IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of:	Al-Ali et al.	
U.S. Patent No.:	8,190,223	Attorney Docket No. 50095-0132IP2
Issue Date:	May 29, 2012	
Appl. Serial No.:	11/367,033	
Filing Date:	Mar. 1, 2006	
Title:	NONINVASIVE MULTI-PARAMETER PATIENT MONITOR	

DECLARATION OF DR. ANDREW COCKBURN

I currently hold the opinions set expressed in this declaration. But my analysis may continue, and I may acquire additional information and/or attain supplemental insights that may result in added observations.

I hereby declare that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true. I further declare that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of the Title 18 of the United States Code.

Dated: 12th December, 2023 By:

Andrew Cockburn

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I. QUALIFICATIONS AND BACKGROUND INFORMATION

1. My education and experience are described more fully in the attached curriculum vitae (Appendix 1). I am a Professor at the Department of Computer Science and Software Engineering at the University of Canterbury, New Zealand. I also currently head the HCI (Human-Computer Interaction) and Multi-Media research group at the University of Canterbury.

2. In 1988, I was awarded a Bachelor of Science with Honors in Computer Science from the University of York, England.

3. In 1993, I was awarded a Ph.D. from the University of Stirling, Scotland. My thesis was on "Computer Supported Cooperative Work" which relates to forms of group interaction supported on computers.

4. In 1993, I joined the University of Canterbury as a Lecturer in the Department of Computer Science (now the Department of Computer Science and Software Engineering). I was subsequently promoted to a Senior Lecturer, and then an Associate Professor, before my appointment as a Professor in 2010. I currently hold the title of Professor.

5. I have over 30 years of experience in the area of HCI. The field of HCI is generally concerned with ways of understanding and improving the interaction between humans and computers, with a view to understanding, evaluating, designing, and building new styles of interactions that improve on one

or more of the end goals of making computers faster to learn, more intuitive, more efficient to use, and more subjectively satisfying.

6. Throughout my career, I have published the results of many research projects that have involved building new user interfaces or reviewing existing user interfaces for performing a particular task, and evaluating their effectiveness. This includes publications relating to:

(a) investigating user experiences with web navigation interfaces, for example when using the "back" button on web browsers;

(b) reviewing and improving various interface schemes for traversing through documents in computer applications, including zooming, scrolling, and other techniques;

(c) analyzing new interfaces for text entry on mobile and touch-sensitive devices;

(d) addressing the problems arising from the small form factor of mobile devices with touch-sensitive displays, including wearable technologies;

(e) examining the influence of haptic feedback on user performance with mouse and touchscreen input devices;

(f) evaluating the importance of spatially stable displays in user interfaces; and

(g) designing, analyzing and evaluating gesture-based input techniques for various user activities, including music data entry, web navigation, text entry, and scrolling.

7. I also have extensive experience in designing and building new user interfaces and reviewing existing user interfaces. This includes a number of projects regarding the design, development and evaluation of user interfaces that I have undertaken with companies in the computing and HCI industry, such as:

(a) working with Airbus SAS in 2016 on methods to assist pilots' gesture-based interaction with touchscreens in turbulent environments;

(b) working with Hewlett-Packard Research Labs from 2010-2012 on the design and evaluation of gesture-based pointing techniques for remote displays, such as interactive TVs;

(c) a number of projects from 2006-2010 working with Logitech on the design, development, evaluation and improvement of user interfaces for next generation mice, including in relation to scrolling and window management tasks;

(d) working with IBM Almaden Research in 2006 on the design, development and evaluation of user interfaces for gesture-based text entry on mobile devices;

(e) working with Digit Wireless in 2002 on the evaluation of user performance for user interfaces for digital text entry on mobile devices; and

(f) working with Microsoft Research in 1999 on the development, evaluation and improvement of user interfaces for web browsing, in particular the mechanisms for revisiting pages (such as through the "back" button or bookmarks).

8. At the University of Canterbury, I currently teach a course on HCI for final year undergraduate students and a course on research methods in HCI for postgraduate students.

9. In the past, I have also taught introductory computer programming courses for first year students across disciplines, which included the implementation of graphical user interfaces.

10. I also manage an active research lab with a number of Ph.D. students. I have previously supervised fourteen students to successful completion of their Ph.D.s in the field of HCI.

11. The Association for Computing Machinery (ACM) is the world's largest scientific an educational computing society. In 2015, I was elected to the ACM Conference on Human Factors in Computing Systems (CHI) Academy, which honors the principal leaders of the field of HCI.

12. I also annually attend conferences relating to the field of HCI and regularly read journals that cover research in the field of HCI.

13. To keep abreast with industry trends, I regularly read broader journals, magazines and websites related to computer science and technology, including Communications of the ACM, ACM TechNews, BBC Technology, and New York Times Technology.

14. A detailed list of my other professional activities, memberships, and speaking engagements is included in my CV.

15. I have been retained on behalf of Apple Inc. to offer technical opinions relating to U.S. Patent No. 8,190,223 ("the '223 Patent") and prior art references relating to its subject matter. I have reviewed the '223 Patent, and relevant excerpts of the prosecution history of the '223 Patent. I have also reviewed the following references:

- APPLE-1004 U.S. Patent No. 6,707,476 ("Hochstedler")
- APPLE-1005 U.S. Patent Pub. No. 2002/0184055 ("Naghavi")
- APPLE-1006 U.S. Patent Pub. No. 2006/0064020 ("Burnes")
- APPLE-1007 U.S. Patent No. 6,151,518 ("Hayashi")
- APPLE-1008 U.S. Patent No. 5,842,979 ("Jarman")
- APPLE-1009 U.S. Patent No. 6,385,471 ("Mortz")
- APPLE-1010 U.S. Patent No. 6,584,336 ("Al-Ali-336")

- APPLE-1011 U.S. Patent Pub. No. 2003/0181798 ("Al-Ali-798")
- APPLE-1012 U.S. Patent Pub. No. 2003/0009119 ("Kamm")
- APPLE-1013 U.S. Patent Pub. No. 2003/0145852 ("Schmidt")
- APPLE-1014 U.S. Patent Pub. No. 2004/0204637 ("Diab-637")
- APPLE-1015 U.S. Patent No. 6,654,624 ("Diab")
- APPLE-1016 U.S. Patent No. 5,331,549 ("Crawford")
- APPLE-1017 U.S. Patent Pub. No. 2003/0092974 ("Santoso")
- APPLE-1018 U.S. Patent No. 6,912,413 ("Rantala")
- APPLE-1019 U.S. Patent No. 6,658,276 ("Kianl")

16. I have also reviewed various supporting references and other documentation as further noted in my opinions below.

17. Counsel has informed me that I should consider these materials through the lens of one of ordinary skill in the art related to the '223 Patent at the time of the earliest possible priority date of the '223 Patent, and I have done so during my review of these materials. The '223 Patent claims the benefit of priority to a number of provisional applications, each of which was filed on March 1, 2005 ("the Critical Date"). Counsel has informed me that the Critical Date represents the earliest possible priority date to which the challenged claims of '223 Patent are entitled, and I have therefore used that Critical Date in my analysis below.

18. I have no financial interest in the parties or in the outcome of this proceeding. I am being compensated for my work as an expert on an hourly basis. My compensation is not dependent on the outcome of these proceedings or the content of my opinions.

19. In writing this declaration, I have considered the following: my own knowledge and experience, including my work experience in the field of HCI; my experience in teaching those subjects; and my experience in working with others involved in those fields. In addition, I have analyzed various publications and materials, in addition to other materials I cite in my declaration.

20. My opinions, as explained below, are based on my education, experience, and expertise in the fields relating to the '223 Patent. Unless otherwise stated, my testimony below refers to the knowledge of one of ordinary skill in the art as of the Critical Date, or before. Any figures that appear within this document have been prepared with the assistance of Counsel and reflect my understanding of the '223 Patent and the prior art discussed below.

II. OVERVIEW OF CONCLUSIONS FORMED

21. This declaration explains the conclusions that I have formed based on my analysis. To summarize those conclusions, based upon my knowledge and experience and my review of the prior art publications listed above, I believe that:

- Claims 1-4, 6, 11-18, 20-22 are obvious over Naghavi, Hochstedler, and Burnes
- Claims 19, 27-28, 32, 34, 36-37, and 42-43 are obvious over Naghavi, Hochstedler, Burnes, and Hayashi
- Claims 42-44 are obvious over Naghavi, Hochstedler, Burnes, Hayashi, and Mortz

III. LEVEL OF ORDINARY SKILL IN THE ART

22. In my opinion, one of ordinary skill in the art relating to, and at the time of, the invention of the '223 Patent would have had at least a bachelor's degree in computer science, computer engineering, electrical engineering, biomedical engineering, human-computer interaction, or a related field, and would have had at least two years of relevant work experience in the design and development of graphical user interfaces (GUIs), human-computer interfaces, or equivalents thereof. Less work experience may be compensated by a higher level of education and vice versa.

23. Based on my experiences, I have a good understanding of the capabilities of one of ordinary skill. Indeed, I have taught, participated in organizations, and worked closely with many such persons over the course of my career. Based on my knowledge, skill, and experience, I have an understanding of

the capabilities of one of ordinary skill. Furthermore, I possess those capabilities myself.

IV. PRIOR ART ANALYSIS

A. [GROUND 1A] – CLAIMS 1-4, 6, 11-18, 20-22 ARE OBVIOUS OVER NAGHAVI, HOCHSTEDLER, AND BURNES

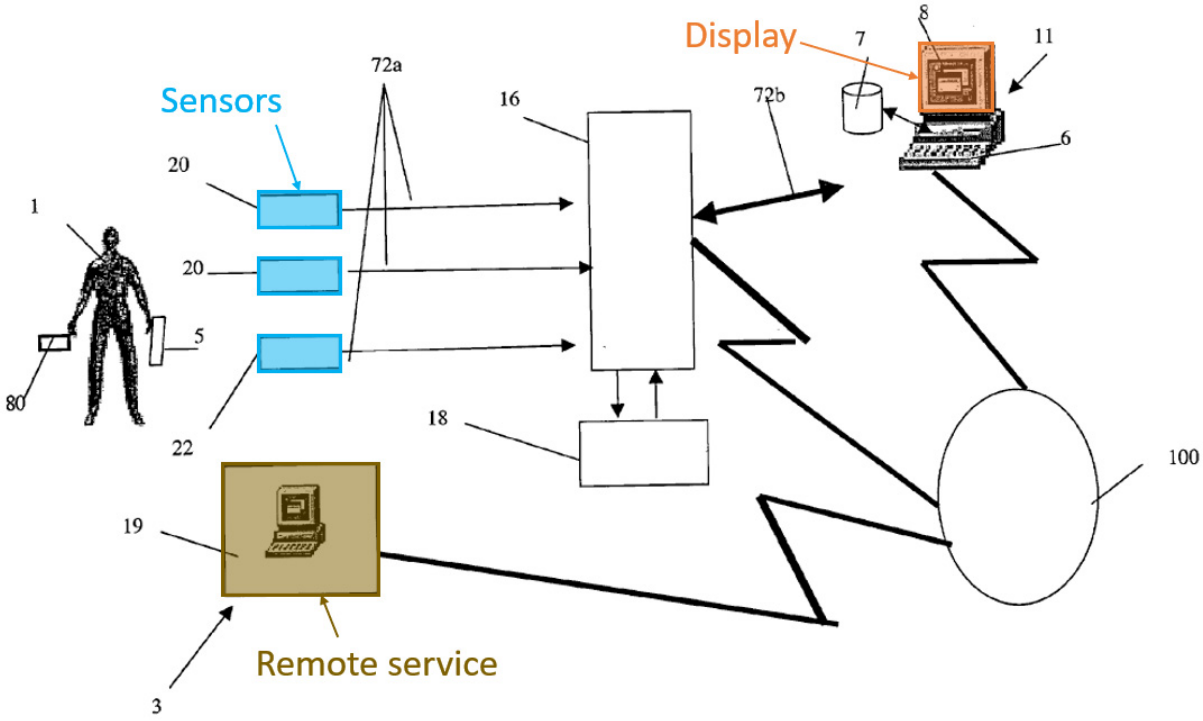
24. The sections below provide a discussion of Naghavi, Hochstedler, Burnes, and the application of the combination of these references to the claims.

1. Naghavi describes changing the display of health information based on a change in severity of a patient's condition

25. Naghavi describes a "[p]ersonal healthcare management system 10" that "provide[s] an out-of-hospital, affordable, real time, automated intelligent system for early managing and risk stratifying of patients 1 based on their symptoms, physiologic data (ECG, BP) and their past medical history." APPLE-1005 (Naghavi), [0024].

26. Referring to FIG. 1, which I have reproduced and annotated below, Naghavi's system can "control and acquire data from a plurality of medical devices 20" and sensors 22 (highlighted in blue) such as "an electrocardiograph device, a blood pressure measurement device, thermometers, digital biochemical devices, glucometers, and physiological laboratory kits, digital biomechanical monitoring devices, peak-flow meter, and the like." APPLE-1005 (Naghavi), [0029]-[0030], [0032]. This system "employs an enhanced dynamic and interactive healthcare

specific graphical user interface, GUI 80," *e.g.*, for display on an "output device 8 such as a monitor," highlighted in orange. APPLE-1005 (Naghavi), [0025], [0056]. Naghavi also describes that the system "may be accessible through data network [], e.g., the Internet, … to a clinical location such as [a] hospital," *e.g.*, as a "remote service 3," highlighted in brown. APPLE-1005 (Naghavi), [0044].



Excerpt from Naghavi, FIG. 1 (annotated)

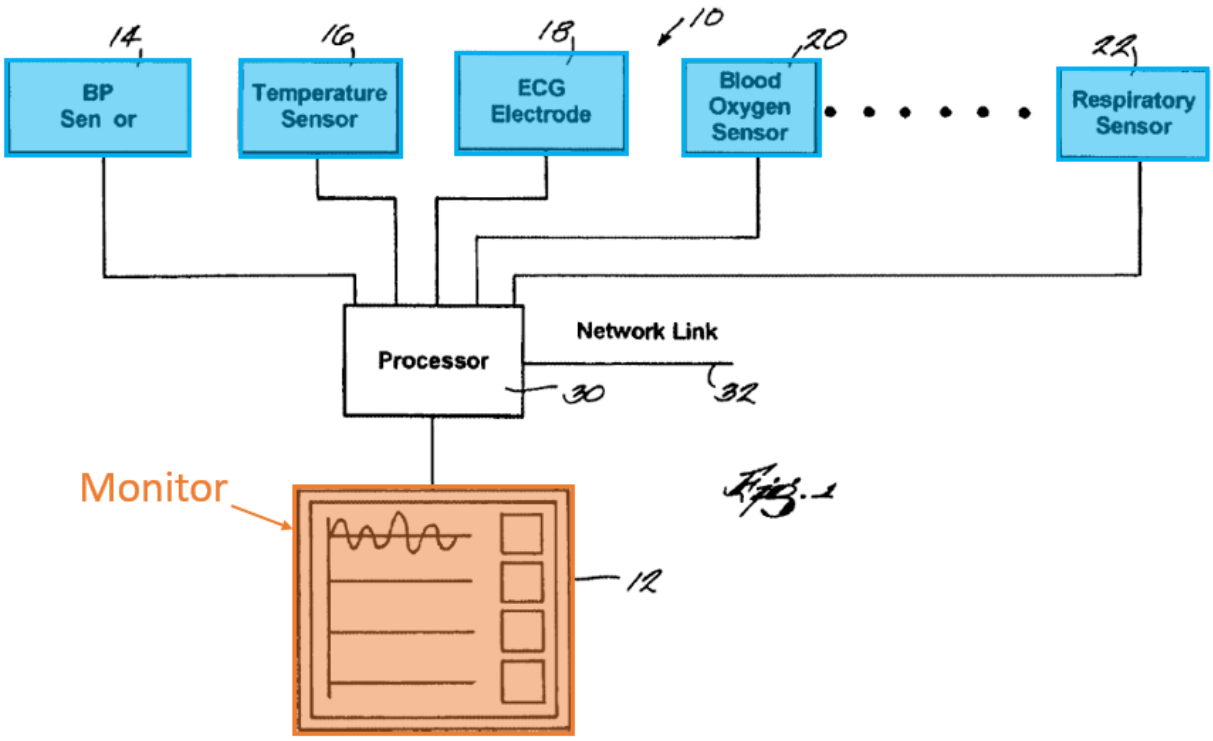
27. Naghavi's GUI 80 "permits taking in information without reading," by "arranging icons and menus in a display area." *Id.*, [0056]-[0057]. The GUI "may … change and show different types of icons and health objects according to different diseases and/or other physical conditions of patient 1." *Id.*, [0059]. Additionally, the GUI "may automatically detect changes in health status and

health plan for patient 1 and automatically react and rearrange the available options to best suit the condition of patient 1." APPLE-1005 (Naghavi), [0063]. For instance, "[t]he icons and health objects may change in color, shape, order, or other mutatable attribute according to different time schedules and severity or degree of some of findings, e.g., the shape, size, color, and relative position of each icon can change according to a current health status and health plan of patient 1." APPLE-1005 (Naghavi), [0059]; *see* claim 1 ("a graphical user interface … capable of mutating a desired mutatable characteristic of a displayed graphic user interface element based on a predefined health status condition of a user of the healthcare specific computer operating system").

2. Hochstedler describes a multiparameter patient monitoring system with automatically updated display layouts

28. Hochstedler describes "a patient monitoring system 10 that displays information on a monitoring device or monitor 12." APPLE-1004 (Hochstedler), 3:6-7; *see* FIG. 1, which I have reproduced and annotated below. The system "includes a plurality of sensors, including a blood-pressure sensor 14, a temperature sensor 16, an ECG electrode 18, a blood oxygen sensor 20, and a respiratory sensor 22," highlighted in blue. *Id.*, 3:14-17. "[T]he information from the sensors 14-22 is displayed in a graphical user interface ('GUI')" on a monitor 12, highlighted in orange, which "includes a number of components that are used

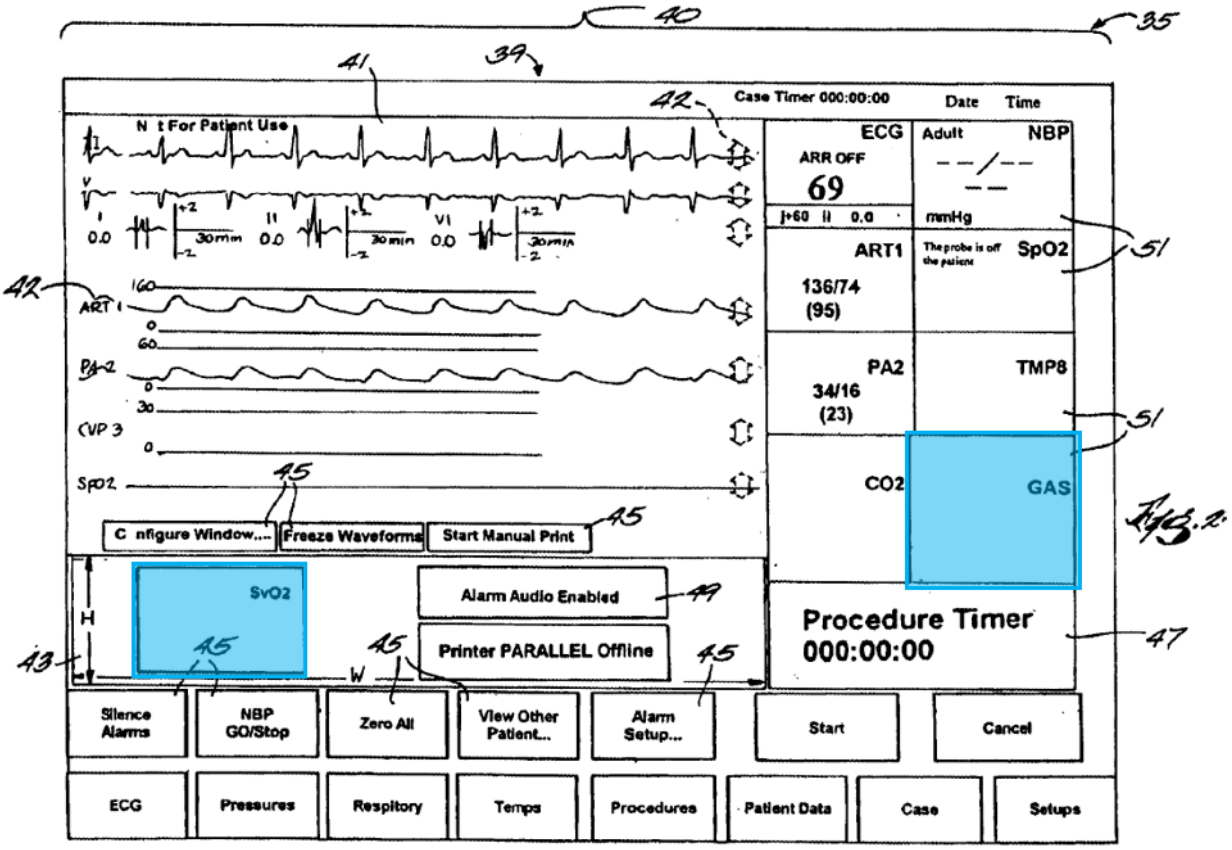
to build or construct a layout." *Id.*, 3:27-29. A layout "refer[s] to the entire group of components displayed on a monitor to display monitored activity." *Id.*, 3:31-33.



