point |
|-------------------------|------|---------|
| Traditional broadcast   | 14   | 0       |
| Internet-only broadcast | 9    | 5       |
| Corporate informational | 4    | 5       |
| Corporate case study    | 4    | 5       |

- Clearly can go either way
- Origins of lighting
  - Set (or not set) mood
  - Model the face

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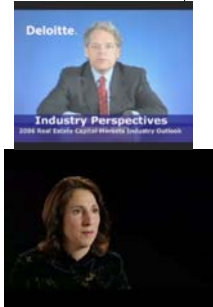
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### 3-Point Usage Patterns

- Subtle modeling
  - Soft lights
  - Low contrast shadows
  - Classy look
  - Deloitte - modeling
  - PW - setting dramatic tone



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### 3-Point Usage Patterns

- Mood lighting - dramatic feel
  - Still soft lights
  - Big variation in power
  - Matches environment (or at least looks like it)



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### 3-Point Usage Patterns

- On the edge
  - Hard lighting
  - Huge contrast and shadows
  - Doesn't match environment (clearly for affect)



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## 3-Point Rules

- Match lighting to mood
  - Subtle modeling to dramatic
- Match lighting to environment
  - Otherwise, lighting may look contrived



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## Lighting Resources

- Setting up three point lighting
  - [http://en.wikipedia.org/wiki/Three-point\\_lighting](http://en.wikipedia.org/wiki/Three-point_lighting)
  - <http://www.3drender.com/light/3point.html>
  - <http://www.5min.com/Video/Video-Lighting-Tutorial--Three-Point-Lighting-164812181>
  - <http://www.streaminglearningcenter.com/articles/lighting-for-streaming.html>
- Setting up flat lighting
  - <http://www.streaminglearningcenter.com/articles/setting-up-flat-and-three-point-lighting.html>

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## The Net/Net on Lighting

- No one ever got fired for using flat lighting
  - Easier to setup and compress, but can be boring
- 3-Point Variations
  - Subtle - to create modeling
  - Dramatic - to create mood
    - Good for case studies and interviews
    - Questionable for fact oriented business video
    - Best when lighting matches environment
    - Watch contrast ratio issues

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## Shooting for Streaming

- Basics
- Progressive vs interlaced source

s/b 10:00

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## Basics

- At identical encoding parameters, which source video compresses to better quality – low motion or high motion
  - Low motion
- Why? Interframe compression, which relies upon interframe redundancies



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## What's this Mean?

- Motion is the enemy of interframe compression
  - Saw chart before – depending upon data rate, have to customize shooting for streaming quality
- At lower bitrates, you have to eliminate extraneous motion in shooting, content and editing.

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## Eliminating Extraneous Motion

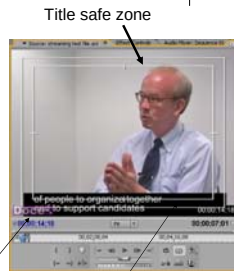
- Camera - shooting techniques – for low bit rate distribution
  - Use a tripod
  - Avoid panning and zooming whenever possible. Cuts are better (multiple cameras help)
- Limit on-screen motion
  - Talent – consider sitting, and advise against excessive motion (better to frame wide than follow around)
  - Background – limit motion
- Editing
  - No goofy 3D effects
  - Dissolves/cross fades should be very fast, .25 - .5/sec.

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## Framing - No Safe Zone

- Safe zone
  - Outer 10-15% eliminated as overscan
  - All pixels show in streaming
- So:
  - Can zoom in a bit tighter b/c more room for other content



OK for streaming, wouldn't be visible on a TV set

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## Should I Shoot Progressive

- Progressive vs. Interlaced
- The tests
  - Low detail/low motion
  - Low detail/high motion
  - High detail/variable motion
- Conclusion

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## Progressive vs. Interlaced

- Most SD cameras capture interlaced video
  - 60 fields per second, not 30 frames
  - Fields are captured 1/60th of a second apart
- All streaming class codecs are frame based
- Converting from fields to frames can cause a stair step or Venetian blind artifacts which deinterlacing can resolve
- Progressive cameras shoot 30 fps and divide into fields
  - Fields match up perfectly for streaming production

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## Overview - Theory

- Traditional camcorders are interlaced (shoot in fields, 1/60 of a second apart)
- Streaming media is FRAME based



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## Overview - Theory

- Shooting in progressive mode eliminates that problem and is vastly superior to interlaced
- But!
  - Most editors/ encoding programs have deinterlacing filters that take you from here:
  - To here.



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## Overview - Theory



**The moral of the story:** Deinterlacing never delivers the same quality as a progressive frame

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## Overview - In Practice



Little Miss Sunshine Trailer

Wal-Mart online video



And now he is very excited about learning.

