# EXHIBIT 17

**IN THE UNITED STATES DISTRICT COURT**
**FOR THE DISTRICT OF DELAWARE**

| | |
|---|---|
| U.S. PHILIPS CORPORATION,<br><br>Plaintiff,<br>v.<br><br>EASTMAN KODAK COMPANY<br><br>Defendant. | Civil Action No. 06-00251-GMS |

# DECLARATION OF PROFESSOR BERND GIROD

# IN SUPPORT OF U.S. PHILIPS CORPORATION'S RESPONSIVE *MARKMAN* BRIEF

October 30, 2007

I, Bernd Girod, declare:

1. I submit this declaration in support of U.S. Philips Corporation's ("Philips") Responsive *Markman* Brief.

## A. SCOPE OF THIS DECLARATION

2. I have been asked by counsel for U.S. Philips Corporation to read US Patent No. 4,901,075 (the Vogel Patent), its prosecution history, and the cited prior art and provide my opinion how certain claim elements would have been understood by a person of ordinary skill in the art at the time of the invention. In particular, I have been asked to consider the October 8, 2007 declaration of Dr. Touradj Ebrahimi in support of Kodak's opening claim construction brief (the Ebrahimi Declaration) and provide my opinion on Dr. Ebrahimi's interpretation of the claim terms and phrases "video signal," "signal," "for transmission at a reduced bit rate," "for transmission at a reduced bandwidth" and "Huffman codeword."

## B. QUALIFICATIONS

3. I am a tenured Full Professor of Electrical Engineering at Stanford University, California, USA, and director of the Stanford Center for Image Systems Engineering. My teaching includes graduate-level courses in image compression and digital image processing.

4. I have more than 25 years experience in the area of image compression. During that time, I have authored or co-authored over 400 scientific publications, including 5 books, the majority of them related to image compression. I am inventor of over 20 patents, with several others pending. Again, most of my patents are related to image compression. I was elected Fellow of the IEEE in 1998, received the Technical Achievement Award of the European Signal Processing Society EURASIP in 2004, and was elected Member of the German Academy of Sciences in 2007.

5. I have been trained as an electrical engineer, with a Master of Science degree in Electrical Engineering from Georgia Institute of Technology, Atlanta, GA, USA, awarded in 1980, and a doctorate in Electrical Engineering from the University of Hannover, Germany, in 1987.

## C. HYPOTHETICAL PERSON OF THE ORDINARY SKILL IN THE ART

6. In my opinion, at the time of the invention of the Vogel Patent, a person of ordinary skill in the art had at least a Bachelor of Science degree in electrical engineering and at least two to three years of experience working as an engineer in the field of image coding.

## D. CLAIM ELEMENTS

### D.1 "Signal"

7. In my opinion, a person of ordinary skill in the art would have understood the claim term "signal" of the Vogel Patent to mean "a sequence or array of values representing information." This is the plain meaning of the term in the field of digital signal processing, which image coding belongs to.

8. The Ebrahimi Declaration equates "signal" and "video signal" and concludes that a person of ordinary skill in the art would have understood that the "signal" of Claim 8 must refer "to the same type of video signal as disclosed in the Chen 1984 article." (Ebrahimi Declaration, no. 25). I disagree.

9. In the Vogel Patent, the word "signal" does not only refer to video signals; it is also used to refer to sequences or arrays of values that are not video signals. In the following example, "signal" generically refers to a sequence of signal values:

> *Bit rate reduction is carried out when coding a **signal**, which comprises a series of digital **signal** values and has a **signal** value A, occurring most frequently in runs.* (Vogel Patent, col. 1: 7-10, emphasis added)

10. In the second example, "signal" refers to the coefficients that result from transforming a block of pixels:

> *The **signal** values of the intermediate **signal** thus represent the transform coefficients*. (Vogel Patent, col. 2: 25-25, emphasis added)

11. In the third example, signal refers to a special indicator that separates one block from another:

> *As it is not known in advance into how many codable events a coefficient block is split, the separate blocks must for this reason already be separated from one another by means of an "end-of-block"* ***signal***. (Vogel Patent, col. 5:22-26 emphasis added)

12. The fourth example is the preamble of Claim 3, where one instance of signal refers to a sequence of transform coefficients, as in the second example above, while another instance refers to a video signal.