Excerpt from Hochstedler, FIG. 1 (annotated)

29. An example of a GUI described by Hochstedler is illustrated in FIG. 2, which I have reproduced and annotated below. The GUI 35 includes, among other components, "a waveform window 41, … sub-layouts 43, command buttons 45, … and parameter blocks 51." APPLE-1004 (Hochstedler), 3:38-40. The parameter blocks "display real-time information about patient vital signs." *Id.*, 1:20-21. The particular GUI illustrated in FIG. 2 includes parameter blocks displaying information about parameters including ECG, SpO2, and GAS (highlighted in blue). The layout also includes a "sub-layout 43" including a

parameter block for SvO2 information (also highlighted in blue). APPLE-1004 (Hochstedler), 4:7.



Excerpt from Hochstedler, FIG. 2 (annotated)

30. Hochstedler "provides a method … for automating the change of the layout of a GUI" responsive to detecting "changes in the system's capabilities (e.g., an additional sensor is added) or changes in the system's environment (e.g., a switch is made from one medical procedure to another)." APPLE-1004 (Hochstedler), 1:54-60. For instance, "[a] first type of change … relates to a change in the capabilities of the system (e.g., a blood oxygen sensor is added)," responsive to which "the layout is modified so that information associated with the

added or subtracted capability is displayed in the GUI." *Id.*, 5:26-31. "A second type of change … relates to a change in the system environment (such as … change in the phase of the case … change in the type of medical procedure being carried out, or other similar change)," responsive to which "the layout is modified according to user specific desires." *Id.*, 5:31-37. The change in layout can be "an automatic layout switch" or "an automatic layout switch [that] occur[s] after prompting the user for approval of the proposed change." *Id.*, 5:42-45.

31. One example of a new layout is the "layout 170 shown in FIG. 9," which is reproduced and annotated below. APPLE-1004 (Hochstedler), 8:40. This new layout "contains a different parameter block 172," highlighted in purple, that replaces the GAS parameter block in the original layout of FIG. 2. *Id.*, 8:41-42. Another example of a new layout is shown in FIG. 13, which I have reproduced and annotated below. In FIG. 13, the sub-layout 43 that was present in the layout of FIG. 2 has been replaced with "a sub layout 210." *Id.*, 8:64-65. The new sub-layout 210 contains a CO2 parameter block, also highlighted in purple, that replaces the SvO2 parameter block in the original layout of FIG. 2.

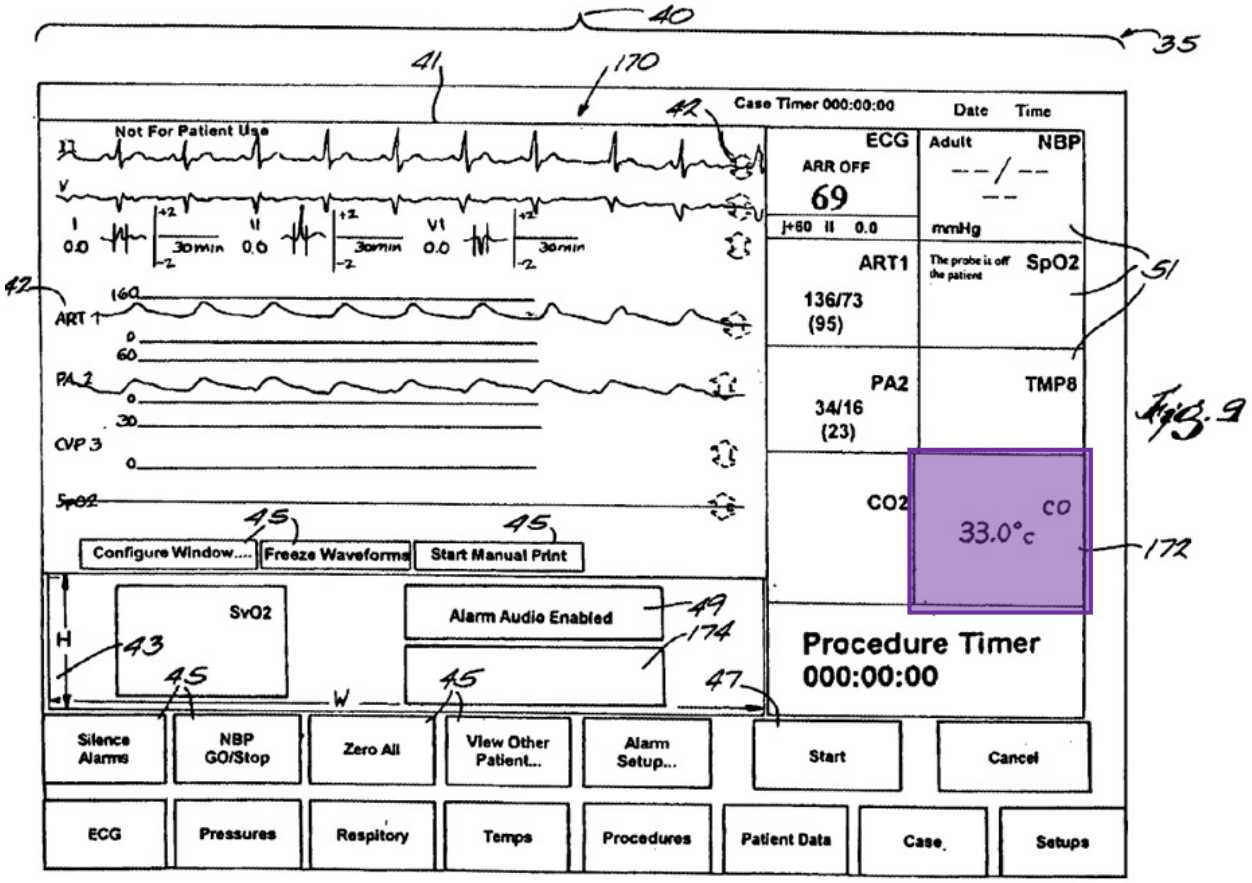


Fig. 9

Excerpt from Hochstedler, FIG. 9 (annotated)

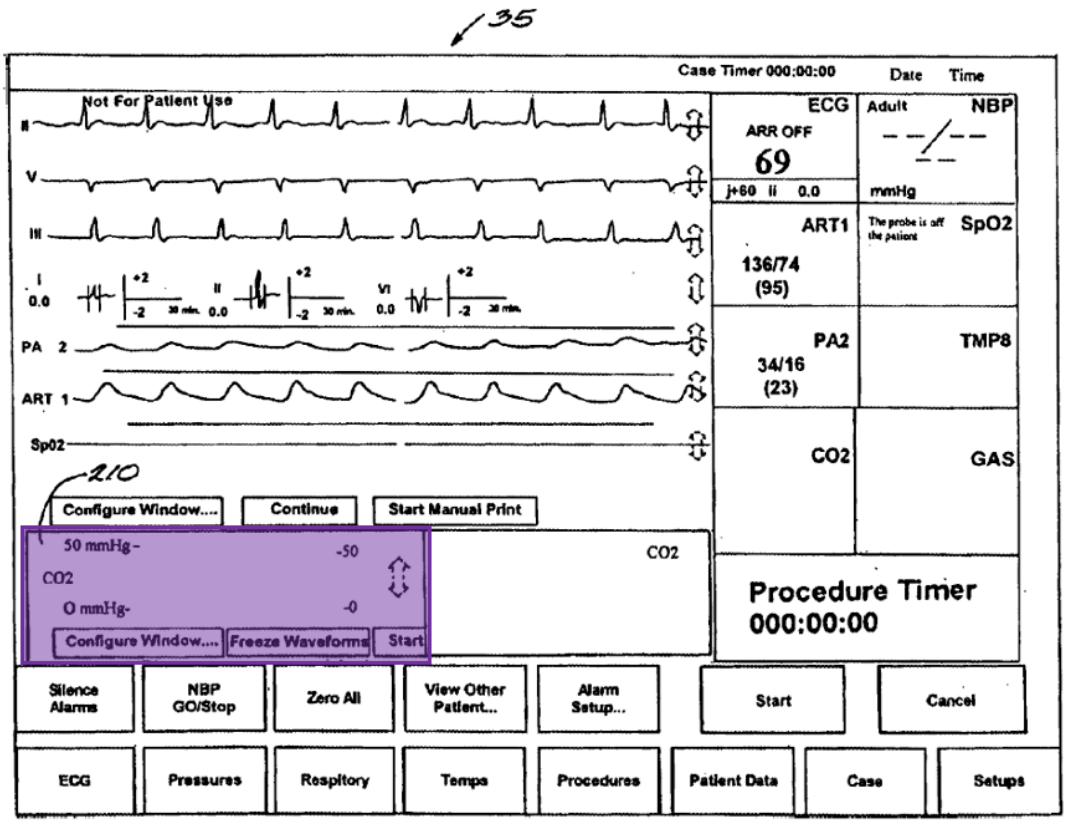


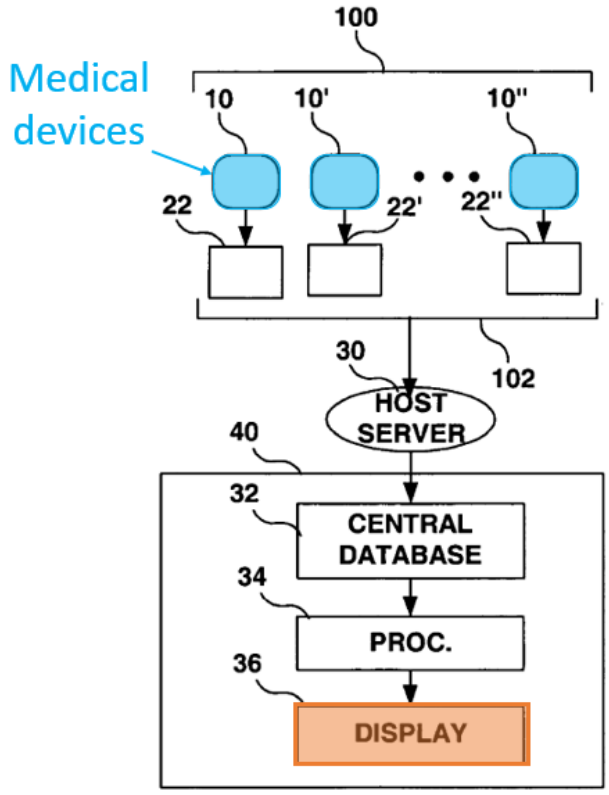
Fig. 13

Excerpt from Hochstedler, FIG. 13 (annotated)

3. Burnes describes a multiparameter monitoring system that displays alerts when parameters become out of range

32. Burnes describes "a remote patient monitoring system including a graphical user interface (GUI) that displays a summary table of categorized parameter values" for monitored patients. APPLE-1006 (Burnes), Abstract. As illustrated in FIG. 4, Burnes's system includes a central monitoring station including a central database 32 that "receives data from multiple, remotely located" medical devices 100, highlighted in blue, such as implantable or external medical devices "used in monitoring or treating a particular patient." *Id.*, [0030]-

[0031]. A processing unit 34 analyzes the data "to parameterize and categorize incoming data such that summary parameter values may be displayed on display 36," orange. *Id.*, [0031].



Excerpt from Burnes, FIG. 4 (annotated)

33. Burnes describes that the parameter values are "categorized according to predefined thresholds or ranges." APPLE-1006 (Burnes), [0037]. For instance, a parameter is determined to be "out of range" if its "value [] has crossed a predetermined threshold or fallen outside a normally accepted range for the given parameter," while a parameter can be "near out of range" if "its value has come within some predetermined range or percentage of a threshold defining the 'out of

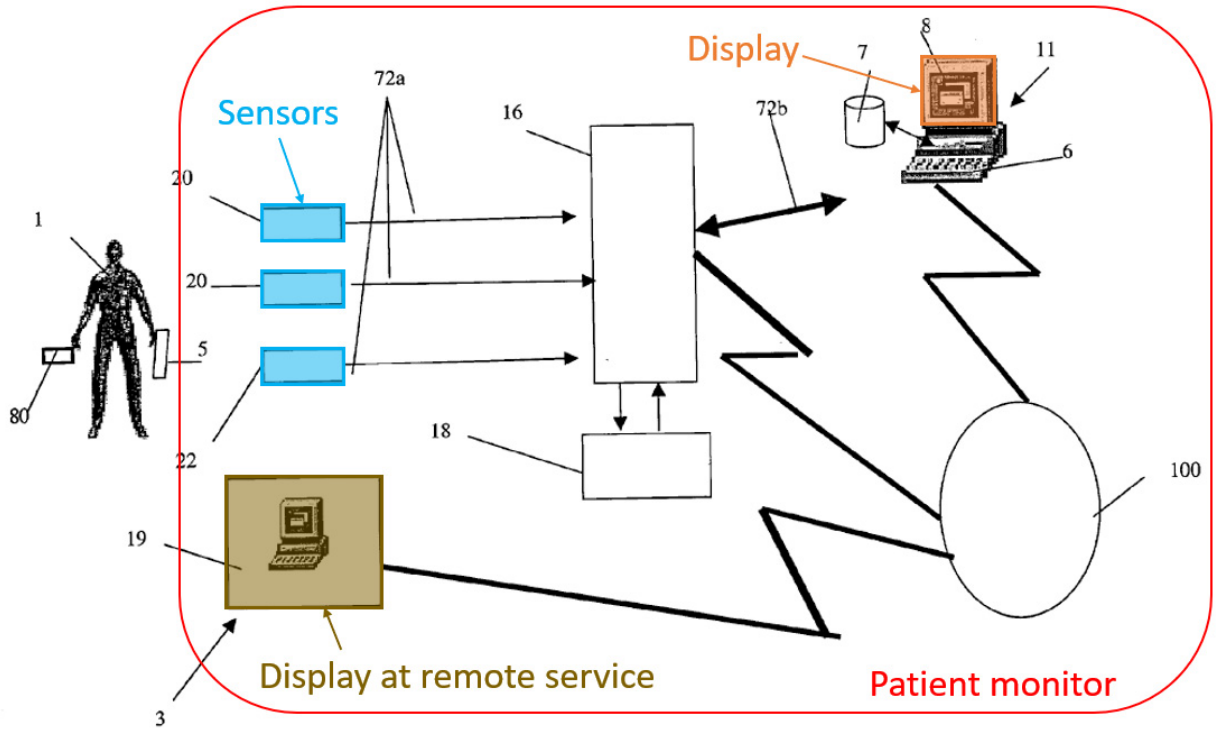
range' boundary." *Id.*, [0038]-[0040]. Burnes's display reflects this categorization of the monitored parameters: "different symbols, color, font, highlighting, shading, or other formatting schemes may be used to differentiate between categories." *Id.*, [0035]. For instance, "an 'alert' symbol" is displayed for an "out of range" parameter, or the value itself "may be highlighted or displayed in particular color, such as red, to draw attention to the value." *Id.*, [0038], [0057]. Moreover, "[c]ategorizing a parameter value in the 'alert' category may trigger an alarm at the clinic." *Id.*, [0038].

4. The Naghavi-Hochstedler-Burnes combination

34. I have generated a composite figure, below, that depicts an example of the Naghavi-Hochstedler-Burnes combination system. As illustrated in the figure, this system is a patient monitoring system that "control[s] and acquire[s] data" from "medical devices 20 and/or sensors 20," highlighted in blue, for monitoring physiological parameters of patients. APPLE-1005 (Naghavi), [0029]-[0030], [0032]. Generally, and as I discuss in more detail in the following paragraphs, in the Naghavi-Hochstedler-Burnes combination, patient information is displayed on a graphical user interface (GUI), which mutates in response to health status conditions of the patient, as taught by Naghavi. *See* APPLE-1005 (Naghavi), [0059], [0099]. Hochstedler provides specificity about how this display mutation is implemented, *e.g.*, via replacement of one display layout with another. *See*

APPLE-1004 (Hochstedler), 1:54-60, 5:26-45. And Burnes provides a description of specific health changes that motivate this display change. APPLE-1006 (Burnes), [0035]-[0040].

35. More specifically, in the Naghavi-Hochstedler-Burnes combination, information from the sensors is displayed in a "dynamic and interactive healthcare specific graphical user interface [GUI]" that displays "different types of icons and health objects." APPLE-1005 (Naghavi), [0056], [0059]. This GUI can be implemented on an "output device 8 such as a monitor," highlighted in orange, or can be implemented on a display of a "remote service" for patient monitoring, highlighted in brown, *e.g.*, at a hospital, as taught by Naghavi. *Id.*, [0025], [0044]. For instance, each icon or health object that is displayed on the GUI of the combination corresponds to information received from one of the sensors. The combination system, also consistent with the operation of Naghavi's GUI, "may automatically detect changes in health status" of the monitored patient and in response, "automatically react and rearrange the available options to best suit the condition of" the patient. APPLE-1005 (Naghavi), [0063].



Naghavi-Hochstedler-Burnes composite figure

36. The particular implementation of the GUI in the combination—for instance, the arrangement of the icons and health objects, and how the arrangement is changed responsive to those changes in health status—is not specifically described by Naghavi, but instead is based on the teachings of Hochstedler. Specifically, the GUI of the combination is implemented (either at the output device 8 or at the display of the remote service) such that the "icons and health objects" are displayed according to the parameter blocks and sub-layouts of Hochstedler's display, and arranged according to Hochstedler's layouts. APPLE-1005 (Naghavi), [0056]-[0057]; *see* APPLE-1004 (Hochstedler), 3:27-33, FIGS. 2, 8-13. With this implementation, "real-time information about patient vital signs,"

e.g., as measured by the sensors of the combination system, is displayed in the parameter blocks and/or sub-layouts of the display. APPLE-1004 (Hochstedler), 1:20-21.

37. Additionally, the automatic rearrangement of the icons and health objects when a "change[] in health status" of the monitored patient is detected (as taught by Naghavi) is implemented based on the teachings of Hochstedler. APPLE-1005 (Naghavi), [0063]. Specifically, in the GUI of the combination, the layout of the display is changed from one layout to another (as taught by Hochstedler) when a change in health status is detected (as taught by Naghavi). Notably, the rearrangement of icons and health objects by switching the display layout is consistent with Hochstedler's teachings of a system that "implement[s] an automatic change" from one display layout to another responsive to detecting "changes in the system's environment." APPLE-1004 (Hochstedler), 1:54-60; *see* 5:26-45. Moreover, consistent with the operation of Hochstedler's GUI, the change in layout can "occur after prompting the user for approval of the proposed change." APPLE-1004 (Hochstedler), 5:43-45.

38. This change in display layout occurs based on "changes in health status," as taught by Naghavi. APPLE-1005 (Naghavi), [0059]. However, although Naghavi indicates that this change in health status can be related to the "severity" of one or more of the parameters, Naghavi provides no further details

about specifically what is considered a change sufficient to prompt a change in display layout; these specifics are provided by the teachings of Barnes. Specifically, based on Burnes, these "changes in health status" related to the "severity" of a parameter are the parameter having a "value[] found to be 'out of range'" or "near or approaching the 'out of range' criteria." APPLE-1006 (Burnes), [0038]-[0039]; APPLE-1005 (Naghavi), [0059]. For instance, when a parameter that is not displayed in a current layout changes to become "out of range" (or to approach an out of range value), this triggers an alarm, as taught by Burnes. APPLE-1006 (Burnes), [0038]-[0039]. Based on the teachings of Hochstedler, this change in the parameter that is not currently displayed also causes the display layout to change to a new layout that does display information about that out of range parameter. *See* APPLE-1005 (Naghavi), [0059] ("GUI 80 may further change and show different types of icons and health objects according to … physical conditions of patient 1"). This implementation allows parameters that are alarming to be made easily visible to the user monitoring the patient, even if that parameter is not otherwise displayed.

39. In one specific example of how this combination can be implemented, with reference to the "layout switches" illustrated by Hochstedler, "the layout is switched" from a layout such as that of Hochstedler's FIG. 2 to a layout such as that of FIG. 9, which "contains a different parameter block 172." APPLE-1004

(Hochstedler), 8:28-41. In the combination, this layout switch occurs when the parameter represented in block 172 changes in "severity" to become "out of range" or "near out of range," as taught by Burnes. APPLE-1005 (Naghavi), [0059]; APPLE-1006 (Burnes), [0038]-[0039]. In another example, the layout is switched from one based on Hochstedler's FIG. 2 to a layout based on FIG. 13, which contains a different "sub layout 210," when the parameter represented in sub layout 210 changes in "severity." APPLE-1004 (Hochstedler), 8:56-65; APPLE-1005 (Naghavi), [0059]; *see* APPLE-1006 (Burnes), [0038]-[0039].

40. Other specific implementation details can also be provided in the combination. For instance, based on the teachings of Burnes, when the layout is switched when a parameter becomes "out of range" or "near out of range," the value of that parameter is "highlighted or displayed in a particular color … to draw attention to the value" such as red (when the parameter becomes out of range) or yellow (when the parameter becomes near out of range). APPLE-1006 (Burnes), [0057]. As another example, still based on the teachings of Burnes, when the layout is switched because a parameter becomes "out of range" or "near out of range," an "alert symbol" such as "a red symbol" or "a yellow symbol," is displayed in the parameter block or sub layout for that parameter. APPLE-1006 (Burnes), [0050].

5. Reasons for the combination

Display of icons and health objects according to layouts such as Hochstedler's

41. It is my opinion that a POSITA would have been motivated to implement the display icons and health objects such as those described by Naghavi in layouts based on the teachings of Hochstedler—and specifically, to change those layouts when the severity of a parameter changes—for at least the following reasons.