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## The Big Questions

- Does a progressive camcorder deliver better quality than interlaced?
  - If so, how much?
  - If so, when does it matter most?
- Implications:
  - If you're buying new, should you buy a progressive unit?
  - If your camcorder is interlaced, should you buy a new one for streaming?
  - If your camcorder has progressive and interlaced, which mode should you use?

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## Test Description

- Shoot same scenes with two cameras simultaneously
  - One progressive - Canon XH A1
  - One interlaced - Sony HDR-FX1
- Scenes
  - High speed sports
  - Low contrast talking head
  - Real world (uncontrolled) shoot

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## Conclusions - Sports

- Even at relatively slow shutter speeds (like 60)
- If you have sharp edges, you have a problem



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## Conclusion - Talking Head



- In those instances where:
  - Minimum sharp detail
  - Relatively slow shutter (like 60)
- Not much distinguishable difference

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## Conclusion - Talking Head



- Even when there's moderate motion, no major difference unless lots of detail in the frame

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## Conclusion - Real World



- If you can't control the detail in the scene, go progressive
  - Swords - :47
  - Background - 1:07

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## Conclusions

- Progressive delivers noticeably better quality in all but the most controlled shoots
- Especially with
  - Sharp edges
- So:
  - If you're buying for streaming, buy progressive
  - If you have progressive, use it
  - If your camcorder doesn't have progressive, and you shoot lots for streaming under uncontrolled circumstances, consider new camcorder

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## Editing/Pre-processing



- Choosing your targets
- Producing the correct output resolution and aspect ratio
- Deinterlacing

s/b 10:40

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## What Output Parameters Should I Use?



- Codec
- Resolution
- Frame rate
- Audio bit rate

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## About the Survey



- Targets
  - Informal survey of 45+ web sites
  - Two categories, media and corporate
- Files chosen
  - Media – video from multiple areas, both preview and episode replay
  - Corporate – Tried to find newest, highest resolution streaming file

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## About the Survey



- Media (partial)
  - ABC, CBS, Fox, CNN, ESPN, The Golf Channel, CNET, Fortune, WSJ, NY Times, DL.TV. E-Online, Accuweather, Forbes, MSNBC
- Corporate (partial)
  - Deloitte, Cisco, Accenture, E&Y, GE, IBM, Intel, McDonalds, Nike, Nokia, Microsoft, Apple, Toyota, Walmart, McKinsey

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## Codec Selection



| Summary                  | VC1 | H264 | VP6 |
|--------------------------|-----|------|-----|
| Broadcast - Conservative |     | 1    | 1   |
| Broadcast - Midrange     |     | 1    | 9   |
| Broadcast - Aggressive   |     | 5    | 5   |
|                          |     |      |     |
| Corporate - Conservative |     |      | 5   |
| Corporate - Midrange     | 1   | 2    | 7   |
| Corporate - Aggressive   | 3*  | 3    | 4   |
|                          | 9%  | 26%  | 66% |

\* - included Microsoft and the Zune website

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## Analysis



- Broadcast channels almost all Flash
  - Some Silverlight for live events (Olympics, etc)
  - Continuation of a very long term trend
- Apple is the only site using QuickTime
- Microsoft sites are 50% of sites using VC-1/WMV

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## What Resolution/Data Rate Should I Use? (5/2010 data)



|                  | Width | Height | Total<br>Pixels | fps | Video<br>Data<br>Rate | Audio<br>Data<br>Rate | Total | B/P/F |
|------------------|-------|--------|-----------------|-----|-----------------------|-----------------------|-------|-------|
| <b>Media</b>     |       |        |                 |     |                       |                       |       |       |
| Conservative     | 377   | 213    | 81,198          | 30  | 466                   | 64                    | 530   | 0.203 |
| Midrange         | 504   | 319    | 160,524         | 27  | 642                   | 98                    | 739   | 0.156 |
| Aggressive       | 690   | 388    | 272,413         | 26  | 699                   | 79                    | 778   | 0.103 |
| <b>Corporate</b> |       |        |                 |     |                       |                       |       |       |
| Conservative     | 342   | 242    | 82,666          | 27  | 410                   | 80                    | 490   | 0.206 |
| Midrange         | 462   | 299    | 138,638         | 26  | 454                   | 82                    | 536   | 0.143 |
| Aggressive       | 693   | 412    | 289,521         | 26  | 938                   | 109                   | 1,047 | 0.132 |

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## Bits Per Pixel



- In general
  - .1 or lower should be fine
  - .15 is very conservative; much beyond that is a waste
  - Formula
    - $\text{Data rate} / (\text{pixels} \times \text{frame rate})$

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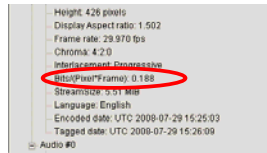
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## Bits Per Pixel



- Or, get MediaInfo
  - Calculates for you, plus lots of other file details
- Free, Mac/Windows utility
  - Installed on every one of my computers



[mediainfo.sourceforge.net/en](http://mediainfo.sourceforge.net/en)

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## Bottom Line



- You should know the bits/pixel/frame for each video that you produce
  - If too low – quality suffers
  - If too high, may not stream smoothly and bandwidth costs (if a factor) may unnecessarily increase

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## Summary



- Compare your media size/data rate to the various groups
- If in the conservative range, identify why
  - Design considerations?
  - Just haven't focused on it lately?
- Clearly, you no longer have to stream at 300 kbps to reach your target and play smoothly
  - Unless bandwidth costs are a factor, consider an upgrade

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## What Frame Rate?