> *In a method of coding a* ***signal*** *comprising a sequence of coefficients which results after a blockwise transform of pixels of a video* ***signal*** *with subsequent quantization, for transmission at a reduced bit rate, said signal comprising a plurality of zero coefficients, and a plurality of non-zero coefficients said method comprising the steps of [. . .]* (Vogel Patent, col. 5:22-26 emphasis added)

Clearly, the claim language distinguishes between a "video signal" and a "signal comprising a sequence of coefficients," which would not have been understood by one skilled in the art as a video signal.

13. Overall, the word "signal" appears in the Vogel Patent over 50 times. All these instances show that in the Vogel Patent the term "signal" has a broader meaning than just "video signal." It is improper to equate the two, as suggested by Dr. Ebrahimi. There is nothing in the Vogel Patent that would support his conclusion. The plain meaning of "signal" in the field of digital signal processing, i.e., "a sequence or array of values representing information," is entirely consistent with the usage of "signal" throughout the Vogel Patent.

## D.2 "Video Signal"

14. In my opinion, a person of ordinary skill in the art would have understood the claim term "video signal" of the Vogel Patent to mean "a sequence or array of values representing visual information." This understanding would necessarily result from the usage of the term in the Vogel Patent, its prosecution history, and the cited prior art. It is consistent with the understanding of the broader term "signal" by one of skill in the art.

15. The Ebrahimi Declaration unduly limits the definition of video signals to "values corresponding to sequential and interdependent moving images that when rapidly displayed are capable of depicting movement" (Ebrahimi Declaration, no. 12). It further asserts that "there is

nothing in the '075 patent that discloses encoding of anything other than video signals." Therefore, it argues, a person of ordinary skill would have understood that "video signal" in Claim 3 and "signal" in Claim 8 exclude still images. I disagree.

16. The Vogel Patent illustrates the advantages of its invention for coding of individual pictures. Such individual pictures are compressed by using transform coding, typically by employing a two-dimensional DCT (Discrete Cosine Transform) that is applied to square image blocks. It was well known to a person of ordinary skill at the time of the invention that a primary application of such a technique is the compression of still images. It was also well known to a person of ordinary skill that one could use such a technique to compress moving images, by treating individual pictures in an image sequence as still pictures and compressing them independently. When the Vogel Patent refers to a "video signal" it clearly contemplates both applications, hence a video signal would have been understood by a person of ordinary skill as a signal that represents visual information, including still images.

17. To justify its narrow definition of the term "video signal," the Ebrahimi Declaration relies heavily on the article by Chen and Pratt[1], published in 1984 and cited by the Vogel Patent as prior art. However, like the Vogel Patent, Chen and Pratt discuss coding of individual pictures. Like in the Vogel Patent, individual pictures are compressed using a two-dimensional transform that is applied to square image blocks. Application to still picture compression is clearly contemplated, as well as the application to color television transmission by treating individual pictures in an image sequence as still pictures and compressing them independently. For example, the Abstract states:

> *Excellent results are demonstrated for coding of color images at 0.4 bits/pixel corresponding to real-time color television transmission over a 1.5 Mbit/s channel.* (Chen and Pratt, Abstract)

This sentence summarizes Chen and Pratt well; all that the article describes is "coding of color images," i.e., still pictures. The results merely correspond to television transmission over a 1.5Mbit/s channel. In the body of the article, Chen and Pratt provide more details that confirm this understanding:

[1] W-H. Chen and W. K. Pratt, "Scene-Adaptive Coder," IEEE Transactions on Communications, vol. Com-32, no. 3, pp. 225-232, March 1984.