42. The first reason why a POSITA would have been motivated to implement the icon and health object display according to the teachings of Hochstedler is because this approach advantageously allows "the layout of the GUI [to] change[] with the needs of users and the stage of medical treatment." APPLE-1004 (Hochstedler), 1:49-50. This change helps ensure that clinically relevant information is displayed, such as information indicating a changing health status of the patient. Notably, this dynamic change of the display responsive to health status of the patient is consistent also with Naghavi's approach to mutating a GUI in response to the health status of a patient. Naghavi describes that "GUI 80 continually determines a status of a predefined health status condition of patient 1 at predetermined intervals. Using the status, GUI 80 mutates one or more desired mutatable characteristics of a displayed graphic user interface element." APPLE-1005 (Naghavi), [0099]; *see* claim 1. For instance, Naghavi refers to "relative

position" changes in response to "severity or degree of some of findings." *Id.*, [0059].

43. In the specific example of the "remote service" implementation of the display (APPLE-1005 (Naghavi), [0069]), the concurrent display of multiple parameters via a multi-parameter layout such as those described by Hochstedler provides the operator at the remote service with a volume of clinically relevant information that is suitable for their role as a medical professional working with a home healthcare monitoring system. The change from one multi-parameter layout to another also serves to provide this remote operator with sufficient, and relevant, information to monitor the health status of the patient.

44. The second reason why a POSITA would have been motivated to pursue this implementation is because the automatic replacement of one layout with another provides a prioritized display in which the most important information (for instance, information that is changing because of a change in a health status of the patient) is displayed in favor of other, less relevant information (for instance, information that is static and thus of less immediate clinical importance). Naghavi states that GUI 80 is interactive and dynamic, and that it will "automatically react and rearrange the available options to best suit the condition of patient 1." (APPLE-1005 (Naghavi), [0063]). Similarly, Hochstedler

states that "It would be preferable, if the layout of the GUI changed with the needs of users and the stage of medical treatment." APPLE-1004 (Hochstedler), 1:49-50.

45. The third reason why a POSITA would have been prompted to pursue this implementation is because this combination is just the application of known techniques (specifically, multiparameter display techniques such as the display layouts of Hochstedler) by an already-known system (specifically, a medical monitoring system such as Naghavi's), and it yields predictable results (specifically, a display of a medical monitoring system implementing those multiparameter display techniques).

46. Moreover, it is my opinion that a POSITA would have expected to be successful in pursuing this combination for at least the following reasons. First, a POSITA would have expected to be successful in implementing a parameter layout based on the teachings of Hochstedler to display health icons such as those described by Naghavi because the integration of display techniques with a medical device is a predictable endeavor. No unexpected results arise from simply implementing a known multiparameter GUI in a system that already measures and displays information about multiple parameters. Additionally, a POSITA would have expected success because Naghavi and Hochstedler are generally in the field of medical monitoring. *See* APPLE-1004 (Hochstedler), 3:6-25; APPLE-1005 (Naghavi), [0011].

Change in severity of a parameter causing change in display layout

47. It is my opinion that a POSITA would have been motivated to switch the layout of the multiparameter display from one layout to another when a parameter changes to become out of range or near out of range (as taught by Burnes) for at least the following reasons.

48. The first reason why a POSITA would have been motivated to implement a switch of the display layout when a parameter becomes out of range is to provide a display of parameters that "best suit[s] the condition of [the] patient." APPLE-1005 (Naghavi), [0063]. For instance, such a change in the severity of a parameter can indicate a change in the patient's health that may require close monitoring. A POSITA would have recognized that implementing an approach to parameter display that enables caregiver monitoring of parameters that have changed in severity would facilitate that necessary close monitoring of those changing parameters, and would have been motivated to implement this approach of the combination in order to achieve that objective.

49. Specifically, a parameter that changes in severity to become out of range or near out of range is, at least in some cases, a parameter that has become severe enough to warrant attention from a caregiver. The combination system, though, does not necessarily display all parameters on a single screen, at least in cases when more parameters are being monitored than there are spaces to display

those parameters in the display layout. A POSITA would have been motivated to implement the system to be able to automatically display a previously undisplayed parameter that changes to become out of range, *e.g.*, such that the caregiver can readily monitor that parameter and attend to the patient as needed. For instance, this approach allows for parameters that are not displayed on a default layout to be displayed when warranted, such as when a change in their value indicates a need for clinical attention.

50. The second reason why a POSITA would have been motivated to pursue this implementation is to "relieve the data analysis burden placed on the clinician while enabling the clinician to maintain thorough patient care." APPLE-1006 (Burnes), [0004]. For instance, a POSITA would have recognized that not all parameters necessarily need to be displayed on a main (*e.g.*, default) layout. For instance, parameters that are less relevant to a patient's condition or that are less likely to change in severity do not necessarily need to be constantly displayed. Indeed, avoiding display of redundant information is a key aspect of Hochstedler's objective—which is, generally, to display the set of parameters that is appropriate for a given situation. *See* APPLE-1005 (Hochstedler), 1:49-60. However, a POSITA also would have recognized that if one of the parameters that is not displayed do change in severity, *e.g.*, to become out of range, it is important to display them to enable the clinician to provide proper care to the patient. *See*

APPLE-1006 (Burnes), [0004], which describes that clinicians have "a mounting task in tracking and analyzing each patient's data in order to recognize events or conditions of clinical importance or concern," and that efficiently designed systems can "relieve the data analysis burden placed on the clinician while enabling the clinician to maintain thorough patient care." By displaying these parameters only when necessary, the amount of information presented as a default to the clinician is maintained at a manageable level (thus "reliev[ing] the data analysis burden") while still providing a mechanism to inform the clinician about other relevant parameters (*e.g.*, parameters that are changing in value in a way that may need clinical attention) as appropriate. APPLE-1006 (Burnes), [0004].

51. The third reason why a POSITA would have been prompted to pursue this implementation is because this combination is just the application of known techniques (specifically, changing a parameter display responsive to a change in parameter status) by an already-known system (specifically, a multiparameter monitoring and display system), and it yields predictable results (specifically a multiparameter monitoring and display system in which the parameter display changes responsive to a change in the status of a parameter).

52. Moreover, it is my opinion that a POSITA would have expected to be successful in pursuing this combination for at least the following reasons. First, a POSITA would have expected to be successful because systems in which a change

in a parameter value triggers a notification or display change were conventional, predictable technologies. *See* APPPLE-1017 (Santoso), Abstract. Also, a POSITA would have expected success because Hochstedler, Naghavi, and Burnes are generally in the field of medical monitoring. APPLE-1004 (Hochstedler), 3:6-25; APPLE-1005 (Naghavi), [0011]; APPLE-1006 (Burnes), Abstract.

Colors or alert symbols to indicate parameter severity

53. It is my opinion that a POSITA would have been motivated to display parameters in different colors, or with different alert symbols, to indicate severity of the parameters (as taught by Burnes) for at least the following reasons.

54. The first reason why a POSITA would have been motivated to use color or alert symbols in the display is to "allow a parameter value category"—*e.g.*, out of range or near out of range—"to be recognized." APPLE-1006 (Burnes), [0007]; *see* [0035] ("values that … are of particular clinical concern may be formatted for display in a conspicuous manner to draw the attention of a clinician or other user"), [0042] ("icons or color-coded symbols … which allows a clinician or other user to easily distinguish between parameter value categories"). For instance, a POSITA would have recognized that using color or alert symbols renders the interface easier to use, *e.g.*, easier for a clinician to understand at quick glance which aspects of the patient's condition may require attention. In an example, if all displayed parameters have the same color, it is difficult for the

clinician to know which parameters need attention. Even if the layout has just switched to display a parameter whose value has changed in a clinically relevant way, the busy clinician will not necessarily notice this parameter. By displaying the changed, clinically relevant parameter in a different color than the standard color for static, within-range parameters, the clinician's attention is naturally drawn to that out-of-range parameter.

55. The second reason why a POSITA would have been motivated to pursue this implementation is because the use of color and/or alert symbols to indicate status of a parameter was well-established in the context of multi-parameter displays. One example of this is provided in Crawford, which describes that "certain colors are used to reinforce the information involved," such as green for "a normal condition," yellow for a "warning," and red for "critical." APPLE-1016 (Crawford), 6:3-27.

56. The third reason why a POSITA would have been prompted to pursue this implementation is because this combination is just the application of known techniques (specifically, the use of color and/or symbols to indicate the status of a displayed parameter) by a known system (specifically, a multiparameter monitoring and display system), and it yields predictable results (specifically, a multiparameter monitoring and display system employing color and/or symbols to indicate status of a parameter).

57. Moreover, it is my opinion that a POSITA would have expected to be successful in pursuing this implementation because display technology was predictable, and adjusting display characteristics to reflect the status of a parameter was a common and well-understood technology. In fact, I note that the '223 Patent itself indicates that its display can be implemented with generic, conventional display technology: "the display may advantageously comprise a CRT or an LCD display including circuitry similar to that available on oximeters commercially available from Masimo Corporation of Irvine, Calif. sold under the name Radical™, and disclosed in the U.S. patents referenced above and incorporated above. However, an artisan will recognize from the disclosure herein many commercially available display components capable of displaying multiple parameter data along with the ability to display graphical data such as plethysmographs, trend traces, and the like." APPLE-1001, 17:22-32.

6. Analysis

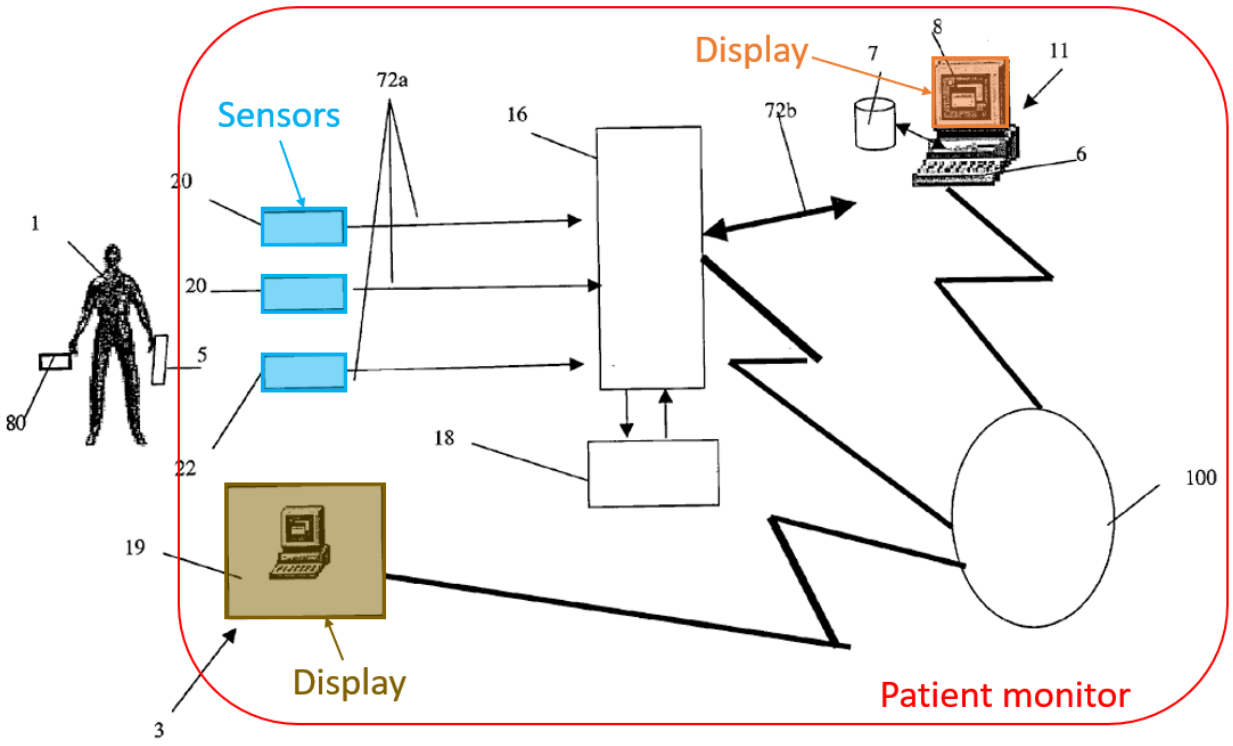
(i) Claim 1

[1pre] A patient monitor capable of measuring at least two physiological parameters,

58. To the extent the preamble is deemed to be limiting, Naghavi-Hochstedler-Burnes renders it obvious, for the following reasons.

59. The combination system, illustrated in the composite figure below, is "a personal healthcare management system," *e.g.*, **a patient monitor**. APPLE-

1005 (Naghavi), [0025]. This is the case at least because the system includes medical devices 20 and/or sensors 22, highlighted in blue, that perform patient monitoring. Naghavi explicitly identifies examples of these sensors: "A variety of sensors 22 for obtaining biophysical, biomechanical, physiological, biochemical, and electromechanical parameters, e.g. ECH electrodes, may be used to connect patients to personal healthcare management system 10." APPLE-1005 (Naghavi), [0033].



Naghavi-Hochstedler-Burnes combination

60. The combination patient monitor is **capable of measuring at least two physiological parameters**. For instance, based on the teachings of Naghavi, the monitoring system includes multiple (*i.e.*, at least two) sensors, including

sensors, highlighted in blue, "for obtaining biophysical, biomechanical, physiological, biochemical, and electromechanical parameters." APPLE-1005 (Naghavi), [0033]. In a specific example, one or more of the sensors can be implemented based on the teachings of Hochstedler to be, *e.g.*, "a blood-pressure sensor 14," which measures the physical parameter of blood pressure, "a temperature sensor 16," which measures the physical parameter of temperature, "an ECG electrode 18," which measures various physiological parameters related to cardiac behavior, "a blood oxygen sensor 20," which measures one or more physiological parameters related to blood oxygenation, and "a respiratory sensor 22," which measures physiological parameters related to respiration. APPLE-1004 (Hochstedler), 3:14-17; *see* 3:17-19 ("Other sensors could be added to the system or the sensors shown could be removed from the system. The type of sensor used will depend on the type of activity monitored"), 3:42-46 ("The number and type of sensors used in the system 10 changes based on the type of information that an end user desires to see. Thus, additional sensors may be added to the system, sensors may be removed from the system, or sensors may be deactivated based on the desires of the user"). Each of these sensors measures a physiological parameter; for instance, biophysical, biomechanical, physiological, biochemical, or electromechanical parameters. *See* APPLE-1005 (Naghavi), [0033].

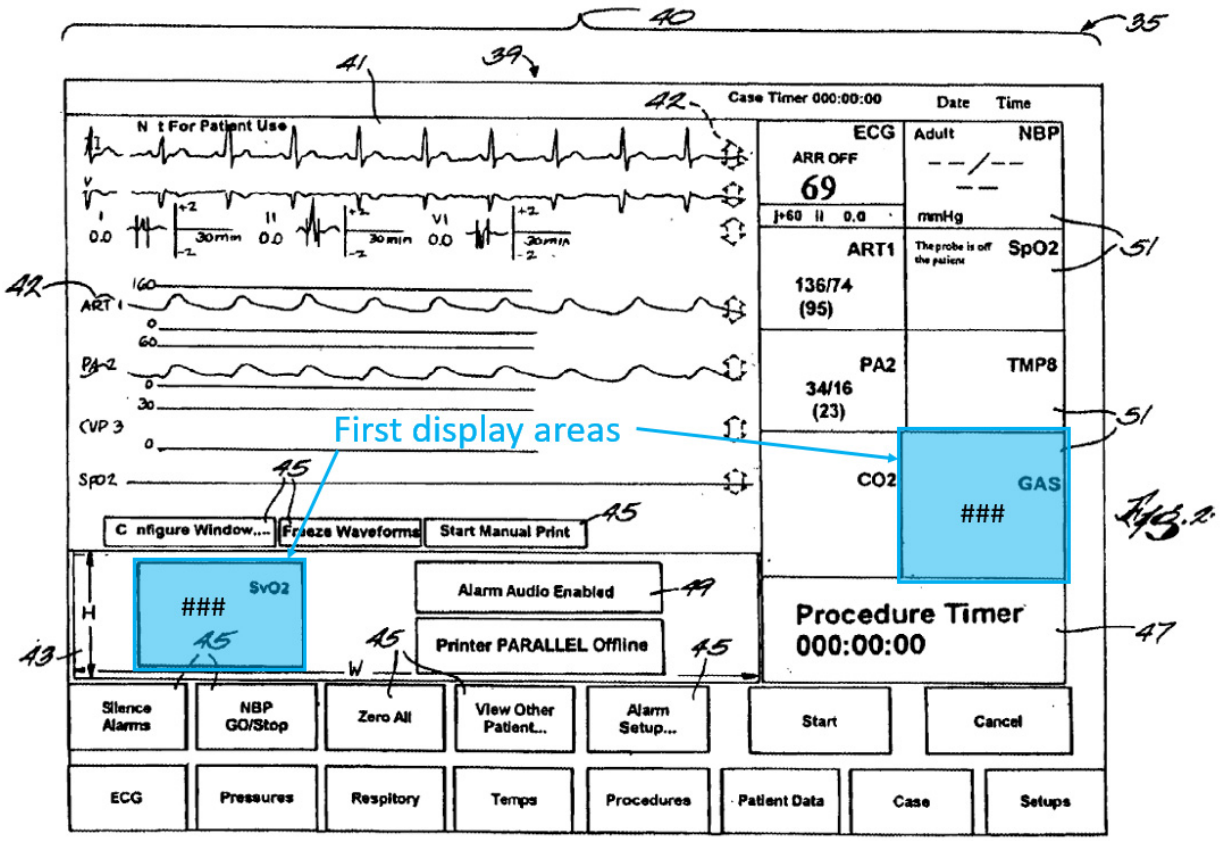
[1a] the patient monitor comprising a display capable of displaying a measured value of a first physiological parameter of body tissue of a

monitored patient in a first display area or displaying a measured value of a second physiological parameter of the body tissue in a second display area where the first display area and the second display area comprise at least some common display area capable of displaying information,

61. The combination monitor includes **a display**. One implementation of the display is based on Naghavi's "output device 8 such as a monitor" (highlighted in orange in the figure in [1pre]), and another implementation of the display is a display at a "remote service" (highlighted in brown) providing healthcare monitoring services, as also described by Naghavi. APPLE-1005 (Naghavi), [0025], [0044]; *see* [0027], [0038], [0057], [0069]. A graphical user interface (GUI) displays "icons and health objects" on the display, *e.g.*, to display information measured by the sensors. APPLE-1005 (Naghavi), [0056]-[0057].

62. In the combination, the GUI displaying the icons and health objects is implemented based on the teachings of Hochstedler to "include[s] a number of components that are used to build or construct a layout 39." *E.g.*, as illustrated in the figure below, which is based on Hochstedler's FIG. 2. APPLE-1004 (Hochstedler), 3:26-34, FIG. 2. An example of a GUI layout is illustrated in Hochstedler's FIG. 2, reproduced and annotated below. *See id.*, Abstract ("Layouts are sets of graphical components that are associated with monitored or sensed activities"), 3:6-8 ("a patient monitoring system 10 that ***displays information on a monitoring device or monitor 12***"), 3:22-23 ("The processor 30 processes the signals from the sensors using algorithms known in the art and

generates ***a graphical display on the monitor 12***"), 1:5-7 ("the invention relates to the display of information using configurable arrangements of interface components"), FIGS. 1-2, 8-13.



Composite figure based on Hochstedler, FIG. 2

63. The GUI, configured with a layout such as described by Hochstedler, is **capable of displaying measurements of physiological parameters of body tissue of a monitored patient**. Specifically, "the information from the sensors" of the combination monitor "is displayed" in the GUI, and in particular is displayed in "parameter blocks 51" which "display real-time information about patient vital signs," as taught by Hochstedler. APPLE-1004 (Hochstedler), 3:40-41, 1:19-23;

see 3:21-23 ("Each of the sensors outputs data signals that are delivered to a processor 30. The processor 30 processes the signals from the sensors … and generates a graphical display on the monitor 12"). As I discussed in [1pre], the sensors of the combination (*e.g.*, based on those of Naghavi's system) measure physiological parameters, and thus the display of information from the sensors in the layout of the GUI (*e.g.*, information about patient vital signs) is display of those physiological parameter measurements.

64. As an example, illustrated in the figure above, the "parameter blocks 51" in the layout of Hochstedler's FIG. 2 are blocks for displaying measurements of physiological parameters, including ECG, NBP, ART1, SpO2, PA2, TMP8, CO2, and GAS. This FIG. 2 layout also includes a "sub-layout 43" that includes a parameter block for displaying measurements for SvO2. APPLE-1004 (Hochstedler), 4:7.

65. In the Naghavi-Hochstedler-Burnes combination, measurements of the parameters from the sensors of the combination system are displayed in parameter blocks such as these of Hochstedler's FIG. 2. Each of these parameters is **a first physiological parameter** (*see* my discussion of element [1pre]). The parameter blocks for these parameters are a **first display area** for display of measurement of the respective first physiological parameters. *See* APPLE-1004 (Hochstedler), 1:19-23. For instance, in the figure above, two example first

display areas are highlighted in blue: the blocks for GAS and SvO2. The other parameter blocks, which I have not highlighted, are other examples of first display areas.