- Media
  - 3 of 22 used 15; the rest were either 24 or 30
- Corporate
  - 3 of 25 used 15; the others used either 24/30
- Recommendation
  - Unless really trying to go low (e.g. mobile), stick with native frame rate

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- MacBreak 143: NAB 2008: Flow**  
 Alex Lindsay  
 MacBreak (Pod video)  
 ps by Ordron Software to check out how they are revolutionizing file management with "Flow"  
 Source: C:\Streaming file archive\sn\Mistake\MacBreak 143\_NAB 2008\_... stereo mov  
 Format: H.264, 640 x 360, Millions  
 Audio: Stereo (L), 44,100 KHz  
 Size: 23.98  
 ing FPS: 23.98  
 ata Size: 24.5 MB  
 ata Rate: 1.20 mbits/sec  
 uration Time: 00:01:10.59  
 uration: 00:02:49.34  
 nal Size: 640 x 360 pixels  
 ntal Size: 640 x 360 pixels



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- ```

MacBreak 143: NAB 2008: Flow
    Alex Lindsay
    MacBreak (Pod video)
    ps by Ordron Software to check out how they are
    revolutionizing file management with 'Flow'.

Source: C:\Streaming file archive\an\mistakes\
MacBreak 143_ NAB 2008_ stereo mov
Format: avc1.42c015.0.1080000
AAC, Stereo (L, R), 44.100 kHz
Video:
    Info FPS: 23.98
    Avg FPS: 23.98
    Data Size: 24.5 MB
    Data Rate: 1.20 mbits/sec
    Int Time: 00:01:10.59
    Duration: 00:02:48.34
    Pixel Size: 640 x 360 pixels
    Int. Resolution: 640 x 360 pixels
  
```

[illegible]

- 
- MacBreak 143: NAB 2008: Flow**  
 Alex Lindsay  
 MacBreak (Pod video)  
 ps by Gridiron Software to check out how they are  
 retooling file management with "Flow"  
 Source: C:\Streaming file archive\lanMistakes\  
 MacBreak\_143\_NAB\_2008\_-\_stereo.mov  
 Format: MPEG-4 AVC H.264, mpeg4  
**AAC, Stereo (L R), 44.100 kHz**  
 Info:  
 File Size: 23.98  
 Duration: 00:02:48.00  
 Data Size: 24.5 MB  
 Audio Rate: 128 mbps/sec  
 Runtime: 00:01:10.59  
 Resolution: 00:02:48.00  
 Pixel Size: 640 x 360 pixels  
 Bit Size: 640 x 360 pixels



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## How Much Audio?

| Summary                  | Mono | Stereo | Bitrate |
|--------------------------|------|--------|---------|
| Media – Conservative     | 2    | 0      | 64      |
| Media - Midrange         | 5    | 5      | 98      |
| Media - Aggressive       | 5    | 5      | 79      |
|                          |      |        |         |
| Corporate - Conservative | 3    | 2      | 80      |
| Corporate - Midrange     | 4    | 6      | 82      |
| Corporate - Aggressive   | 3    | 7      | 109     |

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## Produce Mono Audio in Mono

- The microphone is mono, the audio compressed in stereo
  - Duplicate the mono signal in both stereo tracks, doubling the data rate
- If you convert a mono signal to stereo, you have to double the audio data rate to maintain the same quality
- Better to produce in mono and allocate the extra data to video

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## How Do I Produce the Right Aspect Ratio?

- What's wrong with this picture?
- Producing aspect ratio correct video (the short answer)
- Explanation (bonus)

s/b 10:50

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## Hosing the Aspect Ratio



Video grab

Picture on web site

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## Hosing the Aspect Ratio - CNN



Tiger on CNN

Tiger on ESPN

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## Hosing the Aspect Ratio - PWC



Price Waterhouse  
Coopers Website

Publicity digital  
photo

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## Hosing the Aspect Ratio - Travel Channel



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## Fixing the Problem



- Rule #1

● **PAY  
ATTENTION**

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## Fixing the Problem



- Recognize there's a problem
  - Just because you shoot in widescreen doesn't mean that the video should look stretched when streaming
  - Video frames should look like a digital picture

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## SD Source - You have to Change the Aspect Ratio

- Display aspect ratio of SD video is different from computer
  - e.g. – 4:3 SD video has a display aspect ratio of .9, so it's squeezed when displayed on a computer
  - That's why we use 640x480 rather than the native 720x480

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## SD Source - You have to Change the Aspect Ratio



DV Frame

Same Frame on TV

- If you don't change the display aspect ratio, the video will look distorted

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## Getting it Right (4:3 DV Input)

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## How Do I Get it Right?

- Always output Square Pixel (1:1)
  - Irrespective of input PAR
- When square not available, “distort”
  - You want to change aspect ratio from analog to square
  - Never choose “maintain aspect ratio” unless encoding from square pixel source
- Easiest (but not essential) when output resolution matches display aspect ratio
  - 4:3 - 640x480, 480x360, 400x300, 320x240
  - 16:9 - 640x360, 480x270, 320x180

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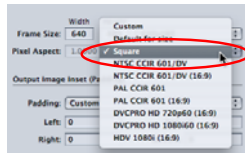