> *The original test images shown in Figs. 8(a) and 9(a) are of size 512 X 512 pixels with each red, green, and blue tristimulus value uniformly quantized to 8 bits/pixel. Figs. 8(b) and 9(b) show the reconstructed images at a combined average bit rate of 0.4 bits/pixel. This rate corresponds to a channel bandwidth of 1.5 Mbits for a 15 frame/s intraframe coding system. The excellent reconstruction of the images is clearly demonstrated.* (Chen and Pratt, Section V. Simulation Results)

18. Clearly, Chen and Pratt compress still images, comprising 512x512 arrays of red, green, and blue pixel values. A person of ordinary skill would have recognized the test image called *"Girl"* in Figure 8 of their article as the *Lena* image, the most famous test image in the history of digital image processing research[2]. The following is an excerpt of a 2001 article in the IEEE Professional Communication Newsletter[3] that is dedicated entirely to its history and its origin:

> *Alexander Sawchuk estimates that it was in June or July of 1973 when he, then an assistant professor of electrical engineering at the University of Southern California Signal and Image Processing Institute (SIPI), along with a graduate student and the SIPI lab manager, was hurriedly searching the lab for a good image to scan for a colleague's conference paper. They got tired of their stock of usual test images, dull stuff dating back to television standards work in the early 1960s. They wanted something glossy to ensure good output dynamic range, and they wanted a human face. Just then, somebody happened to walk in with a recent issue of Playboy.*
>
> *The engineers tore away the top third of the centerfold so they could wrap it around the drum of their Muirhead wirephoto scanner, which they had outfitted with analog-to-digital converters (one each for the red, green, and blue channels) and a Hewlett Packard 2100 minicomputer. The Muirhead had a fixed resolution of 100 lines per inch and the engineers wanted a 512 × 512 image, so they limited the scan to the top 5.12 inches of the picture, effectively cropping it at the subject's shoulders.*

19. Accordingly, the *"Girl"* image of Chen and Pratt was obtained by scanning a photograph printed in a magazine with a wirephoto scanner. The origin of this particular test image was well known to a person skilled in the art. The above account undeniably confirms that the Chen and Pratt experiments were performed with still images.

---

[2] http://en.wikipedia.org/wiki/Lenna

[3] Jamie Hutchison, "Culture, Communication, and an Information Age Madonna," *IEEE Personal Communication Society Newsletter* Vol. 45, No. 3, May/June 2001.

20. Chen and Pratt discuss color television transmission over a 1.5 Mbit/s channel as another possible application of their still image coding results of 0.4 bits/pixel.[4] The applicability to color television transmission, however, does not change the fact that Chen and Pratt only describe a method for still image compression and that they only report experimental results obtained with still images (e.g., the *Lena* image discussed above). A person of ordinary skill would therefore not think that Chen and Pratt is "directed solely to the encoding of video signals; that is, encoding of a sequence of values corresponding to sequential and interdependent moving images that when rapidly displayed are capable of depicting movement," as the Ebrahimi Declaration asserts in obvious contradiction to the article itself.

21. In turning to the Vogel Patent, the Ebrahimi Declaration develops a theory that

> *"there is a significant technical reason that a person of ordinary skill would believe the '075 Patent is restricted to coding of video. The patent expressly states that "coefficients having values of more than 136 do not occur." ('075 Patent, col. 4, ll. 49-54.) To a person of ordinary skill in the art, this statement makes it very clear that the patent is limited to coding video signals. Using 136 values is reasonable for video signals. But only 136 coefficient values is* [sic] *inappropriate for still image compression. For example, the JPEG standard which Philips is accusing of infringement in this case allows for coefficient values greater than one thousand. A person of ordinary skill would not expect to be limited to only 136 values for encoding still images."* (Ebrahimi Declaration, no. 18).

22. Dr. Ebrahimi continues to explain that 136 values would not provide sufficient quality for still images, but they would be sufficient for video since "video had a much lower resolution and quality than still images" (Ebrahimi Declaration, no. 19). I disagree; this theory is flawed for several reasons.

23. The Ebrahimi Declaration appears to confuse unquantized transform coefficients and quantized transform coefficient. The unquantized transform coefficients, for an 8x8 DCT and pixel values ranging between 0 and 255, are real numbers that fall within the range of +/-1024[5].

[4] A person of ordinary skill would have understood that Chen and Pratt refer to a T-1 line with 1.544 Mbit/s, a dedicated phone connection widely used by businesses in the US at the time. NTSC color television standardizes 480 active lines per frame, and 30 frames per second. Chen and Pratt propose to slow down the frame rate to 15 frames per seconds. With 512 samples for the active portion of a line and a bit-rate of 0.4 bits/pixel, one would require: *0.4 bits/pixel x 512 pixels/line x 480 lines/frame x 15 frames/second = 1.475 Mbit/s*

[5] With the exception of the dc coefficient that falls within the positive range between 0 and 2048.