66. **A measured value of the first physiological parameter** is displayed in the respective parameter block, *e.g.*, **in the first display area**. *See* APPLE-1004 (Hochstedler), FIG.2. For instance, measured numeric values of respective parameters are shown in Hochstedler's FIG. 2 as being displayed in the ECG (heart rate), ART1, and PA2 parameter blocks. Although Hochstedler's FIG. 2 does not show numeric values displayed in the other parameter blocks, a POSITA would have understood, or at least found obvious, that the display is **capable of displaying measured values** of the parameters (*e.g.*, measured numeric values) in the respective blocks (*e.g.*, in the first display areas), *e.g.*, given Hochstedler's statement that the purpose of the parameter blocks is to "display real-time information about patient vital signs," and given that such vital signs information is often in the form of measured values. APPLE-1004 (Hochstedler), 1:19-23; *see* APPLE-1006 (Burnes), [0007] ("parameter values are displayed in alphanumeric values, which may be formatted in color-coded text"). For instance, I have placed the symbol "###"in the two blue-highlighted blocks to represent the measured numeric values of the respective parameters that can be displayed in these two blocks.

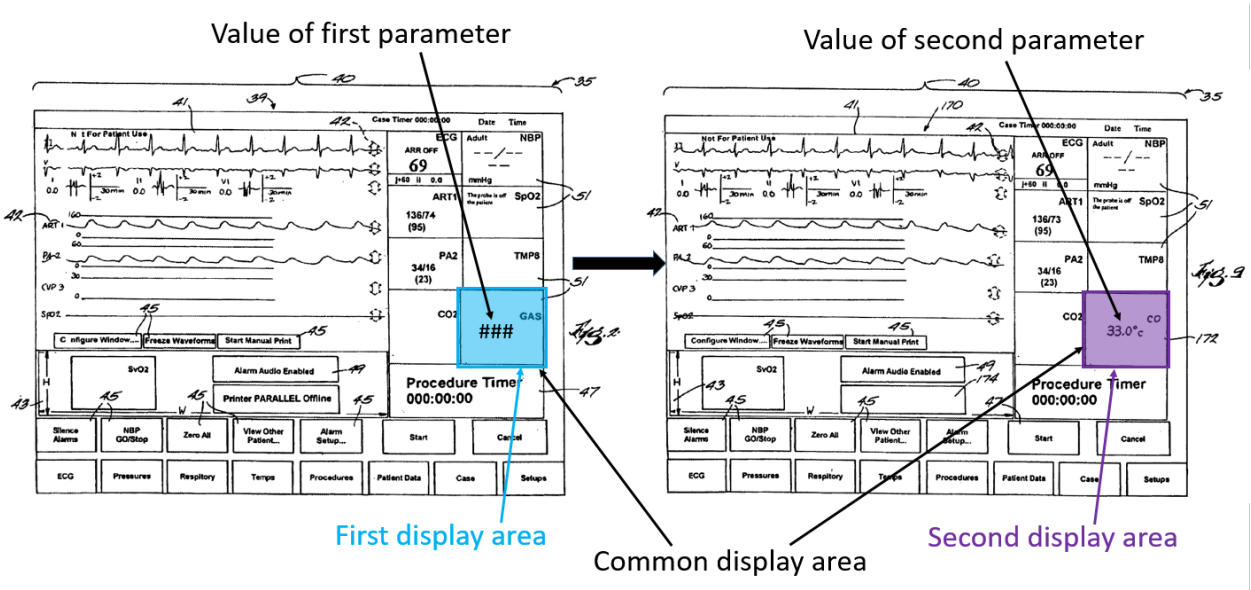
67. As I discussed above in Section §IV.A.4, in the combination, the display layout is changed responsive to a change in severity of a monitored parameter. *See* APPLE-1004 (Hochstedler), 1:54-60 ("a method … for automating the change of the layout of a GUI" responsive to detecting "changes in the system's capabilities … or changes in the system's environment"), 5:26-37; APPLE-1005 (Naghavi), [0059] ("The icons and health objects may change in color, shape, order, or other mutatable attribute according to different time schedules and severity or degree of some of findings, e.g., the shape, size, color, and relative position of each icon can change according to a current health status and health plan of patient 1."), [0063] (describing that the GUI "may automatically detect changes in health status and health plan for patient 1 and automatically react and rearrange the available options to best suit the condition of patient 1."), claim 1 ("a graphical user interface … capable of mutating a desired mutatable characteristic of a displayed graphic user interface element based on a predefined health status condition of a user of the healthcare specific computer operating system"); APPLE-1006 (Burnes), [0038]-[0039]. (Note that I discuss this matter further in my treatment of [1c], below).

68. Based on the teachings of Hochstedler, when the layout is changed, one or more of the parameter blocks in the initial layout (*e.g.*, in the layout illustrated in Hochstedler's FIG. 2, reproduced above) is replaced by respective

new parameter blocks for different physiological parameters. *See* APPLE-1004 (Hochstedler), 8:40-41 ("the layout is switched to a layout 170 shown in FIG. 9. The layout 170 contains a different parameter block 172"), 8:64-65 ("the sub layout 43 is replaced by a sub layout 210"), FIGS. 9 and 13. Each of the parameter blocks in the new layout is **a second display area** for display of a measurement of a respective **second physiological parameter**. Moreover, for the reasons I discussed above, **a measured value of the second physiological parameter** is displayed in the respective parameter block, *e.g.*, **in the second display area**, or at least a POSITA would have understood the display to be **capable of displaying measured values** of the parameters in the respective blocks, consistent with what I discussed above for the first parameters. *See* APPLE-1004 (Hochstedler), 1:19-23.

69. In one example illustration of the parameter display of the combination, the layout of Hochstedler's FIG. 2, reproduced again at left in the figures below, "is switched to a layout 170 shown in FIG. 9," reproduced at right in below. APPLE-1004 (Hochstedler), 8:40-41. In FIG. 9, "[t]he layout 170 contains a different parameter block 172," highlighted in purple in the figure at right. APPLE-1004 (Hochstedler), 8:40-41. The parameter block 172 is **a second display area** in which is displayed **a measured value** ("33.0 ºC") of **a second physiological parameter**, *i.e.*, the parameter ("CO") represented by that block. *See* APPLE-1004 (Hochstedler), FIG. 9. The "GAS" block and the "CO" block

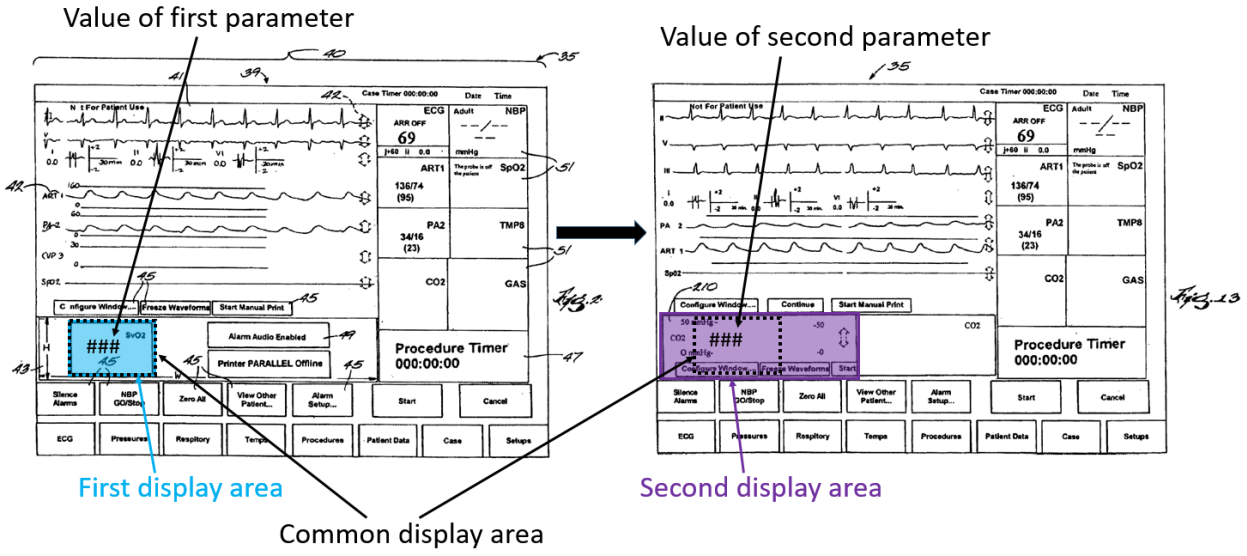
are located in the same position in the layout, and thus the area occupied by the purple-highlighted "CO" block 172 (the **second display area**) and the area occupied by the blue-highlighted "GAS" block (the **first display area**, as discussed above) are substantially the same: this area occupied by both the first and the second display areas can be regarded as **a common display area**, and it is **capable of displaying information**, *e.g.*, the measured values of the first and second parameters. *See* APPLE-1004 (Hochstedler), FIGS. 2 and 9.



Composite figures based on Hochstedler's FIGS. 2 and 9

70. I describe another example of parameter display of the combination with reference to Hochstedler's FIGS. 2 and 11, reproduced below on the left and right, respectively. When the layout is switched from the FIG. 2 layout to the FIG. 11 layout, "the sub layout 43" of FIG. 2 "is replaced by a sub layout 210." APPLE-1004 (Hochstedler), 8:64-65. The sub layout 210 of the new FIG. 11

layout, highlighted in purple in the figure at right, is **a second display area** in which the display is capable of displaying **a measured value of a second physiological parameter** (a measured value (which I have again denoted as "###") for the parameter ("CO2") represented by the sub layout 210). *See* APPLE-1004 (Hochstedler), FIG. 11. The area occupied by the purple-highlighted sub layout 210 (the **second display area**) overlaps and encompasses the area occupied by the blue-highlighted SvO2 parameter block in the sub layout 43 (**the first display area**, as discussed above). This overlapping area can be regarded as **a common display area** at least in that it is a common area of the display shared by both the first display area and the second display area, and it is **capable of displaying information**, *e.g.*, the measured values of the first and second parameters. *See* APPLE-1004 (Hochstedler), FIGS. 2 and 11.



Composite figures based on Hochstedler's FIGS. 2 and 13

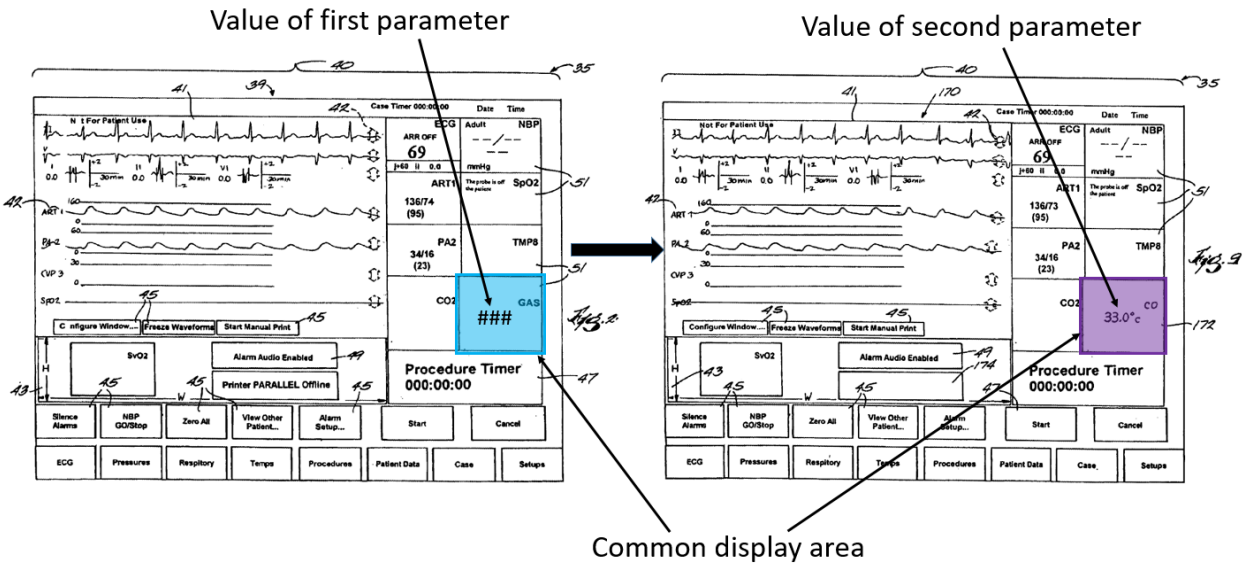
71. Importantly, a POSITA would have understood, or at least found obvious, that the blue- and purple-highlighted parameter blocks and sub layouts in the figures above can display information about parameters other than those illustrated in FIGS. 2, 9, and 13. Hochstedler states that "[t]he number and type of sensors used in the system 10 changes based on the type of information that an end user desires to see," and in light of this flexibility in terms of what sensors to use (and thus what parameters to monitor), a POSITA would have expected the layout to be similarly flexible in terms of which parameters to display. APPLE-1004 (Hochstedler), 3:42-44. For instance, a POSITA would have recognized that the parameter blocks and sub layouts in the GUIs of the combination reflect the sensors that are connected to and/or in use by the system. Moreover, a POSITA also would have understood, or at least found obvious, that parameter blocks and sub layouts other than those highlighted in the figures above, *e.g.*, depending on the environment (*e.g.*, on the patient's health status) and the user's needs. *See* APPLE-1004 (Hochstedler), 1:49-66.

[1b] wherein in the common display area, the display of one of the measured values of the first or second physiological parameter is replaced with the other of the measured values based on an occurrence of an event,

72. As I discussed in §IV.A.4, in the combination, the display layout is changed responsive to a change in monitored parameters. *See* APPLE-1004 (Hochstedler), 1:54-60, 5:26-37; APPLE-1005 (Naghavi), [0059], [0063]; APPLE-

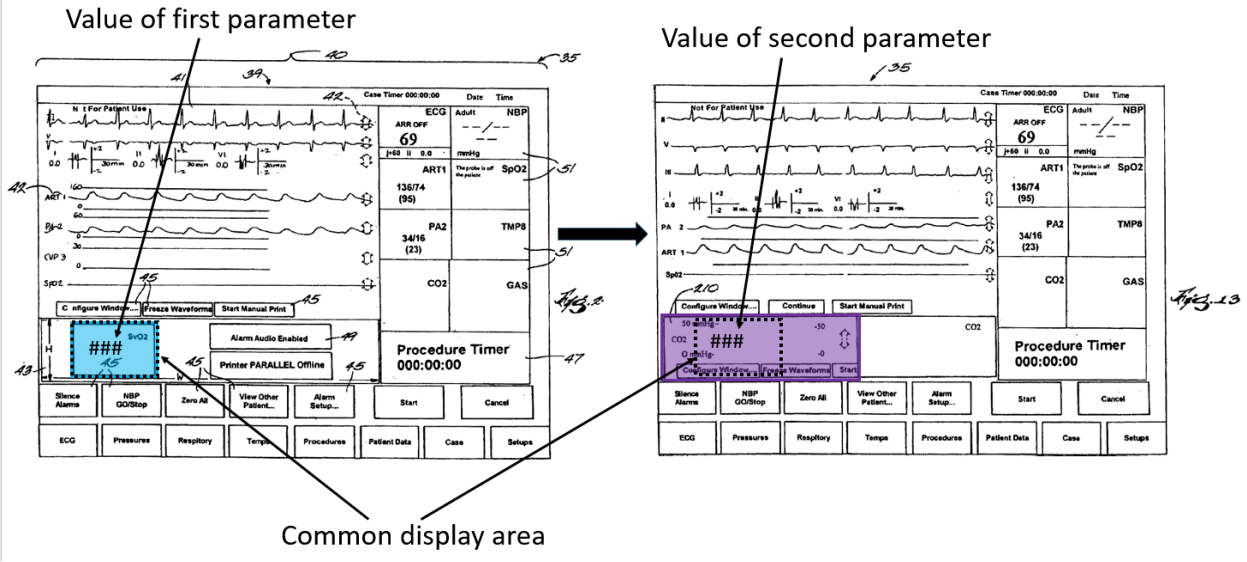
1006 (Burnes), [0038]-[0039]. When the display layout is changed, **the display of the measured value of one parameter is replaced with the measured value of the other parameter**.

73. For instance, as illustrated in the figures below, in the example I discussed above for element [1a], a layout such as that of Hochstedler's FIG. 2 "is switched to a layout 170 shown in FIG. 9." APPLE-1004 (Hochstedler), 8:40-42. The layout based on FIG. 2 includes a parameter block 51, highlighted in blue, for display of the measured value of one parameter (*e.g.*, GAS, as illustrated). The new layout based on FIG. 9 "contains a different parameter block 172," highlighted in purple, for display of the measured value of a different parameter (*e.g.*, "CO," as illustrated). *Id.*, 8:40-42. The purple parameter block 172 in the new layout takes the place of (*i.e.*, **replaces**) the blue parameter block 51 in the original layout in that **the display of the measured value of the first physiological parameter** (in the blue-highlighted parameter block of the FIG. 2-based layout) **is replaced with the measured value of the second physiological parameter** (in the purple-highlighted parameter block). This replacement occurs **in the common display area** at least because both the blue-highlighted block of the initial layout and the purple-highlighted block of the new layout occupy the common display area. *See* my discussion of element [1a] above.



Composite figures based on Hochstedler's FIGS. 2 and 9

74. In another example, illustrated in the figures below, a layout based on Hochstedler's FIG. 2 and including a "sub layout 43," highlighted in blue, "***is replaced by*** a sub layout 210," highlighted in purple, in a new layout based on Hochstedler's FIG. 13: that is, **the display of the measured value of the first physiological parameter** (in the blue-highlighted sub layout) **is replaced with the measured value of the second physiological parameter** (in the purple-highlighted sub layout). This replacement occurs **in the common display area** at least because both the blue-highlighted block and the purple-highlighted block occupy the common display area. *See* my discussion of element [1a] above. APPLE-1004 (Hochstedler), 8:64-65.



Composite figures based on Hochstedler's FIGS. 2 and 13

75. In either example, the replacement is **based on the occurrence of an event**, as I discuss in the following paragraphs.

76. First, based on the teachings of Naghavi and Hochstedler, the display layout of the combination is switched (resulting in the display of one parameter value being replaced with another) when "changes in health status" occur in the patient being monitored. APPLE-1005 (Naghavi), [0063]; *see* [0059] ("GUI 80 may further change and show different types of icons and health objects according to different diseases and/or physical conditions of the patient"), [0063] ("GUI 80 is interactive and dynamic, and may automatically detect changes in health status and health plan for patient 1 and automatically react and rearrange the available options to best suit the condition of patient 1"), claim 1 ("a graphical user interface … capable of mutating a desired mutatable characteristic of a displayed graphic user

interface element based on a predefined health status condition of a user of the healthcare specific computer operating system"); APPLE-1004 (Hochstedler), 5:31-37 ("A second type of change … relates to a change in the system environment (such as … change in the phase of the case … change in the type of medical procedure being carried out, or other similar change").

77. More specifically, the "changes in health status" that trigger the display change relate to "severity" of a monitored parameter. APPLE-1005 (Naghavi), [0059]; *see id.* ("The icons and health objects may change in color, shape, order, or other mutatable attribute according to …severity or degree of some findings, e.g. the shape, size, color, and relative position of each icon can change according to a current health status … of patient 1"). In particular, based on Burnes, the display layout change occurs when the severity of a parameter changes, *e.g.*, when a parameter value changes to become "'out of range' or "'near out of range.'" APPLE-1006 (Burnes), [0038]-[0039]; *see id*. [0038] ("any parameter values found to be 'out of range' are formatted for display as an 'alert symbol,' and "[c]ategorizing a parameter value in the 'alert' category may trigger an alarm"), [0039] ("any parameter values found to be 'near out of range' are assigned a 'warning' symbol to be displayed as the parameter value"), [0043] ("Alarms or warning messages may be displayed based on summary parameter values"). This change in the severity of a parameter is **the occurrence of an event**

that causes the display of one parameter value to be replaced with display of another—specifically, with display of the parameter whose value has become (near) out of range.

78. For instance, the initial layout display includes parameter blocks and sub layouts for display of measured values of various parameters, including the first parameter, as I discussed above for element [1a]. *See* APPLE-1004 (Hochstedler), 1:20-21, 3:38-40, FIG. 2. When the value of a parameter that is not displayed in that initial layout (*e.g.*, the second parameter) changes in severity, the layout changes (*e.g.*, from the FIG. 2 layout to a different layout, such as one based on Hochstedler's FIG. 9 or 13). *See* APPLE-1004 (Hochstedler), 1:54-60, 5:26-45, 8:40-65. In this new layout, the value of that second parameter is displayed, taking the place of the previously displayed first parameter. For instance, this change serves as an alarm that brings the parameter change to the attention of clinical staff treating the patient, as I discussed above in §IV.A.5.

[1c] the event being the measured value of one of the first or second physiological parameters approaching one or more threshold values indicative of a worsening state of a patient.

79. As discussed in [1b], the **event** is the change in severity of a parameter. *See* APPLE-1005 (Naghavi), [0059], [0063], claim 1. Specifically, the **event** is a parameter value (*e.g.*, the value of the second parameter; *see* [1b])

changing to become "out of range" or "near out of range." APPLE-1006 (Burnes), [0038]-[0039], [0043].