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## HD Source - You *Don't* Have to Change Aspect Ratio

- All HD videos have a 1:1 display aspect ratio
  - Should look **the same** on computer and TV
- You get into trouble when you try to match pixel aspect ratio with HD source
  - Always square



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## What is deinterlacing?

- About deinterlacing
- Why it's important

s/b 11:00

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## What is Deinterlacing (Take 2)?

- Most SD cameras capture interlaced video
  - 60 fields per second, not 30 frames
  - Fields are captured 1/60th of a second apart
- All streaming codecs are frame based
- Converting from fields to frames can cause a stair step or Venetian blind artifacts which deinterlacing can resolve

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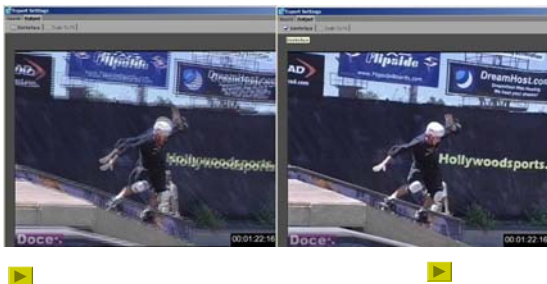
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## Deinterlacing – Why it's Important



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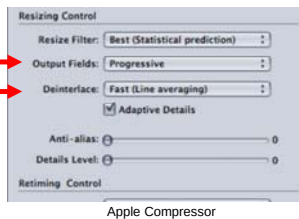
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## Deinterlacing - Rules of the Game

- Always deinterlace when producing with interlaced input
- Editors have different controls, but you may need to :
  - Select deinterlacing (and technique), AND
  - Output a progressive file



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## Deinterlacing - Rules of the Game



- Deinterlacing artifacts are easy to spot; once seen and recognized, you can resolve
- Obviously, don't de-interlace when working with progressive input

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## Encoding



- Terms and techniques
- Working with MPEG-4/H.264/AVC
- Working with Flash
- Working with Windows Media Video

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s/b 11:10

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## Terms and Techniques



- Bitrate control
  - Constant and variable bit rate encoding
- Working with key frames

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## Bitrate Control

- Techniques for achieving your target data rate
  - Constant bit rate encoding (CBR)
  - Variable bit rate encoding (VBR)

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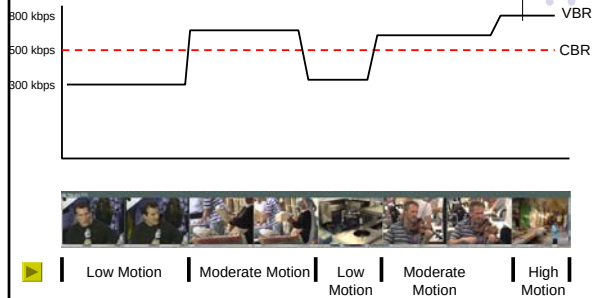
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## Constant vs Variable Bit Rate



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## Constant vs Variable Bit Rate

- Constant Bit Rate (CBR)
  - One bit rate applied to entire video, irrespective of content
  - Pros: Easy and fast
  - Cons: Doesn't optimize quality

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## Constant vs Variable Bit Rate

- Variable Bit Rate (VBR)
  - Dynamic bit rate matches motion in video
  - Pros: Best quality
  - Cons: Slow, can produce erratic stream

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## When Should I Use VBR/CBR?

- Consider VBR when:
  - Clips are longer than 60 seconds – too short, no difference
  - Producing for **progressive download**

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## When Should I Use VBR/CBR?

- Consider CBR when:
  - In a hurry (or live encoding)
  - Producing for **streaming** (as opposed to progressive download – to produce more consistent stream)
  - Restricted bandwidth delivery (e.g. cellular)

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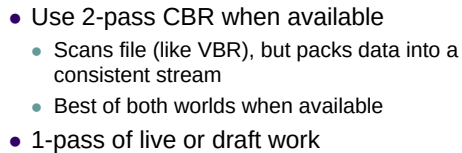
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- 
- Encoding Method
- Two pass VBR Constrained
- Quality = 100
- Smother ☒
- Bit rate: 1000 kbits/second
- Peak bit rate: 10000 kbits/second
- Minimum 2 Pass VBR Data Rate 50 Percent
- Maximum 2 Pass VBR Data Rate 200 Percent

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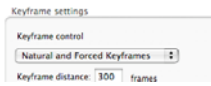


- 
- Frame type
- Display order

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## What do I Need to Know About Key Frames?

- Least efficient – so largest (which is bad)
- But, key frames enhance interactivity
  - All playback starts on a key frame
  - When seeking to random frame, must start playback at key frame
  - Maximum interval should be 5-10 seconds
- Key frames "reset" quality:
  - Useful at scene changes
  - Enable natural key frames or key frames at scene changes



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## What do I Need to Know About B Frames?

- The most "efficient" frame
  - So improves quality (comparisons to come)
- Hardest to decode
  - Decoder has to have all referenced frames in memory to decode B-frame
  - Frame usually delivered out of order, which also complicates playback

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## B-frames - Yes/No



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## B-frames - Yes/No

- Noticeable quality improvement
- 5-10% increase in decompression CPU load
- Recommend
  - Say "YES" to B-frames when available
  - 2-3 is a good number for real world video
  - Experiment with higher numbers with animations

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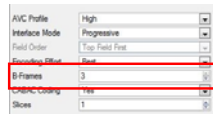