Apparently, Dr. Ebrahimi refers to this coefficient range when he observes that "the JPEG standard […] allows for coefficient values greater than one thousand." The quantized coefficients, however, are integers with a much smaller range. The number of different magnitude values depends on the quantizer step-size. For example, with a relatively fine quantizer step-size of 8, the number of magnitude values is 1024/8=128. With a quantizer step-size coarser than 8, fewer than 128 magnitude values would result. Note that for the embodiment described in the Vogel Patent the unquantized transform coefficients also fall within the range of +/-1024. The at most 136 different magnitude values of the embodiment refer to the quantized transform coefficients.[6]



Fig. 1: Left: Original 512x512 *Lena* image; Right: *Lena* image after quantizing the transform coefficients to 128 magnitude values; both images are almost indistinguishable.

24. The Ebrahimi Declaration apparently asserts that still images compressed with an 8x8 DCT and a quantization step-size of 8 (corresponding to less than 136 different quantized coefficient magnitude values) would be of insufficient quality. This is certainly inconsistent with the JPEG Standard, on which Dr. Ebrahimi relies. For example, Annex K "Examples and guidelines" of the JPEG Standard in Tables K.1 and K.2 suggest "quantization values [which] have been used with good results on 8-bit per sample luminance and chrominance images …" Each suggested quantizer step-size is larger than 8, therefore fewer than 128 magnitude values

[6] In Chen and Pratt, a larger block size of 16x16 is used for the DCT. This results in unquantized DCT coefficients that fall in a larger range +/-2048. Their example Huffman code table implies 256 magnitude values (Chen and Pratt, Table I), corresponding to a quantizer step size of 2048/256 = 8, corresponding closely to the quantizer used in the embodiment of the Vogel Patent. Like the images in Fig. 1 of this declaration, the original and coded images in Fig. 8 and 9 of Chen and Pratt are almost indistinguishable.

would result. To further illustrate this point, Figure 1 shows the *Lena* test image compressed with a stepsize of 8, i.e., with 128 magnitude values on the right. It is compared with the original image, shown on the left. The two images are almost indistinguishable. Unlike Dr. Ebrahimi's assertion, the picture quality is clearly not "inappropriate for still image compression" (Ebrahimi Declaration, no. 18).

25. Quantization errors are more visible when coding pictures at a lower resolution (i.e., with fewer pixels in a picture). Therefore, at a lower resolution, one would need finer quantization, i.e., more "values," for the same quality, and not fewer values, as the Ebrahimi Declaration suggests.

26. My analysis above shows that the "136-value theory" of the Ebrahimi Declaration is entirely unfounded. Unquantized and quantized transform coefficient must be carefully distinguished. The range of the unquantized coefficients is only a function of the range of pixel values and the transform block size. The range of the quantized transform coefficients also depends on the chosen quantizer step-size. A coarser quantizer results in fewer magnitude values, a lower bit-rate, and a lower image quality. A finer quantizer results in more magnitude values, a higher bit-rate, and a better image quality. A person of ordinary skill would have known that the number of different encoded magnitude values can be varied in a wide range and adapted to the appropriate trade-off between bit-rate and image quality of a particular application. A person of ordinary skill would also have known that this is the case both for still image compression and for intraframe compression of sequences of moving images, and that there is no general rule that one should be quantized with more values than the other.

27. The Ebrahimi Declaration further argues that

> *"coding of video signals typically processes only the differences between successive frames. [. . .] Only these differences would be encoded, and to the extent there were small changes from one video frame to the next, many would be zero or whole numbers close to zero. Accordingly, only a small range of values was necessary to encode video signals. This further supports that the understanding of a person of skill in the art at that time that a system limited to 136 coefficient values would have been appropriate for coding video signals."* (Ebrahimi Declaration, no. 21).

I disagree. A person of ordinary skill would, in fact, recognize that this theory is also severely flawed for at least two reasons:

- Neither the Vogel Patent, nor Chen and Pratt, mention coding of frame differences anywhere. Both expressly only perform compression of individual pictures.