80. As described by Burnes, a parameter value becoming "near out of range" is "a value that has come within some predetermined range or percentage of a threshold defining the 'out of range' boundary." APPLE-1006 (Burnes), [0039]. That is, a parameter value that is "near out of range" is a parameter value that has changed over time to become closer to the "out of range boundary," but has not yet crossed that boundary—that is, a parameter value that is **approaching a threshold value**, specifically, the "threshold defining the 'out of range' boundary." *Id.*

81. The "out of range" boundary is a **threshold value indicative of a worsening state of the patient**. Burnes describes why this is the case: "An 'out of range' value is a value that has crossed a predetermined threshold … and is ***an indication that the patient may require clinical attention***." APPLE-1006 (Burnes), [0038]; *see* [0048] ("patients having one or more summary parameters categorized as 'out of range' … or otherwise are determined to have an indication that warrants medical attention"), [0037] ("parameter values are characterized according to … an 'alarm' category, indicating the patient may require medical attention based on the parameter value"). A patient who has a physiological parameter that has changed such that the patient requires clinical attention is a patient whose state has changed to become severe enough to warrant clinical

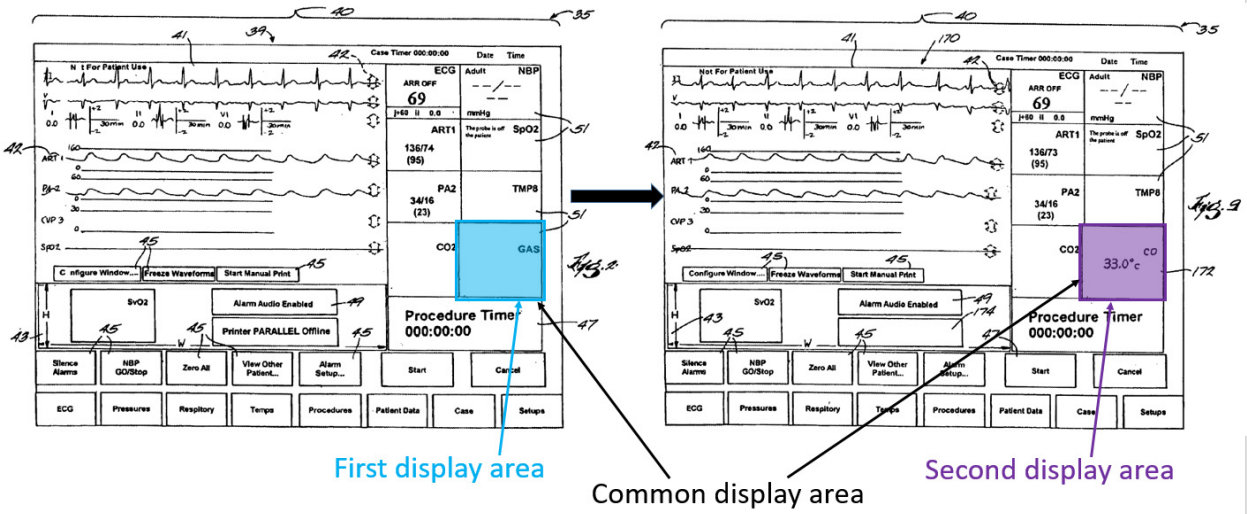
attention, *e.g.*, whose state is worsening. For at least this reason, the "out of range boundary" threshold is **indicative of a worsening state of the patient**.

82. Moreover, when the value of the parameter becomes "near out of range" (approaching the threshold value), this is also **indicative of a worsening state of the patient**. For instance, Burnes states that a parameter value that is "near out of range" is indicative that "the patient may soon require medical attention based on the corresponding parameter value." APPLE-1006 (Burnes), [0039]; *see* [0048] ("patients having one or more summary parameters categorized as … ' near out of range' or otherwise are determined to have an indication that warrants medical attention"), [0037] ("parameter values are characterized according to … a 'warning' category, indicating the patient may soon require medical attention based on the parameter value").

(ii) **Claim 2**

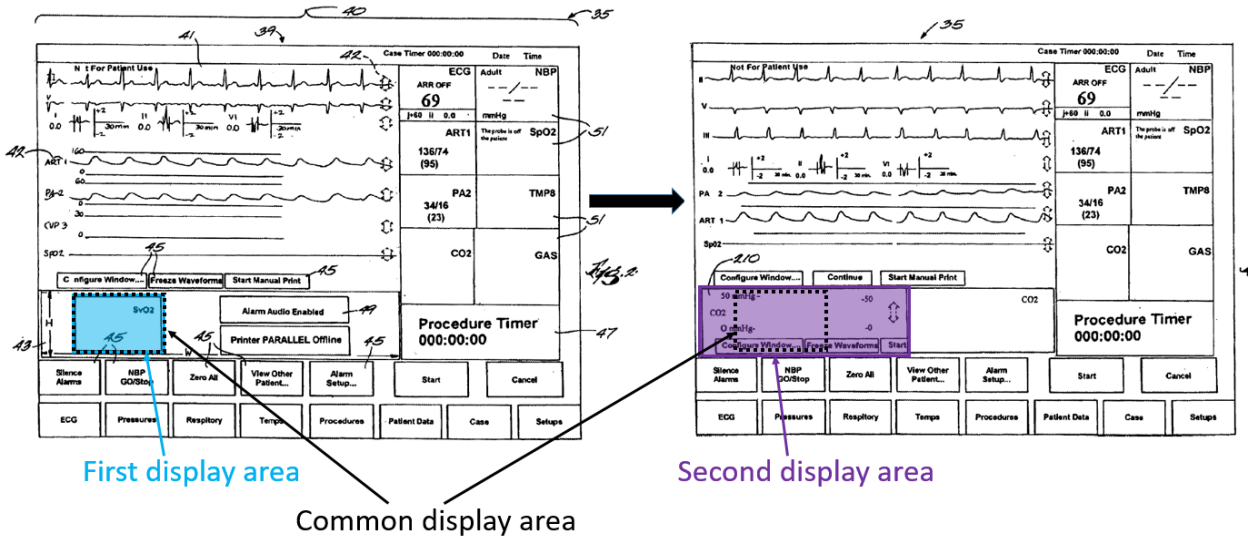
[2] The patient monitor of claim 1, wherein the first display area and the second display area comprise the common display area.

83. *See* my discussion of elements [1a]-[1b]. As illustrated in the figures below, when one parameter block replaces another (*e.g.*, when the layout is changed from Hochstedler's FIG. 2 layout to the FIG. 9 layout), the first and second display areas occupy substantially the same display area, and thus the first display area and the second display area include the common display area.



Composite figures based on Hochstedler's FIGS. 2 and 9

84. Alternatively or additionally, again illustrated in the figures below, when one sub-layout replaces another (*e.g.*, when the layout is changed from Hochstedler's FIG. 2 layout to the FIG. 13 layout), the common display area falls entirely within both the first and second display areas, *e.g.*, both display areas include the common display area.



Composite figures based on Hochstedler's FIGS. 2 and 13

(iii) **Claim 3**

[3] The patient monitor of claim 1, wherein activation of a user input causes the common display area to replace one of the measured value of the first or second physiological parameter with the other of the measured value of the first or second physiological parameter.

85. In the combination, Hochstedler describes that the change in layout (the **replacement**; *see* my discussion of [1b]) can be "an automatic layout switch [that] occur[s] after prompting the user for approval of the proposed change." APPLE-1004 (Hochstedler), 5:42-45; *see* 1:63-67 ("the system may … prompt the user to change the layout by presenting a selection of layout options"), 8:39-42 ("If the user selects the OK button 162, the layout is switched to a layout 170 shown in FIG. 9. The layout contains a different parameter block 172"), FIG. 5 ("Prompt for Approval"), FIG. 8 ("Select Layout Configuration"). Receipt of the user's approval is **activation of a user input**, which results in the change in layout, *e.g.*, **causes the replacement**.

(iv) **Claim 4**

[4] The patient monitor of claim 1, wherein the common display area is configured to default to displaying one of the measured values of the first or second physiological parameters.

86. In the combination, Hochstedler describes that a dialog box, shown in Hochstedler's FIG. 8, reproduced and annotated below, is presented to a user in advance of a change in the layout. *See* APPLE-1004 (Hochstedler), 8:30-42. One or more "layouts [are] listed in the dialog box," which also includes "an acceptance

mechanism in the form of an OK button 162 to confirm the switch" to a new layout and "a default selection button 163," highlighted in red. APPLE-1004 (Hochstedler), 8:36-38. In the context of a dialog box for selection of a layout, a POSITA would have understood, or at least found to be obvious, that user activation of the "default selection button" causes display of a default layout. APPLE-1004 (Hochstedler), 8:36-38.

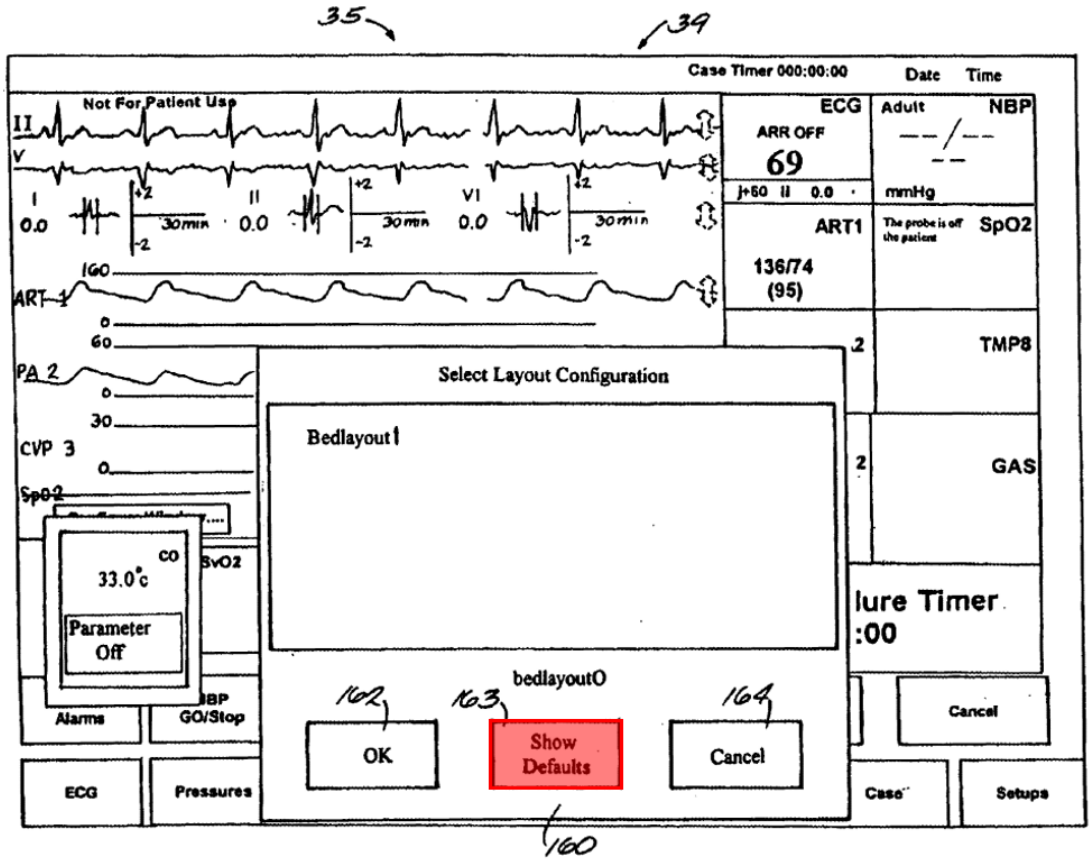


Fig. 8

Excerpt from Hochstedler, FIG. 8 (annotated)

87. As I discussed above for element [1a], each layout displays the measured value of at least one physiological parameter in the common display area, and the common display area is thus configured to default to displaying the

measured value of the parameter that is represented in the default layout. For instance, when a layout such as that of Hochstedler's FIG. 2 is the default layout, **the common display area is configured to default to displaying the measured value of the first parameter**; when a layout such as that of Hochstedler's FIG. 9 or 13 is the default layout, **the common display area is configured to default to displaying the measured value of the first parameter**.

(v) **Claim 6**

[6] The patient monitor of claim 1, wherein the measured value of the first physiological parameter comprises a non-invasively measured value.

88. In the combination, the physiological parameters are measured using non sensors such as "a blood-pressure sensor 14, a temperature sensor 16, an ECG electrode 18, a blood oxygen sensor 20, and a respiratory sensor 22." APPLE-1004 (Hochstedler), 3:14-17. These sensors perform **non-invasive** measurements, *e.g.*, because their measurements are performed external to body tissue, and thus the parameter values measured by these sensors are **non-invasively measured values**.

(vi) **Claim 11**

[11] The patient monitor of claim 1, wherein an aspect of the display changes to illustrate a change in the severity of one of the measured values of the first or second physiological parameters.

89. In the combination, "[t]he icons and health objects may change in color, shape, order, or other mutatable attribute," *e.g.*, the layout is switched, based

on "***severity*** or degree of some findings." APPLE-1005 (Naghavi), [0059]; *see* [0063] ("GUI 80 … may automatically detect changes in health status … and automatically react and rearrange the available options to best suit the condition of patient 1"); *see* my discussion of element [1b]. For instance, the layout is switched to display the parameter block for the second parameter responsive to a change in severity of the second parameter. *See* my discussion of element [1b]. This change in layout is **an aspect of the display that changes to illustrate a change in the severity** of the value of the second parameter. Alternatively or additionally, the "color, shape, … or other mutatable attribute" is also each **an aspect of the display that changes to illustrate a change in the severity** of the value of the second parameter. APPLE-1005 (Naghavi), [0059].

90. Specifically, in the combination, based on the teachings of Burnes, when the layout is switched responsive to the value of the second parameter becoming "out of range" (*see* my discussion of element [1c] above), the displayed value of the second parameter "may be highlighted or displayed in particular color, such as red, to draw attention to the value a parameter value." APPLE-1006 (Burnes), [0057]; *see* [0007] ("parameter values are displayed in alphanumeric values, which may be formatted in color-coded text … which allow a parameter value category to be recognized"), [0035] ("different symbols, colors, font, highlighting, shading, or other formatting schemes may be used to differentiate

between categories [of parameter values]. In particular, values that require updating or are of particular clinical concern may be formatted for display in a conspicuous manner to draw the attention of a clinician or other user"). Moreover, when the layout is switched responsive to the value of the second parameter becoming "near out of range," the displayed value of the second parameter "may be displayed or highlighted in yellow." APPLE-1006 (Burnes), [0057]; *see* [0007], [0035]. In either case, the color of the displayed value of the second parameter is **an aspect of the display that changes** to illustrate the value of the second parameter changing to become (near) out of range, *i.e.*, **to illustrate a change in the severity** of the value of the second parameter.

91. Alternatively or additionally, when the layout is switched responsive to the value of the second parameter becoming "out of range" (*see* my discussion of element [1c] above), "a red symbol may be used as an alert symbol" in the parameter block or sub layout for the second parameter. APPLE-1006 (Burnes), [0050]; *see* [0038] ("any parameter values found to be 'out of range' are formatted for display as an 'alert' symbol"), [0008] ("categorized parameter values are displayed by a red, yellow, or green symbol where a red symbol indicates the parameter value falls in a range that indicates a need for clinical attention"), [0035] ("different symbols, colors, font, highlighting, shading, or other formatting schemes may be used to differentiate between categories [of parameter values]. In

particular, values that require updating or are of particular clinical concern may be formatted for display in a conspicuous manner to draw the attention of a clinician or other user"), [0042], [0056], FIG. 6, claim 11. When the layout is switched responsive to the value of the second parameter becoming "near out of range," "a yellow symbol [is used as] as a warning symbol" in the parameter block or sub layout for the second parameter. APPLE-1006 (Burnes), [0050]; *see* [0039] ("any parameter values found to be 'near out of range' are assigned a 'warning' symbol to be displayed as the parameter value in the summary display"), [0008] ("categorized parameter values are displayed by a red, yellow, or green symbol where … a yellow symbol indicates the parameter value is approaching or near a value that indicates a need for clinical attention"), [0035], [0042], [0056], FIG. 6, claim 11. In either case, the display of a symbol in the parameter block or sub layout for the second parameter is **an aspect of the display that changes** to illustrate the value of the second parameter changing to become (near) out of range, *i.e.*, **to illustrate a change in the severity** of the value of the second parameter.

(vii) **Claim 12**

[12] The patient monitor of claim 11, wherein the aspect that changes comprises a display color.

92. *See* my discussion of element [11]. In the combination, Burnes describes that **the display color** of the displayed parameter value changes. *See* APPLE-1006 (Burnes), [0008], [0042], [0050], [0057].

(viii) **Claim 13**

[13pre] A patient monitor capable of measuring at least two physiological parameters,

93. Naghavi-Hochstedler-Burnes renders element [13pre] obvious for at least the same reasons I discussed above for element [1pre].

[13a] the patient monitor comprising a display capable of displaying a measured value of a first physiological parameter of body tissue of a monitored patient in a first display area or displaying a measured value of a second physiological parameter of the body tissue in a second display area where the first display area and the second display area comprise at least some common display area capable of displaying information,

94. Naghavi-Hochstedler-Burnes renders element [13a] obvious for at least the same reasons I discussed above for element [1a].

[13b] wherein the common display area changes from displaying one of the measured values of the first or second physiological parameter to displaying the other of the measured values based on an occurrence of an event,

95. *See* my discussion of element [1b]. **Based on an occurrence of an event**, the display is switched from one layout to another, thus replacing the display of the value of the first parameter with the value of the second parameter.

See APPLE-1004 (Hochstedler), 1:54-60, 5:26-45. When this replacement occurs, **the common display area changes from displaying the measured value of the first physiological parameter** (*e.g.*, in the blue-highlighted parameter block or sub layout of a layout based on Hochstedler's FIG. 2) **to displaying the measured value of the second physiological parameter** (in the purple-highlighted parameter block or sub layout of a layout based on Hochstedler's FIG. 9 or 13). *See* APPLE-1004 (Hochstedler), 1:54-60, 5:26-45.

[13c] the event being the measured value of one of the first or second physiological parameters approaching one or more threshold values indicative of a worsening state of a patient,

96. Naghavi-Hochstedler-Burnes renders element [13c] obvious for at least the same reasons I discussed above for element [1c].

[13d] wherein an aspect of the display changes to illustrate a change in the severity of one of the measured values of the first or second physiological parameters, wherein the aspect that changes comprises a display size.

97. In the Naghavi-Hochstedler-Burnes combination, **an aspect of the display changes to illustrate a change in the severity** of the value of the second parameter. *See* APPLE-1005 (Naghavi), [0059], [0063]; APPLE-1006 (Burnes), [0007], [0035], [0057], *see* my discussion of elements [1b] and [11]. For instance, Naghavi describes that "the shape, ***size***, color, and relative position of each icon can change according to a current health status … of patient 1." APPLE-1005 (Naghavi), [0059]. In the combination, when the layout is switched responsive to

the value of the second parameter becoming "out of range" (APPLE-1006 (Burnes), [0057]; *see* my discussion of element [1c] above), the display of the second parameter changes in size, as taught by Naghavi.

(ix) **Claim 14**

[14] The patient monitor of claim 11, wherein the aspect that changes comprises a display intensity.

98. *See* my discussion of element [11] above. In the combination, based on the teachings of Burnes, when the layout is switched responsive to the value of the second parameter becoming "out of range" (*see* my discussion of element [1c] above), the displayed value of the second parameter "may be ***highlighted*** or displayed in particular color, such as red, to draw attention to the value a parameter value." APPLE-1006 (Burnes), [0057]; *see* [0035] ("different symbols, colors, ***font***, ***highlighting***, shading, or other formatting schemes may be used to differentiate between categories [of parameter values]. In particular, values that require updating or are of particular clinical concern may be formatted for display in a conspicuous manner to draw the attention of a clinician or other user"). Moreover, when the layout is switched responsive to the value of the second parameter becoming "near out of range," the displayed value of the second parameter "may be displayed or ***highlighted*** in yellow." APPLE-1006 (Burnes), [0057]; *see* [0007], [0035]. In either case, the highlighting or change in font of the displayed value of the second parameter is **a display intensity**.

(x) Claim 15

[15pre] A patient monitor capable of measuring at least two physiological parameters,

99. Naghavi-Hochstedler-Burnes renders element [15pre] obvious for at least the same reasons I discussed above for element [1pre].

[15a] the patient monitor comprising a display capable of displaying a measured value of a first physiological parameter of body tissue of a monitored patient in a first display area or displaying a measured value of a second physiological parameter of the body tissue in a second display area where the first display area and the second display area comprise at least some common display area capable of displaying information,

100. Naghavi-Hochstedler-Burnes renders element [15a] obvious for at least the same reasons I discussed above for element [1a].

[15b] where in the common display area, the display of one of the measured values of the first or second physiological parameter is replaced with the other of the measured values of the first or second physiological parameters based on an occurrence of an event,

101. Naghavi-Hochstedler-Burnes renders element [15b] obvious for at least the same reasons I discussed above for element [1b].

[15c] the event being one of the measured values of the first or second physiological parameters alarming.

102. As I discussed previously in conjunction with element [1c], the **event** is the value of the second parameter changing to become "out of range" or "near out of range." APPLE-1006 (Burnes), [0038]-[0039]. This change in the second parameter (**the event**) is **the measured value of the second parameter alarming** at least because the change in the value of the second parameter causes a display

change (*e.g.*, causes the value of the second parameter to be displayed) that acts as an alarm, alerting clinical staff of the value of the second parameter. *See* APPLE-1006 (Burnes), [0007]-[0008], [0034]-[0035], [0037]-[0039].

103. Alternatively or additionally, the value of the second parameter changing to become "out of range" or "near out of range" (**the event**) is itself **the measured value of the second parameter alarming**. APPLE-1006 (Burnes), [0038]-[0039]. For instance, the value of the parameter becoming "out of range" is the value **alarming** at least because this change "is an indication that the patient may require clinical attention" and "may trigger an alarm." APPLE-1006 (Burnes), [0038]; *see* [0037] ("an 'alarm' category, indicating the patient may require medical attention based on the parameter value"), [0038] ("any parameter values found to be 'out of range' are formatted for display as an 'alert' symbol"), [0039] ("any parameter values found to be 'near out of range' are assigned a 'warning' symbol to be displayed as the parameter value in the summary display"), [0007]-[0008], [0034]-[0035]. More specifically, a parameter becomes "out of range" when it "has crossed a predetermined threshold or fallen outside a normally accepted range." APPLE-1006 (Burnes), [0038]; *see* [0039] ("uniquely defined thresholds or ranges may be used to define both the 'out of range' and 'near out of range' categories for any given parameter"). The value of the second parameter crossing a threshold is **the measured value of the second parameter alarming**,

e.g., because the value of the second parameter has changed to beyond a threshold that triggers an alarm, such as a display change (alarm) to alert staff of the change in value of the second parameter.