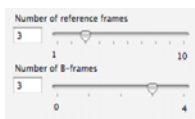
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## Typical B-Frame Encoding Parameters



- Number is number of B frames between I and P-Frames; (IBBBPBBBPBBBPBBBP)
  - 3 is recommended
- Reference frames
  - Number of frames searched for redundancies
  - 3 is recommended setting

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## Applicability

- Key frames
  - All codecs (H.264, VP6, WMV/VC-1)
- B-frames
  - H.264 Main/High profiles
  - VC-1 Advanced Profile

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## Codec Specific Controls

- H.264
- Flash
- Windows Media

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## What is H.264?

| ITU –<br>International<br>Telecommunications Union<br>Telephone, Radio, TV | ISO –<br>International Standardization<br>Organization<br>Photography, Computer,<br>Consumer Electronics |
|----------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| 1994 H.120                                                                 |                                                                                                          |
| 1999 H.261 – Video Conferencing                                            |                                                                                                          |
| 1993                                                                       | MPEG-1 – Video CD                                                                                        |
| 1994 (H.262)                                                               | MPEG-2 – Digital Cable and Satellite TV                                                                  |
| 1995 H.263 – Improved Video Conferencing                                   |                                                                                                          |
| 1997                                                                       | ATSC – U.S. HDTV                                                                                         |
| 1999                                                                       | MPEG-4                                                                                                   |
| 2002 AVC (H.264)                                                           | AVC (MPEG-4 Part 10)                                                                                     |

- Adapted by ISO and ITU
  - Telephony/cellular
  - TV - consumer electronics
  - Computer electronics
- Only codec adopted by top three streaming providers (Apple, Adobe, Microsoft)

Streamcrest Associates  
<http://www.streamcrest.com/SDF%20Final1.pdf>

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## What's H.264 Cost?

- For free Internet video (e.g. no subscription or pay per view), free until at least 2015
  - Still technically a licensing obligation, but there are no teeth and no motivation to enforce
- For subscription or PPV, there may be a royalty obligation
- Check [www.mpeg-la.com](http://www.mpeg-la.com)

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## What is an MP4 file (and what are the variants)?

- .MP4 - official MPEG-4 wrapper
- .M4V - Apple's variant for iTunes and devices
- .MOV - H.264 file for editing or QuickTime delivery
- .F4V - H.264 for Flash
- .3GP - (not shown) - phone
- .MPG - H.264 in MPEG-2 transport stream
- W4M? - will Microsoft create a new extension?

|              |                          |              |                         |                                                          |
|--------------|--------------------------|--------------|-------------------------|----------------------------------------------------------|
| File Format: | MPEG-4                   | Extension:   | mp4                     | <input checked="" type="checkbox"/> Allow Job Segmenting |
| File Format: | H.264 for Apple Devices  | Extension:   | m4v                     | <input checked="" type="checkbox"/> Allow Job Segmenting |
| File Format: | H.264 for DVD Studio Pro | Extension:   | mov                     | <input checked="" type="checkbox"/> Allow Job Segmenting |
| Screen Type: | F4V                      | Video Basis: | MPEG-2 Transport Stream |                                                          |
| Width:       | 1280                     | Height:      | 720                     |                                                          |
| Audio:       | Flash H.264 Stream       |              |                         |                                                          |

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## H.264 Encoding Targets

- Computers (Flash, QT, Silverlight)
- Devices
  - iPad – podcasts via iTunes
  - iPad – 3G/Wi-Fi
  - iPhone/iPod Touch/iPod – podcasts via iTunes
  - iPhone/iPod Touch/iPod – 3G/Wi-Fi

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## What's the Point?

- Typical encoding tool gives you several H.264 encoding options
  - Profile
  - B-Frames (covered)
  - Reference frames (not in Squeeze)
  - CABAC – yes/no

|                 |                 |
|-----------------|-----------------|