- If one were to encode the frame-to-frame difference, the range of values is doubled. For example, if the original image had values between 0 and 255, the frame difference signal could have values between -255 and +255. Correspondingly, the range of both unquantized and quantized transform coefficients is also doubled, and twice as many values would have to be provided by the system. Therefore, the Ebrahimi Declaration is incorrect to assert that "only a small range of values was necessary to encode video signals."

28. In summary, the theories put forward by the Ebrahimi Declaration in order to narrow the definition of "video signal" and exclude still image coding from the scope of the Vogel Patent have serious technical flaws that a person of ordinary skill in the art at the time of the invention would have recognized. A person of ordinary skill would have understood that the specification of the Vogel Patent describes a still image coding system, which could be applied in many contexts, including intraframe coding of moving images. Accordingly, the claim element "video signal" would have been understood to mean "a sequence or an array of values representing visual information."

## D.3 "For Transmission at a Reduced Bit Rate" (Claim 3)

29. A person of ordinary skill in the art at the time of the invention would have understood "for transmission at a reduced bit rate" to plainly mean "for transmission with fewer bits per pixel." Since the Vogel Patent specification discusses primarily still image coding, bits per pixel is the natural measure of bit-rate. This also corresponds to the usage of the term "bit rate" in Chen and Pratt reporting, e.g., "coding of color images at 0.4 bits/pixel" (Chen and Pratt, Abstract) or "a combined average bit rate of 0.4 bits/pixel" (Chen and Pratt, Section V. Simulation Results). The term "reduced" would have been understood by a person of ordinary skill as relative to a system without compression, which would require typically 8 bits per pixel (or possibly 3x8 bits for a color pixel with a red, green, and blue values). This corresponds to the

common use of the term "bit-rate reduction" in the art, as well as its use in the title of the Vogel Patent ("Method and Apparatus for Bit Rate Reduction") and in its specification.

30. The Ebrahimi Declaration asserts that the phrase "for transmission at a reduced bit rate" is ambiguous and would not have been understood by a person skilled in the art. I disagree. As explained above, a person skilled in the art have would have understood the phrase to mean "for transmission with fewer bits per pixel," where the "reduced bit rate" or "fewer bits per pixel" are relative to a system that does not use compression.

31. The Ebrahimi Declaration alternately asserts that the claim language "should be construed as a 12% reduction as compared to the Chen Method." (Ebrahimi Declaration, no. 36). I disagree. Again, a person skilled in the art would have understood the bit-rate reduction to be relative to a system without compression. A person skilled in the art would have further understood that the 12% figure reported in the patent specification depends on several experimental parameters, including the contents of images encoded, the spatial sampling density, and the quality of the image acquisition device. In other words, depending on the image being compressed, the improvement relative to Chen and Pratt could be larger, or it could be smaller, than 12%. It would therefore be unreasonable to peg the meaning of claim language to this number, as suggested in the Ebrahimi Declaration.

## D.4 "For Transmission at a Reduced Bandwidth" (Claim 8)

32. A person of ordinary skill in the art at the time of the invention would have understood "for transmission at a reduced bandwidth" in the context of the Vogel Patent to be synonymous with "for transmission at a reduced bit rate." As discussed above, it plainly means "for transmission with fewer bits per pixel."

33. The Ebrahimi Declaration defines "bandwidth" as "the actual space in a frequency spectrum through which data is sent." I disagree. The suggested definition is not correct in the context of the Vogel Patent. The Ebrahimi Declaration overlooks that the term "bandwidth" is also commonly used to refer to the capacity for data transfer of an electronic communication system (*e.g.*, graphics consume more *bandwidth* than text does).[7] This usage, which does not

[7] This definition is provided, for example, at http://mw1.merriam-webster.com/dictionary/bandwidth.

relate to space in a frequency spectrum, was familiar to a person of ordinary skill at the time of the invention. Chen and Pratt themselves provide an example of this usage:

> *An efficient single-pass adaptive bandwidth compression technique using the discrete cosine transform is described. [. . . ] Excellent results are demonstrated for coding of color images at 0.4 bits/pixel.* (Chen and Pratt, Abstract, emphasis added.)