(xi) **Claim 16**

[16] The patient monitor of claim 15, wherein an aspect of an alarm changes when the common display area changes from displaying one of the measured values of the first or second physiological parameters.

104. The change from one display layout to another such that **the common display area changes from displaying the measured value of the first parameter** to displaying the measured value of the second parameter is **an aspect of an alarm**. *See* my discussion of elements [1b] and [15c]; APPLE-1004 (Hochstedler), 1:54-60, 5:26-37, 8:40-65.

105. As discussed in [11], the color of the displayed parameter value is **an aspect of an alarm that changes** to reflect a change in severity of the second parameter. *See* APPLE-1006 (Burnes), [0007], [0035], [0057]. Alternatively or additionally, as also discussed in [11], the display of a symbol in the parameter block or sub layout for the second parameter is **an aspect of an alarm that changes** to reflect a change in severity of the second parameter. *See* APPLE-1006 (Burnes), [0008], [0035], [0038]-[0039], [0042], [0050], [0056], FIG. 6, claim 11. Each of these is specifically **an aspect of the alarm** because it is an aspect (color

or symbol) of the display change triggered by the measured value of the second parameter alarming. *See* my discussion of element [15c].

(xii) **Claim 17**

[17] The patient monitor of claim 16, wherein the aspect that changes comprises a display color.

106. *See* my discussion of element [16]. In the combination, Burnes describes that **the display color** of the displayed parameter value changes. *See* APPLE-1006 (Burnes), [0008], [0042], [0050], [0057].

(xiii) **Claim 18**

[18pre] A patient monitor capable of measuring at least two physiological parameters,

107. Naghavi-Hochstedler-Burnes renders element [18pre] obvious for at least the same reasons I discussed above for element [1pre].

[18a] the patient monitor comprising a display capable of displaying a measured value of a first physiological parameter of body tissue of a monitored patient in a first display area or displaying a measured value of a second physiological parameter of the body tissue in a second display area where the first display area and the second display area comprise at least some common display area capable of displaying information,

108. Naghavi-Hochstedler-Burnes renders element [18a] obvious for at least the same reasons I discussed above for element [1a].

[18b] wherein in the common display area, the display of one of the measured values of the first or second physiological parameters is replaced with the other of the measured values of the first or second physiological parameters

automatically based on which is a more critical one of the measured values of the first or second physiological parameters.

109. In the combination, in the common display area, the display of one of the measured values of the first or second physiological parameters is replaced with the other of the measured values of the first or second physiological parameters when a parameter changes to become "out of range" or "near out of range." *See* my discussion of elements [1b]-[1c]; APPLE-1005 (Naghavi), [0059], [0063]; APPLE-1006 (Burnes), [0038]-[0039], [0043]. For instance, when the second parameter so changes, the display of the value of the first parameter is replaced with the value of the second parameter. *See* my discussion of element [1b]. The second parameter becoming (near) out of range is an indication that the second parameter is a more critical one of the measured values of the parameters, *e.g.*, as compared to a first parameter that has not changed toward being out of range. Moreover, the replacement is automatic. *See* APPLE-1004 (Hochstedler), 5:42-45 (describing that the change in layout can be "an automatic layout switch"); APPLE-1005 (Naghavi), [0063] ("GUI 80 is interactive and dynamic, and may automatically detect changes in health status and health plan for patient 1 and automatically react and rearrange the available options to best suit the condition of patient 1").

(xiv) **Claim 20**

[20] The patient monitor of claim 18, wherein at least one of measured physiological parameters is determined noninvasively.

110. Naghavi-Hochstedler-Burnes renders claim [20] obvious for at least the same reasons I discussed above for claim [6].

(xv) **Claim 21**

[21pre] A method of displaying two physiological parameter measurements using a display location of a display of a patient monitoring device, the display location being generally capable[1] of displaying a single physiological parameter measurement, the method comprising:

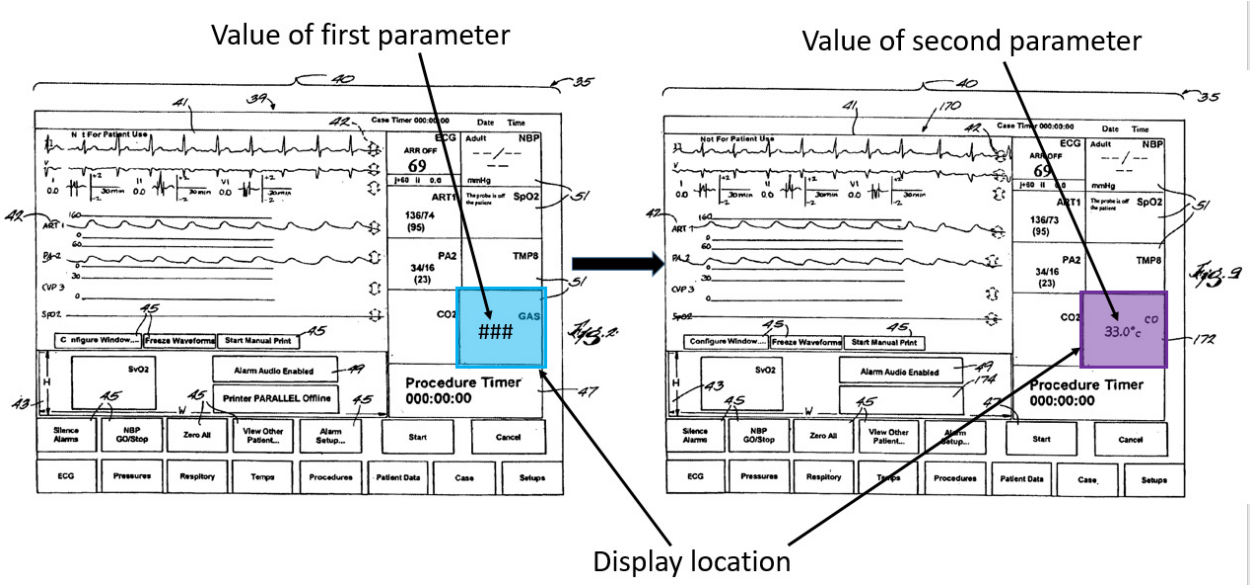
111. To the extent the preamble is deemed to be limiting, Naghavi-Hochstedler-Burnes renders it obvious, for the following reasons.

112. In the Naghavi-Hochstedler-Burnes combination, a patient monitoring device includes a display. *See* my discussion of elements [1pre]-[1a]. Also in the combination, two physiological parameter measurements are displayed using a display location of the display, illustrated in the figures below. *See* my discussion of element [1a].

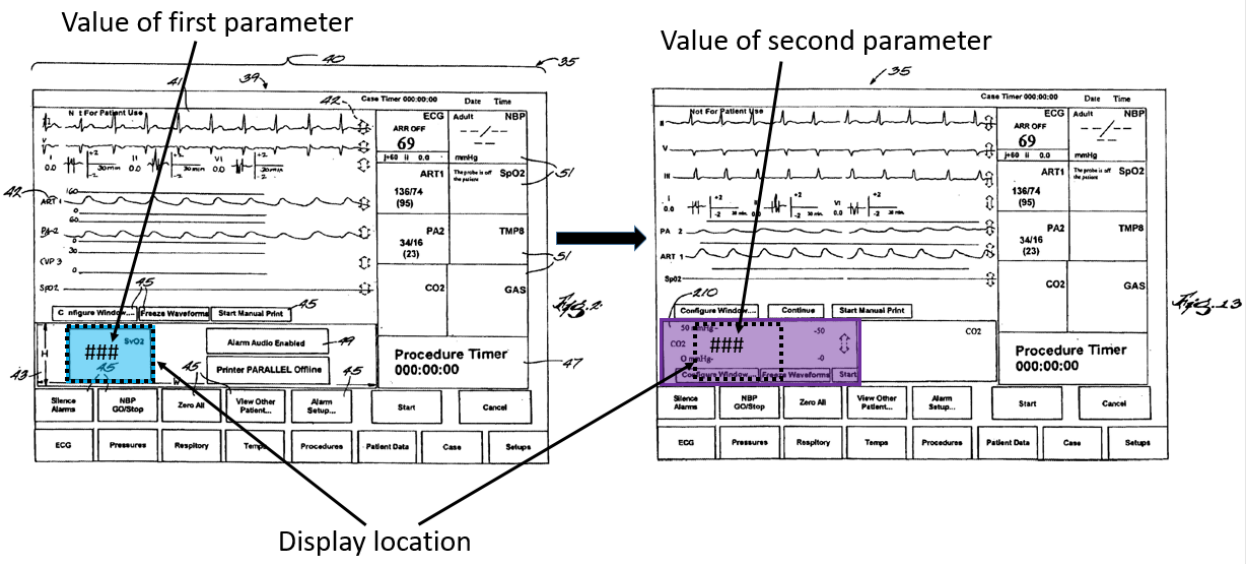
113. The display location is the area of a parameter block or sub-layout in which a parameter value is displayed. This **display location is generally capable of displaying a single physiological parameter measurement**: the parameter value represented by the parameter block or sub-layout in the currently displayed

[1] I interpret the phrase "generally capable" as best understood.

layout. *See* my discussion of element [1a]; APPLE-1004 (Hochstedler), 1:54-60, 5:26-37, 8:40-65, FIG. 1, FIG. 9, FIG. 13. For instance, as illustrated in both pairs of figures below, the display location is the area occupied by the blue-highlighted parameter block or sub-layout in the layout at left, and displays the value of a single parameter: the first physiological parameter. When the layout changes from the layout on the left of each pair to the layout on the right of each pair, the display location (highlighted in purple in the new layout) displays the value of a single (different) parameter: the second physiological parameter. *See* my discussion of element [1a].



Composite figures based on Hochstedler's FIGS. 2 and 9



Composite figures based on Hochstedler's FIGS. 2 and 13

[21a] displaying a measured value of a first physiological parameter in a display location of an electronic display; and

114. *See* my discussion of element [1a]. The combination patient monitor includes **an electronic display**, *e.g.*, based on Naghavi's "output device 8 such as a monitor" or implemented as a display at a "remote service." APPLE-1005 (Naghavi), [0025], [0044]; *see* [0027], [0038], [0057], [0069]. In the combination, **a measured value of a first physiological parameter is displayed in a display location of the electronic display**, *e.g.*, in the blue-highlighted parameter block in the first pair of figures in [21pre] or in the blue-highlighted sub-layout in the second pair of figures in [21pre]. *See* my discussion of element [1a].

[21b] replacing the display of the measured value of the first physiological parameter with a display of a measured value of a second physiological

parameter in the display location when a change in the measurement of the second physiological parameter indicates a worsening state of the patient.

115. *See* my discussion of element [1b]. In the combination, **the display of the measured value of the first physiological parameter is replaced with a display of a measured value of a second physiological parameter in the display location**, *e.g.*, the value of the first parameter displayed in the blue-highlighted parameter block or sub-layout in the initially displayed layout (at left in the figures in [21pre]) is replaced with the value of a second parameter displayed in the purple-highlighted parameter block or sub-layout (at right in the figures in [21pre]). *See* APPLE-1004 (Hochstedler), 1:54-60, 5:26-37, 8:40-65.

116. This replacement occurs **when the measured value of the second parameter changes** in severity, *e.g.*, to become "out of range" or "near out of range," which **indicates a worsening state of the patient**. *See* my discussion of element [1c]; APPLE-1005 (Naghavi), [0059], [0063]; APPLE-1006 (Burnes), [0037]-[0039], [0043], [0048].

(xvi) **Claim 22**

[22] The method of claim 21, wherein the indication of the worsening state comprises an alarm condition.

117. In the combination, the measured value of the second parameter changing to become "out of range" or "near out of range" (**the indication of the worsening state**; *see* my discussion of element [21b], [1c]) is the measured value

of the second parameter alarming, *e.g.*, **an alarm condition**. *See* my discussion of element [15c]; APPLE-1006 (Burnes), [0037]-[0039].

B. [GROUND 1B] – CLAIMS 19, 27-28, 32, 34, 36-37, AND 42-43 ARE OBVIOUS OVER NAGHAVI-HOCHSTEDLER-BURNES-HAYASHI

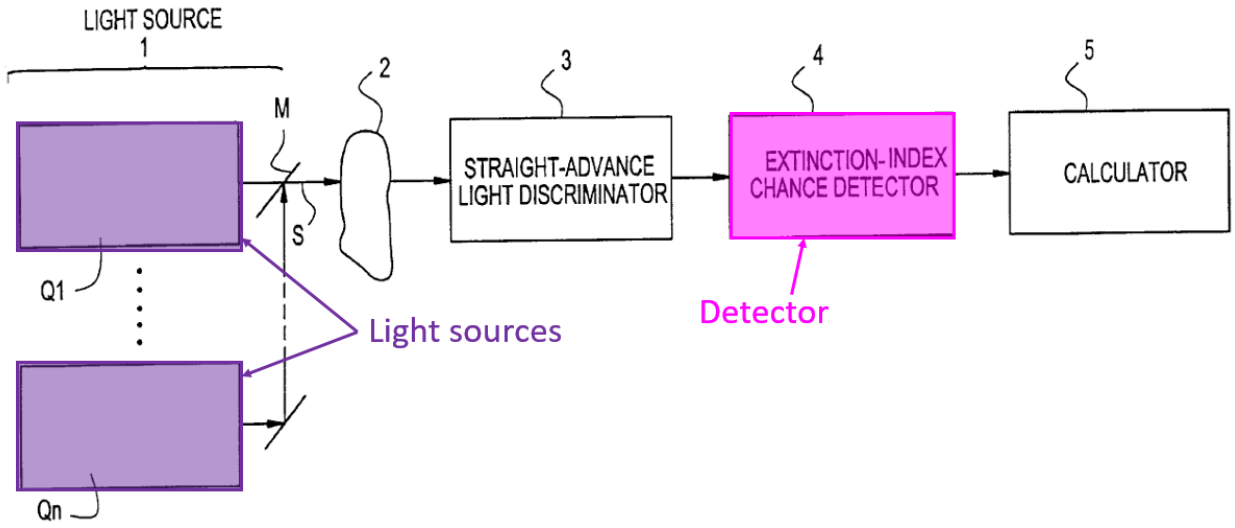
118. The sections below provide a discussion of Hayashi and the application of the Naghavi-Hochstedler-Burnes-Hayashi combination to the claims.

1. Hayashi describes optical measurement of blood constituents

119. Hayashi describes a "blood-constituent concentration measuring instrument capable of accurately measuring concentrations of the constituent parts of blood without invading tissue." APPLE-1007 (Hayashi), Abstract. For instance, Hayashi's instrument measures "the concentration of the hemoglobin (oxyhemoglobin, deoxyhemoglobin, carboxyhemoglobin, methemoglobin, etc.) in blood and the concentration of the bilirubin in blood." *Id.*, 1:10-14.

120. Hayashi's instrument, shown in FIG. 1, reproduced and annotated below, includes a "light source means 1" with "n light sources Q1~Qn," highlighted in purple, that "emits measuring light … [that] consists of wavelength components corresponding in number to variables to be measured." APPLE-1007 (Hayashi), 4:32-36. The light is incident on tissue; "absorption and scattering will take place in the tissue, the vein, and the artery. As a result, incident light will be

attenuated." *Id.*, 4:63-66. A "[s]traight-advance light discrimination means 3 discriminates only a straight-advance light component or a scattered light component close thereto … from the light scattered by the living organism." *Id*., 4:56-61. An "[e]xtinction-index change detection means 4," highlighted in pink, "detects an extinction index change in the straight-advance light component or a scattered light component close thereto, extracted by the straight-advance light discrimination means 3." *Id.*, 5:3-8. In a specific implementation, the "extinction-index change detection means" includes "an optical detector" that "detects the light of respective wavelengths emitted by the light sources." *Id.*, 7:19-23; *see* FIG. 4. This extinction index change for each of the wavelengths of the incident light enables calculation of the "concentrations … of constituent parts," *e.g.*, the concentrations of oxyhemoglobin, deoxyhemoglobin, carboxyhemoglobin, methemoglobin, and/or bilirubin. *Id.*, 5:8-40; *see* 7:31-40.



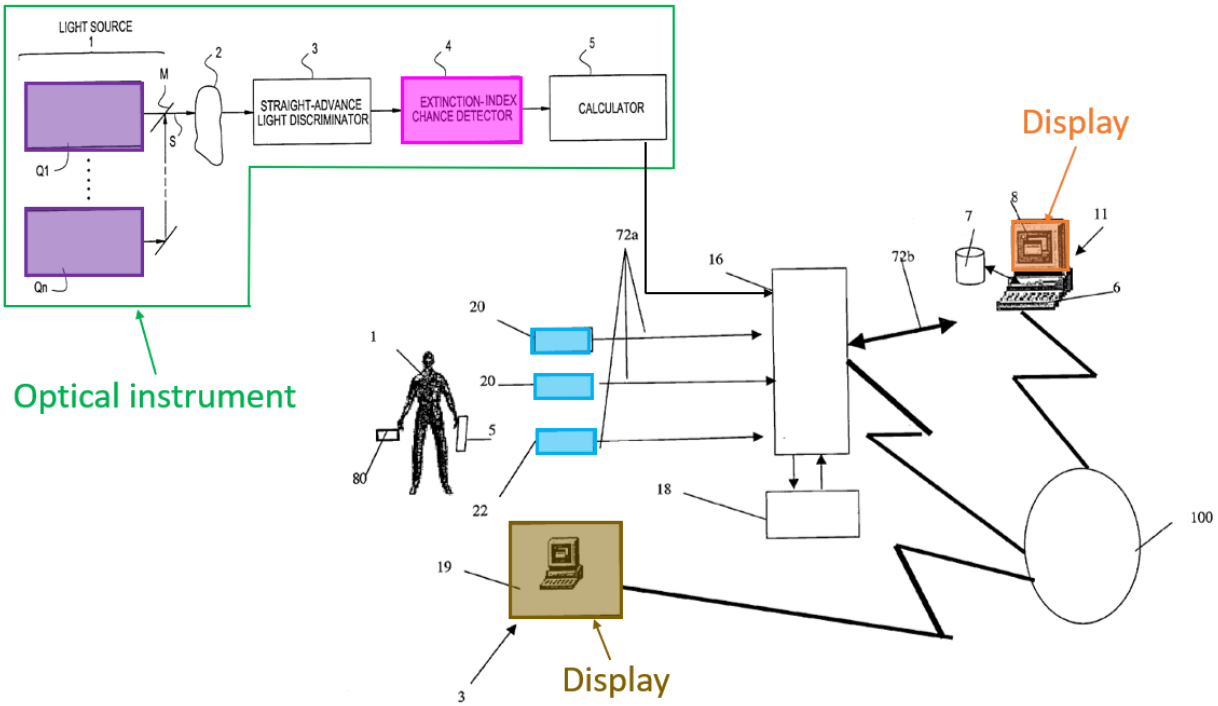
Excerpt from Hayashi, FIG. 1 (annotated)

2. The Naghavi-Hochstedler-Burnes-Hayashi combination

121. I have generated a composite figure, below, illustrating an example of the combination patient monitor resulting from the combination of Naghavi, Hochstedler, Burnes, and Hayashi. This combination patient monitor incorporates an optical instrument "for optically measuring the concentration of the constituent parts of the blood of a living organism," e.g., "the concentration of the hemoglobin (oxyhemoglobin, deoxyhemoglobin, carboxyhemoglobin, methemoglobin, etc.) in blood and the concentration of the bilirubin in blood," based on the teachings of Hayashi. APPLE-1007 (Hayashi), 1:7-14.

122. This Hayashi-based instrument, outlined in green in the figure below, is included in addition to (as illustrated) or instead of other sensors (highlighted in blue) such as those described by Naghavi. *See* APPLE-1005 (Naghavi), [0029]-

[0030], [0032]. Importantly, as I discussed above for element [1pre], one or more of the sensors in this combination system can be implemented based on the teachings of Hochstedler. Hochstedler identifies a "blood oxygen sensor" as one example of such a sensor. APPLE-1004 (Hochstedler), 3:14-17. In a specific implementation of the Naghavi-Hochstedler-Burnes-Hayashi combination, the "blood oxygen sensor" indicated by Hochstedler is implemented as an optical instrument such as that described by Hayashi.



Naghavi-Hochstedler-Burnes-Hayashi composite figure

123. In the illustrated implementation, a calculator of the optical instrument calculates the concentrations of the blood constituents, *e.g.*, as described by Hayashi, and the calculation results are displayed in respective parameter blocks

on the combination display (highlighted in orange or brown). *See* APPLE-1007 (Hayashi), 7:32-40; APPLE-1004 (Hochstedler), 1:20-21, 3:38-40.

3. Reasons for the combination

124. It is my opinion that a POSITA would have been motivated to implement the Naghavi-Hochstedler-Burnes-Hayashi combination described in the preceding section for at least the following reasons.