| AVC Profile     | High            |
| Interface Mode  | Progressive     |
| Field Order     | Top Field First |
| Encoding Effort | Best            |
| B-Frames        | 3               |
| CABAC Coding    | Yes             |
| Slices          | 1               |

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## Producing for Computers

- Parameters range from 320x240 to 1080p
- If switching from:
  - VP6 - better quality at same data rate
  - WMV/VC-1 much better quality at same data rate
- If switching, required CPU horsepower
  - Similar to VC-1/VP-6 with Flash Player 10.0
  - Flash Player 10.1 will use GPU for H.264 playback on Mac and Windows (so H.264 will be much more efficient than VP6)

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## H.264 Encoding - The Basics

| Video            | Computer | iPad     | iPhone/iPod Touch/ iPod 5G | iPod – earlier generations |
|------------------|----------|----------|----------------------------|----------------------------|
| Max resolution   | 1080p    | 720p     | 640x480                    | 320x240                    |
| Max data rate    | NA       | 14 mbps  | 2.5 mbps                   | 768 kbps                   |
| Profile          | High     | Main     | Baseline                   | Baseline                   |
| CABAC            | Yes      | Yes      | NA                         | NA                         |
| B-frame          | 3        | 3        | NA                         | NA                         |
| Reference frames | 3        | 3        | 3                          | 3                          |
| Audio            |          |          |                            |                            |
| Audio codec      | AAC-LC   | AAC-LC   | AAC-LC                     | AAC-LC                     |
| Data rate        | 160 kbps | 160 kbps | 160 kbps                   | 160 kbps                   |

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## H.264 Configurations for your Reference

|                     | Resolution | Profile | CABAC | Fps   | Video | Audio | B/P/F |
|---------------------|------------|---------|-------|-------|-------|-------|-------|
| CNN – embedded      | 416x236    | Main    | Yes   | 29.97 | 432   | 63    | 0.147 |
| Accuweather         | 480x270    | Main    | No    | 29.97 | 400   | 48    | 0.103 |
| CNN – video library | 640x360    | Main    | Yes   | 29.97 | 735   | 64    | 0.106 |
| Sports Illustrated  | 668x376    | Main    | Yes   | 29.97 | 1,098 | 63    | 0.146 |
| ABC - Castle        | 768x432    | Main    | No    | 23.97 | 602   | 128   | 0.076 |
| CNET - large        | 852x480    | BL      | NA    | 30    | 645   | 40    | 0.053 |
| GE – video library  | 480x268    | BL      | NA    | 29.97 | 452   | 64    | .117  |
| Apple – iPad small  | 640x360    | Main    | No    | 23.98 | 926   | 128   | .168  |
| Tiger Woods.com     | 640x360    | Main    | Yes   | 29.97 | 942   | 45    | .136  |
| YouTube – 720p      | 1280x720   | High    | Yes   | 29.97 | 2,242 | 123   | .081  |

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## Producing iPad Podcasts – Popular Show Configurations



|                                    | Width | Height | FPS   | Kb/s  | B/P/F | Profile | CABAC |
|------------------------------------|-------|--------|-------|-------|-------|---------|-------|
| Washington Post                    | 1280  | 720    | 24    | 4,947 | 0.224 | Main    | No    |
| NASA - Spirit of Mars              | 1280  | 720    | 29.97 | 4,612 | 0.167 | Main    | No    |
| Lost                               | 1280  | 720    | 29.97 | 4,135 | 0.150 | Main    | No    |
| Victorious                         | 1280  | 720    | 23.98 | 4,089 | 0.185 | Main    | No    |
| Inside Breaking Bad                | 1280  | 720    | 23.98 | 4,088 | 0.185 | Main    | No    |
| Damages: Willful Acts              | 1280  | 720    | 23.98 | 4,015 | 0.182 | Main    | No    |
| CNET                               | 1280  | 720    | 24    | 2,160 | 0.098 | BL      | No    |
| TekZilla – (mixed video/screencam) | 1280  | 720    | 23.98 | 1,463 | 0.066 | Main    | Yes   |
| Mac Break (mixed video/screencam)  | 960   | 540    | 23.98 | 549   | 0.044 | Main    | No    |

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## Best Practice – Device Wi-Fi/3G



- Use adaptive delivery
  - Multiple files
  - Adapts to connection speed of viewer
- Benefits
  - Rewards high bitrate customer
  - Continues to serve low bit rate viewer
- Only technology available is Apple's HTTP Live Streaming
  - If delivering to Apple devices, you NEED to check this out

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## If not using Adaptive



- Either deliver very small file
- Or let viewer choose which to view

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## Recommended Encoding Parameters – WiFi/3G



| Encoding Parameters | Reasonable Quality Wi-Fi Only | Lowest Common Denominator (iPhone/iPad) – 3G |
|---------------------|-------------------------------|----------------------------------------------|
| <b>Video</b>        |                               |                                              |