34. Clearly, "bandwidth compression" here means bit-rate reduction, and the results of that bandwidth compression are measured in bits/pixel. Chen and Pratt make no reference to frequency spectrum anywhere in their article. Similarly, the Vogel Patent makes no reference to frequency spectrum anywhere. Therefore both "for transmission at a reduced bit rate" and "for transmission at a reduced bandwidth" would have been understood to mean "for transmission with fewer bits per pixel."

## D.5 "Huffman Codeword"

35. Huffman codes are *instantaneous* codes, i.e., each input value or symbol is represented by a binary code word. These code words can be of different lengths (i.e., contain different number of bits), but a bit-stream of concatenated code words can nevertheless be decoded unambiguously, since no code word is the prefix of any other code word. A code with this property is known in the art as a *prefix code*[8]. Huffman codes describe frequently occurring values efficiently, i.e., with few bits. Values that occur infrequently, on the other hand, require more bits. On average, the bit-rate is reduced.

36. Huffman's seminal work in 1952[9] showed how to construct a code book for an instantaneous variable-length prefix code in such a way that it minimizes the average code word length by exploiting the distribution of symbols probabilities. It improved previously suggested methods to construct such code books, such as the Shannon-Fano method. Since Huffman's method is optimal and widely used, the term "Huffman coding" has become synonymous with variable-length coding with an instantaneous prefix code which takes advantage of different

[8] More accurately, a prefix code is referred to as a prefix-free code.
[9] D. A. Huffman, "A method for the construction of minimum redundancy codes," Proc. IRE, vol. 40, pp. 251-252, Sept. 1952.

symbol probabilities, even if the method that was used to construct the code book is not strictly Huffman's method.

37. A person of ordinary skill in the art would understand that, to incorporate practical constraints, Huffman code books are often constructed by techniques that are modifications or extensions of Huffman's original method. For complexity reduction, it is common to limit the maximum code word length or require that subsets of code words have the same length[10]. Instantaneous variable-length prefix coders that incorporate such practical constraints are still referred to as "Huffman coders," and their code words as "Huffman code words." While such Huffman coders are no longer optimal in the strict mathematical sense, they nevertheless strive to minimize the average code word length.

38. A person of ordinary skill in the art would understand that, in the context of image coding, the probability distribution needed for Huffman code construction would usually be obtained by measuring the probabilities for a representative set of images. A person of ordinary skill would also understand that, alternatively, an analytical model for the probability distribution could be used. A person of ordinary skill would further understand that, as a further alternative, the distribution measured for the specific image to be coded could be used, but that this approach has some practical drawbacks. In particular, both encoder and decoder would have to be endowed with the capability to construct Huffman codes on the fly, and the overhead required to transmit the code table would increase the bit-rate. A person of ordinary skill would have known that, for these reasons, a Huffman code construction based on the distribution measured for the specific image to be coded was rarely used.

39. The Ebrahimi Declaration characterizes a Huffman code word as "a variable-length code word […] where the code word is shorter for more frequently occurring events and longer for less frequently occurring events" (Ebrahimi Declaration, no. 39). This characterization fails to acknowledge that Huffman coding strives to minimize the average code word length with respect to a given probability distribution. Moreover, the characterization is imprecise, since it appears to exclude the use of code words of equal length for events with different probabilities. Proper

[10] An example is the table in Figure 3 of the Vogel Patent, where Code Words 61 – 87 are made the same length of 16 bits.

Huffman code construction, however, often results in code words of equal length for events with different probabilities.

40. Therefore, it is my opinion that a person of ordinary skill in the art would understand the term "Huffman codeword" of the Vogel Patent to mean "a sequence of bits assigned to represent a particular event or events in accordance with a predefined set of rules with the following characteristics: a) the code words may be of different lengths; b) no code word is a prefix of another code word; c) the predefined set of rules strives to minimize the average code word length by exploiting the distribution of event probabilities."

## E. SIGNATURE

41. I declare under penalty of perjury under the laws of the United States of America and the State of Delaware that the foregoing is true and correct. Executed this 30th day of October, 2007, at Stanford, California.

October 30, 2007
Stanford, California



Bernd Girod