125. The first reason why a POSITA would have recognized the clinical utility of monitoring concentrations of specific blood constituents, and would have been motivated to integrate an instrument such as Hayashi's into the combination system, is to obtain a system with the capability of monitoring these clinically relevant parameters. For instance, the concentrations of hemoglobin (including oxyhemoglobin, deoxyhemoglobin, carboxyhemoglobin, methemoglobin, etc) provide a detailed picture of the oxygen concentration of the issue of a living organism that has "extremely great significance in clinical medicine." APPLE-1007 (Hayashi), 1:17-19. The clinical relevance of these parameters is corroborated by Jarman, which explains that the blood concentration of carboxyhemoglobin is an indication of carbon monoxide, and that a carboxyhemoglobin measurement can indicated medication or drug usage or pathological issues. *See* APPLE-1008 (Jarman), 1:23-37. Similarly, there is a need to monitor the concentration of bilirubin in the blood "in order to monitor for

jaundice in newborn babies." APPLE-1007 (Hayashi), 1:46-47. A POSITA would have been motivated to have such measurements provided in the combination monitor to have access to these clinically relevant data.

126. The second reason why a POSITA would have been motivated to pursue this implementation is because of the advantages of non-invasive monitoring of blood constituents, for instance, non-invasive optical monitoring of an instrument such as Hayashi's. *See* APPLE-1007 (Hayashi), 3:22-28 ("a blood-constituent concentration measuring instrument that is capable of measuring the concentrations of various constituent parts of blood … without invading tissue"). For instance, a POSITA would have understood that non-invasive instruments present a lower risk of infection or injury to the patient than do invasive instruments, *e.g.*, because they do not break the patient's skin and thus provide fewer routes for entry of contaminants or pathogens into the patient's body. A POSITA also would have expected non-invasive health monitoring to be a simpler and more efficient method for monitoring than using an invasive instrument. For instance, with a non-invasive monitor, a patient can perform his or her own monitoring at home (particularly relevant in the context of a home-based monitoring system such as that of Naghavi). This flexibility and portability is advantageous and can help enhance compliance with monitoring protocols, which

in turn can lead to better health outcomes for the patients participating in Naghavi's home health monitoring system.

127. To the extent an instrument having the specific configuration described by Hayashi is incorporated into the combination patient monitor, the third reason why a POSITA would have been motivated to pursue this implementation is because this particular instrument has the advantage that it "is capable of accurately measuring the concentrations of various constituent parts of blood." APPLE-1007 (Hayashi), 3:24-25; *see* 4:29-31 ("the concentrations of the constituent parts of blood can be measured with a high degree of accuracy"), 5:40-46, 8:67-9:3. As I discussed earlier in this section, monitoring various parameters (such as hemoglobin) has clinical advantages, for instance, because different types of hemoglobin are indicators for different clinical issues. APPLE-1008 (Jarman), 1:23-37.

128. The fourth reason why a POSITA would have been prompted to pursue this implementation is because this combination is just the application of known techniques (specifically, optical monitoring of blood constituent concentrations) by an already-known system (specifically, the Naghavi-Hochstedler-Burnes monitor) and it yields predictable results (specifically, a multi-parameter monitoring system with capability to monitor blood constituent concentrations).

129. Moreover, it is my opinion that a POSITA would have expected to be successful in pursuing this combination for at least the following reasons. First, a POSITA would have expected to be successful in pursuing this implementation given that monitoring of the concentration of various blood constituents in multiparameter patient monitoring systems was common. *See* APPLE-1008 (Jarman), Abstract. Second, a POSITA would have expected success because of Naghavi's flexibility with regard to the attached sensors; Naghavi describes that the system can incorporate or interface with "[a] variety of sensors 22 for obtaining biophysical, biomechanical, physiological, biochemical, and electromechanical parameters … may be used to connect patients to personal healthcare management system." APPLE-1005 (Naghavi), [0033]. Hochstedler's specific implementation of the user interface is similarly flexible with respect to the type of sensor: "[o]ther sensors could be added to the system or the sensors shown could be removed from the system," *e.g.*, "depend[ing] on the type of activity monitored." APPLE-1004 (Hochstedler), 3:17-19. Third, a POSITA would have expected success because Hayashi, like Hochstedler, Naghavi, and Burnes, is generally in the field of medical monitoring. *See* APPLE-1007 (Hayashi), Abstract.

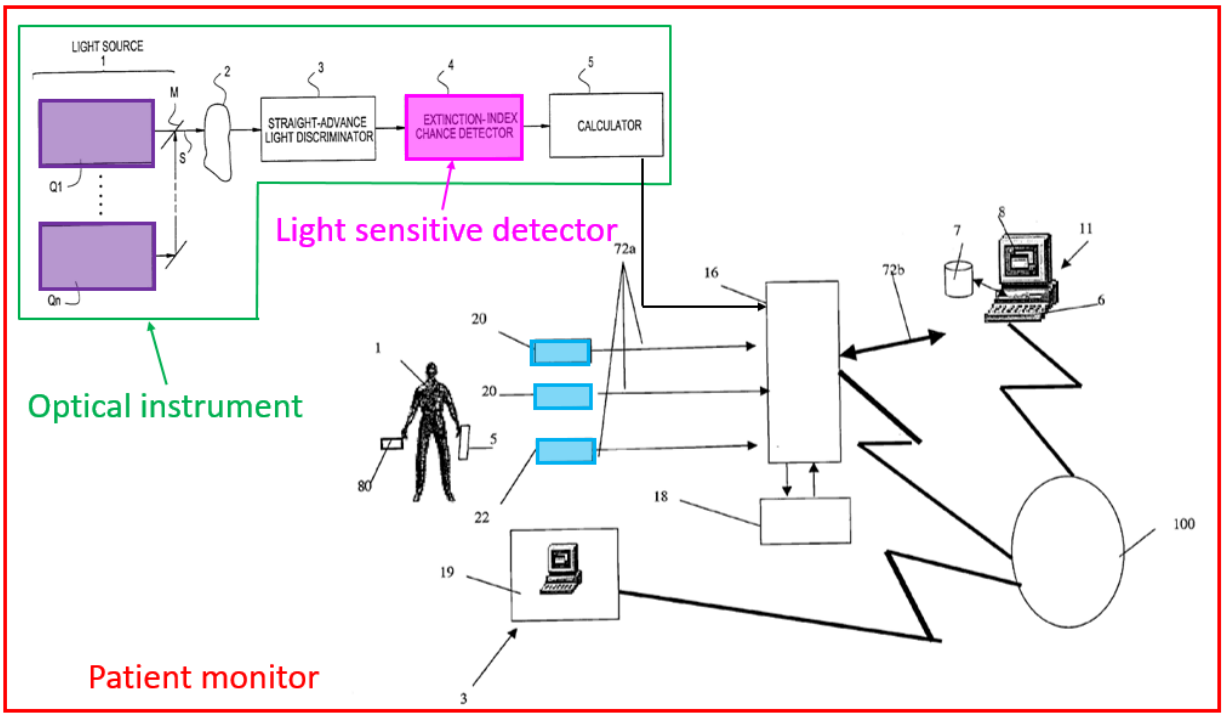
4. Analysis

(i) **Claim 19**

[19] The patient monitor of claim 18, wherein measured values of the first and second physiological parameters are determined using an output signal of a

light sensitive detector capable of detecting light attenuated by the body tissue.

130. As discussed in §IV.B.2, the Naghavi-Hochstedler-Burnes-Hayashi combination patient monitor includes an optical instrument, outlined in green in the figure below, "for optically measuring the concentration of the constituent parts of the blood of a living organism." APPLE-1007 (Hayashi), 1:7-14; *see* Abstract. These concentrations include "the hemoglobin concentration in blood (e.g., oxyhemoglobin, deoxyhemoglobin, carboxyhemoglobin, and methemoglobin concentrations)." APPLE-1007 (Hayashi), 3:23-27. The measured concentration of each of these constituents is **a measured value of a physiological parameter**.



Naghavi-Hochstedler-Burnes-Hayashi composite figure

131. The optical instrument of the combination patient monitor includes an "extinction-index change detection means," highlighted in pink. APPLE-1007 (Hayashi), 5:4-8, 6:26-32; expert. This extinction-index change detection means is **a light sensitive detector** at least because it includes an "***optical detector***" which "detects the light of respective wavelengths emitted by the light sources," highlighted in purple APPLE-1007 (Hayashi), 7:19-23; *see* 3:33-44 ("The blood-constituent concentration measuring instrument comprises … extinction-index change detection means for detecting an extinction index change in the straight-advance light component or the scattered light component"), 5:4-6 ("Extinction-index change detection means 4"), 4:19-23, 3:66-4:66, 9:47-51, Abstract, claim 1, claim 14.

132. The detector is **capable of detecting light attenuated by body tissue**. For instance, Hayashi describes that light is incident on a living organism, and "the incident light ***will be attenuated***" due to "absorption and scattering … in the tissue, the vein, and the artery," and that "the intensity of the emergent light" (*e.g.*, the light attenuated by body tissue of the organism) "is observed." APPLE-1007 (Hayashi), 3:64-66. Moreover, Hayashi describes that its extinction-index change detection means (*e.g.*, a light sensitive detector) detects "an extinction index change in the straight-advance light component or a scattered light component close thereto," and explains that the extinction indices are a function of μ, which is

the "***attenuation coefficient***" of the tissue. APPLE-1007 (Hayashi), 4:52, 5:4-17; *see* 8:5-57.

133. In the combination, **measured values of the physiological parameters** (*e.g.*, the blood constituent concentrations) **are determined using an output signal of the light sensitive detector**. For instance, in the combination, Hayashi describes "calculating the concentrations C1~Cn-1" of blood constituents based on "the extinction index changes ΔA" that is detected by the extinction-index change detection means, *e.g.*, **using an output of the detector**. APPLE-1007 (Hayashi), 5:27-42; *see* Abstract ("Calculation means (5) calculates concentrations of the constituent parts of the blood, based on the extinction index change for each wavelength component of the measuring light"), 3:44-47 ("calculation means for calculating concentrations of the constituent parts of blood, based on the extinction index change for each wavelength component of the measuring light"), 4:6-10. In a specific example, the optical detector of the extinction-index change detection means "detects the light of respective wavelengths emitted by the light sources 101~106, and the aforementioned beat signal contained in the output is amplified by the amplifier 402 and is obtained as an extinction-index signal." APPLE-1007 (Hayashi), 7:21-25. The blood constituent concentrations are then determined using this extinction-index signal. *See id.*, 7:25-40.

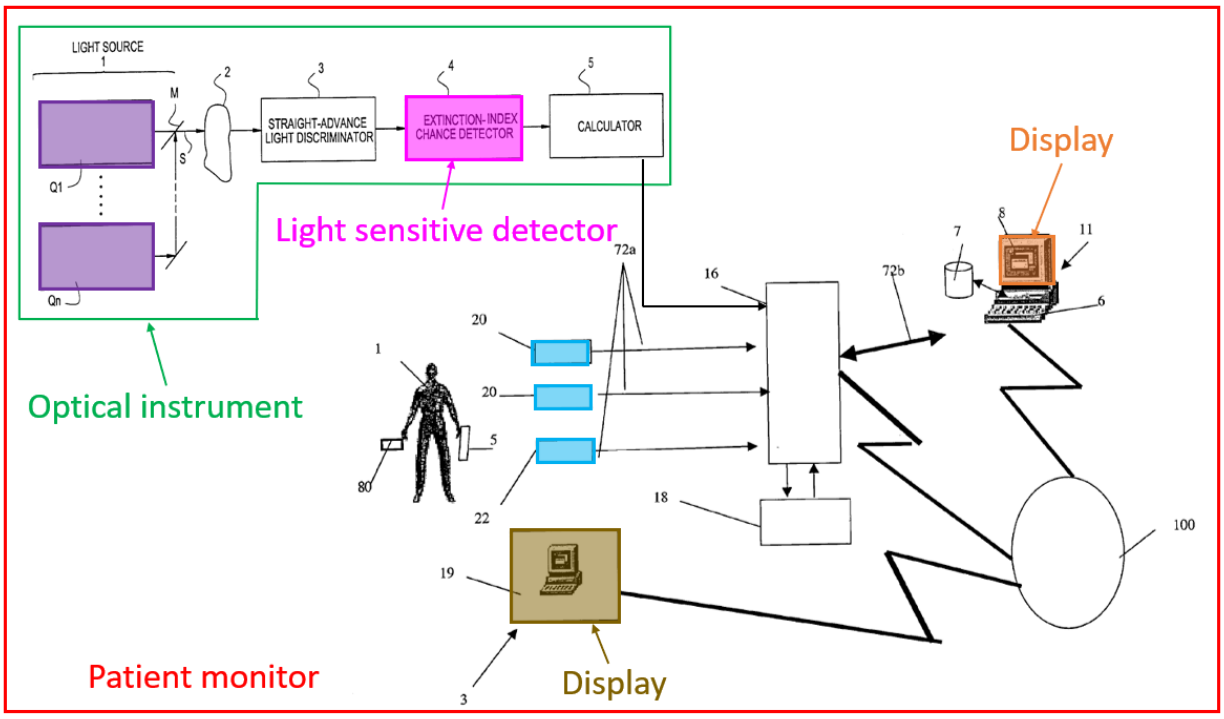
(ii) **Claim 27**

[27pre] A patient monitor capable of determining a plurality of physiological parameters from an output signal of a light sensitive detector capable of detecting light attenuated by body tissue, the patient monitor comprising:

134. To the extent the preamble is deemed to be limiting, Naghavi-Hochstedler-Burnes-Hayashi renders obvious **a patient monitor capable of determining a plurality of physiological parameters** (*e.g.*, oxyhemoglobin, deoxyhemoglobin, carboxyhemoglobin, methemoglobin concentrations). *See* my discussion of elements [1pre] and [19]; APPLE-1007 (Hayashi), 1:11-13 ("a method and an instrument suitable for measuring the concentration of the hemoglobin (oxyhemoglobin, deoxyhemoglobin, carboxyhemoglobin, methemoglobin, etc.) in blood"), 3:21-28.

135. The patient monitor of the combination includes an optical instrument, outlined in green in the figure below. As discussed in [19], the optical instrument includes **a light sensitive detector capable of detecting light attenuated by body tissue**: the optical detector of the extinction-index change detection means (pink). *See* my discussion of element [19]; APPLE-1007 (Hayashi), 3:33-34, 6:26-32, 7:19-23. The measured values **of the first and second physiological parameters** (*e.g.*, oxyhemoglobin, deoxyhemoglobin, carboxyhemoglobin, methemoglobin concentrations) **are determined from an output signal of the light sensitive**

detector. *See* my discussion of element [19]; *see* APPLE-1007 (Hayashi), 3:44-47, 4:6-10, 5:27-42, 7:21-40 Abstract.



Naghavi-Hochstedler-Burnes-Hayashi composite figure

[27a] a display capable of displaying a measured value of a first blood parameter of body tissue of a monitored patient or displaying a measured value of a second blood parameter of the body tissue; and

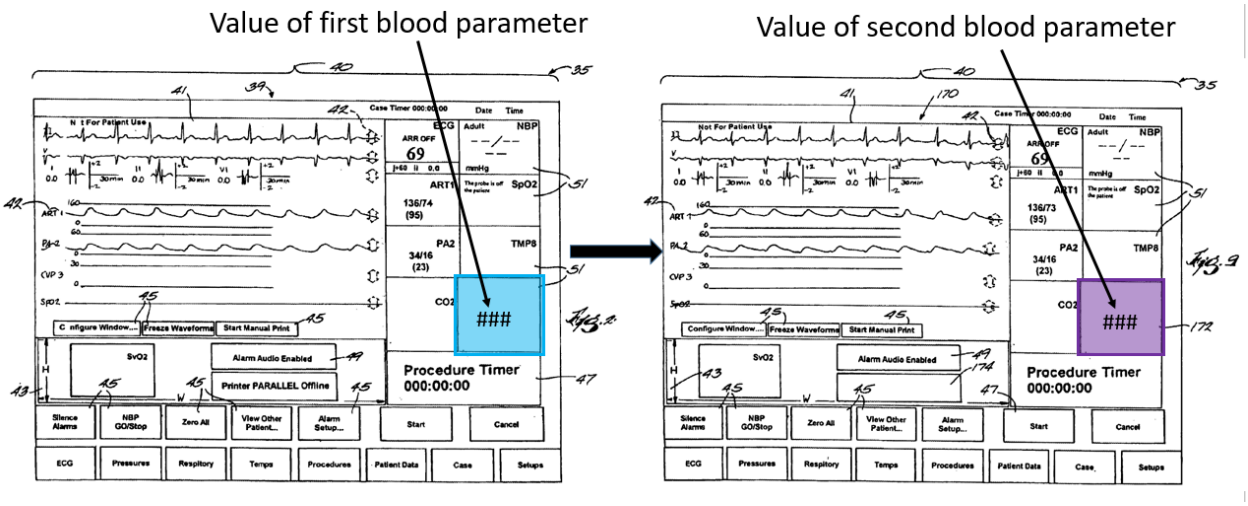
136. In the combination, the measured blood analyte concentrations (*e.g.*, oxyhemoglobin, deoxyhemoglobin, carboxyhemoglobin, methemoglobin concentrations) are **blood parameters** at least because they are measured concentrations of constituents in blood. *See* APPLE-1007 (Hayashi), 1:12-13, 3:21-28.

137. In the combination, the **display** (*e.g.*, based on Naghavi's monitor or a display of the remote monitoring service), highlighted in orange or brown in the figure in [27pre], is **capable of displaying a measured value of a first blood parameter** (*e.g.*, one of the blood analyte concentrations) **or displaying a measured value of a second blood parameter** (*e.g.*, a different one of the blood analyte concentrations). *See* my discussion of element [1a]; *see* APPLE-1004 (Hochstedler), 1:19-23, 3:40-41. For instance, measured values of one or more of the blood concentrations are displayed in corresponding parameter blocks of one display layout (*e.g.*, based on the layout illustrated in Hochstedler's FIG. 2), and measured values of one or more other blood concentrations are displayed in corresponding parameter blocks of another display layout.

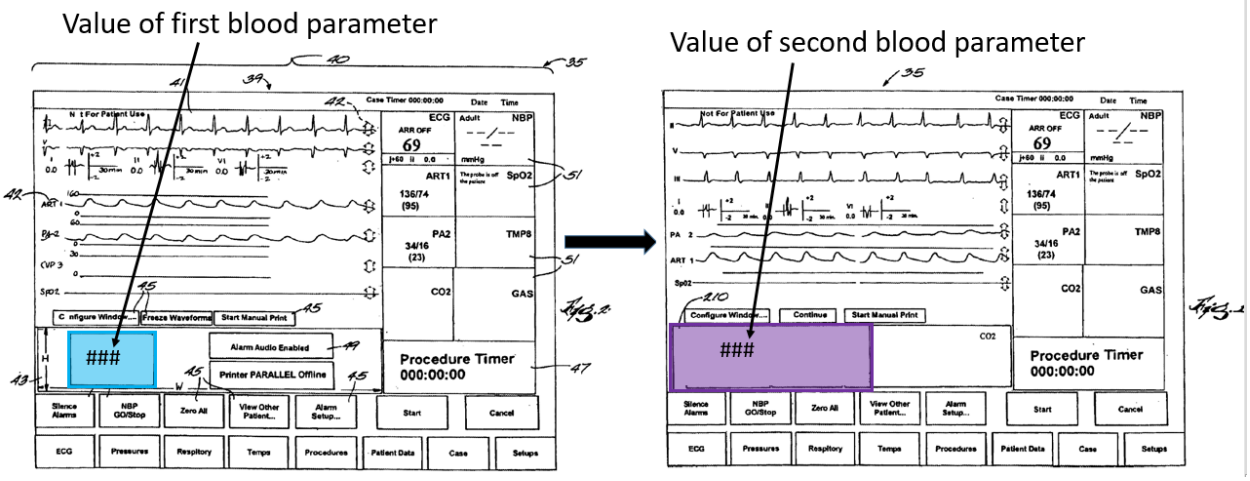
138. Two non-limiting examples of layouts in the combination for display of measured values of first and second blood parameters are illustrated in the figures below.

139. In both examples, an initial layout (at left) based on Hochstedler's FIG. 2 includes a parameter block or sub-layout (highlighted in blue) capable of displaying a measured value of a first blood parameter, *e.g.*, one of the blood concentrations. *See* APPLE-1004 (Hochstedler), 3:38-40. Responsive to detection of a change in the environment (*e.g.*, a change in severity of a second blood parameter), the layout is replaced with a layout (at right), *e.g.*, such as a layout

based on Hochstedler's FIG. 9 or 13. *See* my discussion of element [1a]-[1b]; APPLE-1004 (Hochstedler), 1:54-60, 5:26-37, 8:41-65. The updated layout includes a parameter block or sub-layout (highlighted in purple) capable of displaying a measured value of a second blood parameter, *e.g.*, a different one of the blood concentrations. *See* my discussion of element [1a]-[1b]; APPLE-1004 (Hochstedler), 8:41-42, 8:64-65.



Composite figures based on Hochstedler's FIGS. 2 and 9



Composite figures based on Hochstedler's FIGS. 2 and 13

140. Each display layout of the Naghavi-Hochstedler-Burnes-Hayashi combination includes multiple parameter blocks for display of parameter values. *See* APPLE-1004 (Hochstedler), 1:54-60, FIG. 2, FIG. 9, FIG. 13. A POSITA would have found it obvious for one or more of the blood parameters to be displayed in one layout while other blood parameters are displayed in another layout, *e.g.*, such that the display is capable of displaying the measured value of one blood parameter **or** the measured value of another blood parameter, as discussed in the following paragraphs.