| Resolution          | 640x360                       | 400x224                                      |
| Frame rate          | 29.97                         | 15 (assuming 30 fps source)                  |
| Profile/Level       | Main/3.1                      | Baseline, 3.0                                |
| VBR/CBR             | CBR                           | CBR                                          |
| CABAC/CAVLC         | CABAC                         | NA                                           |
| Video data rate     | 600 kbps                      | 200 kbps                                     |
| Key frame interval  | 3 seconds (90 frames)         | 3 seconds (45 frames)                        |
| B-frame interval    | 1                             | NA                                           |
| Reference frames    | 2                             | NA                                           |

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## Recommended Encoding Parameters – Single File Delivery



| Audio       | Reasonable Quality | Lowest Common Denominator |
|-------------|--------------------|---------------------------|
| Codec       | AAC-LC             | AAC-LC                    |
| Data rate   | 40 kbps            | 40 kbps                   |
| Channels    | Mono               | Mono                      |
| Sample rate | 22.05              | 22.05                     |
| VBR/CBR     | CBR                | CBR                       |

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## Recommended Encoding Parameters – iPod/iPod Touch/iPhone - Podcast



| Device             | Old iPods                     | iPod 5G/iPhone/iTouch         |
|--------------------|-------------------------------|-------------------------------|
| Resolution         | 320x240                       | 640x480                       |
| <b>Video codec</b> | H.264 codec, Baseline profile | H.264 codec, Baseline profile |
| Data rate          | 768,000/CBR                   | 1,120,000/CBR                 |
| Key frames         | 150 - 300                     | 150 - 300                     |
| Frame rate         | match source                  | match source                  |
| <b>Audio</b>       | AAC Low                       | AAC Low                       |
| Data rate          | 128 kbps/stereo               | 128 kbps/stereo               |
| Extension          | .m4a                          | .m4a                          |

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## Encoding H.264



- Quality
  - If the data rate is high enough, all encoders produce similar quality
  - If you're pushing for optimum quality, avoid Apple Compressor

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## Encoding H.264 – Mac Performance



|               | Squeeze 5 | Apple Comprs | AME - CS4 | Episode 5.3 | Squeeze 6 |
|---------------|-----------|--------------|-----------|-------------|-----------|
| Speed ranking | 3         | 2            | 1         | 5           | 4         |
| 1 file        | 1:47      | 1:19         | :31       | 2:39        | 3:18      |
| 8 files       | 5:30      | 4:10         | 4:08      | 21:12       | 10:40     |

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## Encoding H.264 – Windows Performance



|               | Squeeze 5 | AME- CS4 | Episode 5.3 | Expression Encoder | Squeeze 6 |
|---------------|-----------|----------|-------------|--------------------|-----------|
| Speed ranking | 2         | 1        | 5           | 4                  | 3         |
| 1 file        | 1:15      | :29      | 2:24        | 2:20               | 2:08      |
| 8 files       | 7:06      | 3:52     | 19:12       | 13:45              | 9:44      |

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## What Do I Need to Know About VP6?



- What do I need to know about producing VP6?
- What's the best Flash Encoder?
  - Quality
  - Speed

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## Overview – the FLV



- FLV – Flash video file
  - VP6/Spark video codec
    - Can also be H.264, but moving towards F4V extension
  - MP3 audio
- Not accelerated by GPU in Flash Player 10.1
  - Will require substantially more CPU horsepower to decode on supported hardware

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## Which Codec?



- Sorenson Spark or On2 VP6?



- Always use On2 VP6
  - Much better quality
  - Universal compatibility

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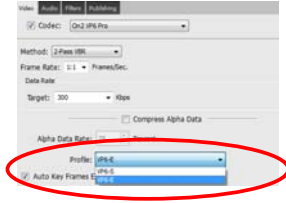
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## VP6-E and VP6-S

- What's the quality difference?
- What's the difference in playback?



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## VP6-E and VP6-S

- Quality difference is real, but not substantial
- Playback difference on some computers can be significant
  - Use VP6-S for HD video > 640x480
  - Use VP6-E for SD video
- If your encoder doesn't offer both options, it's VP6-E

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## VP6 Configurations for your Reference

| Site                         | Width | Height | Frame Rate | Video kbps | B/P/F |
|------------------------------|-------|--------|------------|------------|-------|
| Forbes                       | 480   | 270    | 29.97      | 652        | 0.168 |
| NY Times - in library        | 504   | 284    | 29.97      | 650        | 0.152 |
| Wall Street Journal - inline | 512   | 288    | 24         | 438        | 0.124 |
| Weather Channel              | 468   | 350    | 15         | 800        | 0.326 |
| ABC News                     | 480   | 360    | 30         | 404        | 0.078 |
| E-Online                     | 480   | 360    | 30         | 900        | 0.174 |
| The Street                   | 480   | 360    | 30         | 900        | 0.174 |
| ESPN                         | 576   | 324    | 24         | 774        | 0.173 |
| Fortune                      | 576   | 324    | 29.95      | 500        | 0.089 |

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## Producing VP6



- Very little difference in VP6 encoding quality among all encoding tools
  - Speed is the most important differentiator

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## Encoding VP6 – Mac Performance



|               | Squeeze 5 | Apple Cmpr | AME - CS4 | Episode 5.3 | Squeeze 6 |
|---------------|-----------|------------|-----------|-------------|-----------|
| Speed ranking | 3         |            | 4         | 2           | 1         |
| 1 file        | 29:15     | NA         | 17:40     | 3:49        | 6:00      |
| 8 files       | 41:02     | NA         | 2:21:20   | 30:32       | 8:23      |

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## Encoding VP6 – Windows Performance



|               | Squeeze 5 | AME- CS4 | Episode 5.3 | Expression Encoder | Squeeze 6 |
|---------------|-----------|----------|-------------|--------------------|-----------|
| Speed ranking | 2         | 4        | 3           |                    | 1         |
| 1 file        | 6:20      | 4:23     | 4:10        | NA                 | 3:54      |
| 8 files       | 7:05      | 35:02    | 33:22       | NA                 | 5:31      |

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## What Do I Need to Know About Windows Media?



- What's VC-1 and how does it relate to WMV9?
- What are the relevant Windows Media profiles (and do I care)?
- Configurations for reference
- Producing WMV

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## What's VC1 and How Does it Relate to WMV9?



- From the mouth of Ben Waggoner, MSFT
  - "VC-1 is SMPTE's version of WMV 9. Windows Media Video 9 is Microsoft's brand for our VC-1 implementation."
  - "Basically, just think of "WMV 9" and "VC-1" in a WMV file as synonymous."
- After installing WMF SDK 11
  - Windows Media Encoder *still* calls the codecs WMV 9
  - Silverlight Expression Encoder calls the same codecs VC-1
  - Both create WMV files

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## What are the Windows Media Profiles?



- Now two profiles
  - Main - backwards compatible, no codec update required
  - Advanced Profile
    - Supports interlaced video (for Blu-ray)
    - No real quality difference, not compatible with older WMV players (I use Main)

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## WMV Configurations for your Reference



| Site                | Width | Height | Frame Rate | Video kbps | B/P/F |
|---------------------|-------|--------|------------|------------|-------|
| Microsoft main site | 628   | 356    | 23.97      | 500        | 0.093 |
| Zune preview site   | 640   | 360    | 23.97      | 1,096      | 0.181 |

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## Which WMV Encoder is Best?



- Quality
  - Relatively uniform, except for Telestream Episode
    - Drops frames during high motion sequences at low data rates (other encoders don't)
- Features
  - Microsoft Expression Encoder provides many more encoding options
    - Valid only for advanced users
- Speed

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## Encoding VC-1 – Mac Performance



|                      | Squeeze 5 | Apple Cmpr | AME - CS4 | Episode 5.3 | Squeeze 6 |
|----------------------|-----------|------------|-----------|-------------|-----------|
| <b>Speed ranking</b> | <b>2</b>  |            |           | <b>3</b>    | <b>1</b>  |
| 1 file               | 58        | NA         | NA        | 4:37        | 50        |
| 8 files              | 7:46      | NA         | NA        | 32:32       | 1:41      |

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## Encoding VC-1 – Windows Performance



|            | Squeeze<br>5 | AME-<br>CS4 | Episode<br>5.3 | Expressio<br>n Encoder | Squeeze<br>6 |
|------------|--------------|-------------|----------------|------------------------|--------------|
| <b>WMV</b> | <b>2</b>     | <b>4</b>    | <b>5</b>       | <b>3</b>               | <b>1</b>     |
| 1 file     | 1:42         | 1:26        | 2:28           | 1:13                   | 1:09         |
| 8 files    | 4:20         | 11:26       | 19:45          | 5:20                   | 3:22         |

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## Questions?



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