141. First, in the combination, Hochstedler describes that the layouts are set according to user input: "[h]ow the system 10 displays information may be modified through the controls 42 and buttons 45 that are associated with the layout 39," *e.g.*, to "adjust[] the display of information to suit that user's preferences or needs." APPLE-1004 (Hochstedler), 3:55-59. The question of which blood parameters are displayed on which layout is thus a user preference. A POSITA would have recognized that in certain situations, it would make sense to display certain blood parameters in one layout and other blood parameters in a different layout, *e.g.*, depending on factors such as patient condition or medical issues. For instance, for a patient for whom carbon monoxide saturation is not likely to be a concern, blood parameters indicative of carbon monoxide saturation (*e.g.*, carboxyhemoglobin concentration) are not displayed on the main layout, and

replace other, more relevant blood parameters (*e.g.*, oxyhemoglobin and/or deoxyhemoglobin concentration; *see* my discussion of element [8]) only should an issue arise (*e.g.*, should the carboxyhemoglobin concentration pass an alarm threshold, as discussed below in conjunction with element [27c]).

142. Alternatively or additionally, a POSITA would have been motivated to implement the combination layout such that one or more of the blood parameters are displayed in one layout while other blood parameters are displayed in another layout because the display arrangement of parameters is merely the non-inventive rearrangement of parts and as such, is an obvious design choice. Which parameter is displayed in which location and in which layout provides no unexpected results. Moreover, the location of each parameter's display has no impact on function of the patient monitor: the display of the patient monitor is capable of replacing display of one parameter value with another regardless of the identity of the parameters themselves.

[27b] a user input button, the activation of which replaces the display of the measured value of the first blood parameter with the measured value of the second blood parameter,

143. As discussed in [1b] and [27a], the switch of the layout is **replacing the display of the measured value of one parameter** (*e.g.*, the first blood parameter) **with the measured value of another parameter** (*e.g.*, the second blood parameter). *See* APPLE-1004 (Hochstedler), 1:54-60, 5:26-37, 8:40-65.

144. In the combination, Hochstedler describes that the change in layout (the replacement) is "an automatic layout switch [that] occur[s] ***after prompting the user for approval of the proposed change***," *e.g.*, that user input causes the display replacement. APPLE-1004 (Hochstedler), 5:42-45; *see* 6:1-3 ("the user has the choice to cancel the layout switch, perform the layout switch, or pick an alternate layout set"), 1:63-67 ("If an available layout more closely matches the changed system, then the system may … prompt the user to change the layout"), 8:39-42 ("***If the user selects the OK button 162***, the layout is switched to a layout 170 shown in FIG. 9"), FIG. 5, FIG. 8; *see* my discussion of element [8]. For instance, when "changes in health status" of the monitored patient are detected that warrant the display change (*e.g.*, a parameter passing a threshold, as I discuss below for element [27c]), the user is prompted for approval of the proposed display change. *See* my discussion of elements [1b]-[1c]; APPLE-1004 (Hochstedler), 1:54-60, 5:26-45; APPLE-1005 (Naghavi), [0059], [0063]; APPLE-1006 (Burnes), [0038]-[0039]. In the combination, Hochstedler's "OK button" corresponds to a user input button, and **activating of the user input button** (*e.g.*, user selection of the OK button) results in the layout being switched, *i.e.*, **replaces the display of the measured value of the first blood parameter with the measured value of the second blood parameter**. *See* APPLE-1004 (Hochstedler), 1:54-60, 5:26-45, 8:40-65.

145. Notably, the replacement of the display of the measured value of the first blood parameter with the measured value of the second blood parameter is instantiated on the display (*e.g.*, the physical display device based on Naghavi's monitor or a display of the remote monitoring service) by a GUI that has two alternative states: one state in which the measured value of the first blood parameter is displayed, and a second state in which the measured value of the second blood parameter is displayed.

146. Alternatively or additionally, Hochstedler explains that user input (*e.g.*, user selection of the OK button) can be provided "using a variety of mechanisms such as a pointing device or a stylus." APPLE-1004 (Hochstedler), 1:13-15. A POSITA would have been aware of various other input mechanisms that were well-known in the context of multi-parameter patient monitors, including, *e.g.*, physical buttons that can be activated (*e.g.*, pressed) to select a displayed button on a GUI. Consistent with Hochstedler's indication that any of "a variety of mechanisms" for selection of displayed buttons can be used, a POSITA would have found it obvious for the combination system to include physical buttons for user input, *e.g.*, a button to select the displayed "OK button" to approve a layout switch. APPLE-1004 (Hochstedler), 1:13-15, 8:36-40. In this implementation, **activation of the user input button**, *e.g.*, by pressing a physical button to select the displayed "OK button," results in the layout being switched,

i.e., **replaces the display of the measured value of the first blood parameter with the measured value of the second blood parameter**.

147. It is my opinion that a POSITA would have found it obvious to implement the user input mechanism in the combination system as a physical button for at least the following reasons.

148. The first reason why a POSITA would have been motivated to implement a pushbutton is to provide a user input mechanism that works regardless of a type of glove the user is wearing. In clinical/hospital environments, caregivers can wear various types of gloves, *e.g.*, latex, rubber, or nitrile, not all of which are compatible with touchscreens. The presence of a pushbutton with which the user can provide input helps to ensure that the functionality of the combination monitor is available under a wide range of use conditions.

149. The second reason why a POSITA would have been motivated to provide a pushbutton is because of the reliability of mechanical buttons in dirty or harsh environments. For instance, in a critical medical situation, medical debris may foul a touchscreen; the presence of a pushbutton allows the user to provide input even in such circumstances.

150. The third reason why a POSITA would have been prompted to pursue this implementation is because this combination is just the application of known techniques (specifically, a physical pushbutton) by an already-known system

(specifically, the Naghavi-Hochstedler-Burnes combination system) to yield predictable results (*e.g.*, a medical display system in which input can be provided via a physical button).

151. Moreover, it is my opinion that a POSITA would have expected to be successful in pursuing this combination for at least the following reasons. First, a POSITA would have expected to be successful in integrating a physical button as a user input mechanism in the combination system because this was a known device with predictable integration and functionality. Moreover, a POSITA would have expected success given Hochstedler's indication that a variety of input mechanisms are suitable, and given the widespread use of physical input buttons in patient monitoring systems. *See* APPLE-1004 (Hochstedler), 1:13-15;

[27c] wherein the display of the measured value of the first blood parameter is replaced by the measured value of the second blood parameter when the second blood parameter passes an alarm threshold,

152. As discussed in [1c], the layout is switched, thus **replacing the display of the measured value of the first blood parameter with the value of the second blood parameter** when the second blood parameter changes to become "out of range" or "near out of range" (and upon receipt of user approval of the proposed change, as I discussed above for element [27b]). *See* APPLE-1005 (Naghavi), [0059], [0063]; APPLE-1006 (Burnes), [0038]-[0039], [0043]. The second parameter value changing to become "out of range" is that parameter

passing an alarm threshold. *See* my discussion of element [15c]; APPLE-1006 (Burnes), [0038] ("An 'out of range' value is a value that ***has crossed a predetermined threshold***"), [0039] ("uniquely defined thresholds or ranges may be used to define both the 'out of range' and 'near out of range' categories for any given parameter"). The second parameter changing to become "near out of range" is also that parameter **passing an alarm threshold**, *e.g.*, because the value of the second parameter has changed to beyond a threshold that triggers an alarm. *See* my discussion of element [15c]; APPLE-1006 (Burnes), [0039]. These thresholds are specifically **alarm** thresholds at least because the value of the second parameter exceeding that threshold "is an indication that the patient may require clinical attention" and "may trigger an alarm." APPLE-1006 (Burnes), [0038]; *see* [0007]-[0008], [0034]-[0035], [0037], [0039]; *see* my discussion of element [1c], [15c].

[27d] wherein the measured values of the first and second blood parameters are determined using an output signal of a noninvasive light sensitive detector capable of detecting light attenuated by the body tissue.

153. The measured values of the first and second blood parameters—*e.g.*, oxyhemoglobin, deoxyhemoglobin, carboxyhemoglobin, methemoglobin, bilirubin (*see* my discussion of element [27a])—are determined using an output signal of a light sensitive detector capable of detecting light attenuated by the body tissue. *See* my discussion of element [19], [27pre]; *see* APPLE-1007 (Hayashi), 3:33-34,

6:26-32, 7:19-23. The light sensitive detector is noninvasive, *e.g.*, because it operates external to the body tissue.

(iii) **Claim 28**

[28pre] A patient monitor capable of determining a plurality of physiological parameters from an output signal of a light sensitive detector capable of detecting light attenuated by body tissue, the patient monitor comprising:

154. Naghavi-Hochstedler-Burnes-Hayashi renders element [28pre] obvious for at least the same reasons I discussed above for element [27pre].

[28a] a display capable of displaying a measured value of a first blood parameter of body tissue of a monitored patient or displaying a measured value of a second blood parameter of the body tissue, and

155. Naghavi-Hochstedler-Burnes-Hayashi renders element [28a] obvious for at least the same reasons I discussed above for element [27a].

[28b] a user input button, the activation of which causes the display to change from displaying the measured value of the first blood parameter to displaying the measured value of the second blood parameter,

156. *See* my discussion of element [27b]. The Naghavi-Hochstedler-Burnes-Hayashi combination includes **a user input button, the activation of which** results in "an automatic layout switch," replacing the display of one parameter value with another, *e.g.*, **causes the display to change from displaying the measured value of the first blood parameter to displaying the measured value of the second blood parameter**. APPLE-1004 (Hochstedler), 5:42-45; *see* 1:54-60, 5:26-45, 8:40-65; *see* my discussion of element [13b].

[28c] wherein the display also changes from displaying the measured value of the first blood parameter to displaying the measured value of the second blood parameter when the second blood parameter passes an alarm threshold,

157. In the combination, display of one parameter value is replaced by another (*e.g.*, the display changes from displaying the measured value of the first parameter to displaying the measured value of the second parameter; *see* my discussion of element [28b]) **when the second blood parameter passes an alarm threshold**. *See* my discussion of element [27c]; APPLE-1005 (Naghavi), [0059]; APPLE-1006 (Burnes), [0007]-[0008], [0034]-[0035], [0037]-[0039].

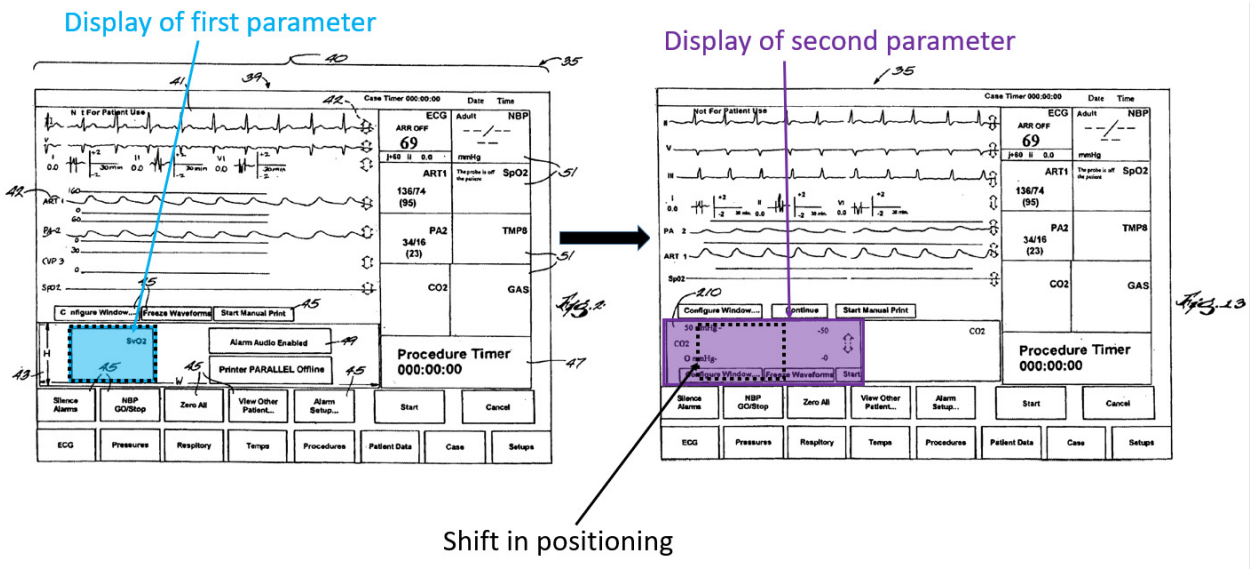
[28d] wherein the measured values of the first and second blood parameters are determined using an output signal of a noninvasive light sensitive detector capable of detecting light attenuated by the body tissue,

158. Naghavi-Hochstedler-Burnes-Hayashi renders element [28d] obvious for at least the same reasons I discussed above for element [27d].

[28e] wherein the display shifts a positioning of the display of the second blood parameter with respect to a positioning of the display of the first blood parameter.

159. As illustrated in the figures below, a POSITA would have found obvious that when a display layout based on Hochstedler's FIG. 2 is replaced with a display layout based on Hochstedler's FIG. 13, **a positioning of the display of the second blood parameter is shifted with respect to a positioning of the display of the first blood parameter**. For instance, the display area for the second parameter, in the purple-highlighted sub-layout at right, occupies a space encompassing and extending beyond the display area for the first parameter, in the

blue-highlighted sub-layout at left; that is, the display area for the second blood parameter is shifted with respect to the display area for the first blood parameter. Alternatively or additionally, a POSITA would have recognized that in many implementations of these two layouts, the positioning of the display of the second parameter value itself within its sub-layout is shifted relative to the positioning of the display of the first parameter value within its (smaller) sub-layout, *e.g.*, given the different spaces available for display of each parameter. For instance, display of each parameter value in the center of, or aligned with the same edge of, its respective sub-layout, would cause display of one parameter value to be shifted relative to display of the other. And as illustrated in Hochstedler's FIG. 2 and FIG. 13, parameters values in different layouts can be displayed in different locations relative to one another.



Composite figures based on Hochstedler's FIGS. 2 and 9

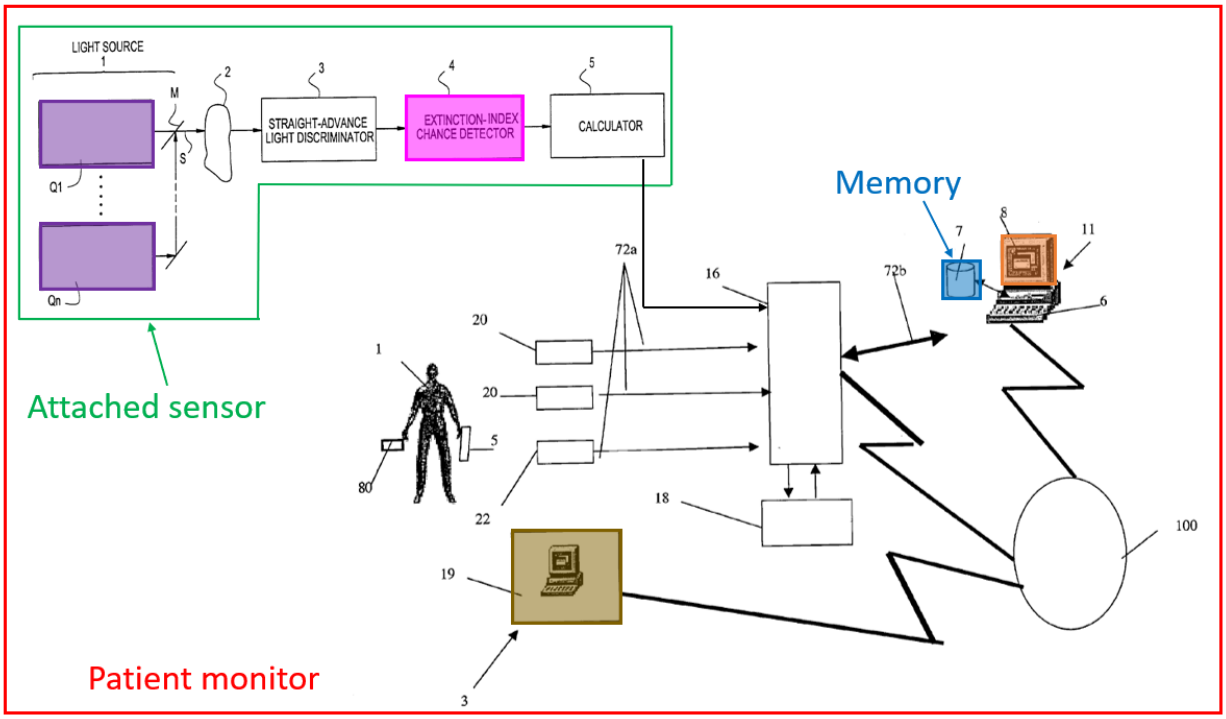
160. Indeed, there is nothing inventive about the specific positioning of each blood parameter value within its respective sub-layout. A POSITA would have recognized the positioning of the display of each blood parameter (*e.g.*, the display of the value of each blood parameter) within their respective sub-layout as mere rearrangement of parts and as such, as an obvious design choice. The particular position of each parameter value within its sub-layout presents no unexpected results. Moreover, the particular position of each parameter value within its sub-layout has no impact on function of the patient monitor: the display of the patient monitor is capable of replacing display of one parameter sub-layout with another regardless of the display position of the parameter values within the respective sub-layouts.

161. Moreover, this shift in positioning is an action on the display (***the display shifts the positioning***), *e.g.*, because the positioning of one blood parameter is shifted relative to the positioning of the other on the physical display (*e.g.*, on a display based on Naghavi's monitor or a display of the remote monitoring service). For instance, to shift the positioning of the display of one blood parameter relative to the other, a state of the display (*e.g.*, a state of the GUI displayed on the physical display device) is changed, thereby shifting the positioning of one blood parameter is shifted with respect to the positioning of the other.

(iv) **Claim 32**

[32] The patient monitor of claim 27, wherein the attached sensor can provide data through the output signal and through a memory device.

162. In the combination, the optical instrument based on the teachings of Hayashi, outlined in green in the figure below, is **an attached sensor**. *See* APPLE-1007 (Hayashi), 4:32-5:8. The **attached sensor can provide data through the output signal** (*e.g.*, the output signal of the light sensitive detector, highlighted in pink; *see* my discussion of elements [19], [27pre]). *See* APPLE-1007 (Hayashi), Abstract, 3:44-47, 4:6-10, 5:27-42, 7:21-40.



Naghavi-Hochstedler-Burnes-Hayashi-Mortz composite figure

163. In the combination, Naghavi's "personal healthcare management system" includes "memory such as RAM memory, and persistent data store 7 [highlighted in dark blue in the figure below] such as a fixed or removable electronic, magnetic, and/or optical medium." Naghavi, [0027]. Additionally, Naghavi discloses that a patient database may be stored in the persistent data store, such as "heartfolio database 30 resident in persistent data store 7," dark blue in the figure above. Naghavi, [0068]. The RAM and/or the persistent data store is **a memory device**.

164. Also in the combination, Burnes describes a "central database 32" which receives data from "external medical devices used in monitoring or treating" a patient, and "processing unit 34 for analyzing data received by the central database 32." APPLE-1006 (Burnes), [0031]; *see* FIG. 4. Based on these teachings of Burnes, the **memory** of the combination patient monitor receives data from the optical instrument (outlined in green) and/or other sensors of the combination monitor and provides data to a processor (*e.g.*, the CPU of Naghavi's computer) for analysis. *See* APPLE-1006 (Burnes), [0031]; APPLE-1005 (Naghavi), [0027].

165. That is, the **attached sensor** (*e.g.*, the optical instrument) **can provide data through the memory device**, *e.g.*, in that the signal from the optical instrument is provided to a memory device such as Naghavi's data store 7 based on

Burnes' teaching of a database, from where the signal is processed and displayed. *See* APPLE-1006 (Burnes), [0031], FIG. 4; APPLE-1005 (Naghavi), [0027] ("memory such as RAM memory, and persistent data store 7 such as a fixed or removable electronic, magnetic, and/or optical medium").

(v) **Claim 34**

[34] The patient monitor of claim 27, further comprising a memory for storing trend data on one or more of the first and second blood parameters.

166. In the combination, the RAM and/or the persistent data store 7 (dark blue in the figure in [33]) is **a memory**. *See* APPLE-1005 (Naghavi), [0027], [0068]. Also in the combination, based on the teachings of Burnes, the **memory** of the combination patient monitor receives data from the optical instrument (green) and/or the sensors of the combination monitor and provides data to a processor (*e.g.*, the CPU of Naghavi's computer) for analysis, as I also discussed above for [33]. *See* APPLE-1006 (Burnes), [0031], FIG. 4; APPLE-1005 (Naghavi), [0027].

167. Moreover, Burnes describes that "any cell may be selectable by a user for causing a more detailed display of data related to the respective parameter value," where "[s]uch detailed displays may include histograms, strip chart like recordings, long term parameter trends, data plots or other graphical displays and/or tabular lists of data." APPLE-1006 (Burnes), [0065]; *see* [0067] ("A HF symptoms trends button 366 may be selected to review a chronological listing or other tabular or graphical display of clinical data … A pressure trends button 368

may be selected to review a graphical or tabular display of blood pressure measurements or other hemodynamic measurements or changes over time"). In the combination, based on these teachings, a displayed parameter value (*e.g.*, the displayed value of the first or second blood parameter) is "selectable by a user" to access "detailed displays" such as "histograms … [or] long term parameter trends," among other things, about the selected blood parameter. APPLE-1006 (Burnes), [0065]. This information is **trend data on one or more of the first and second blood parameters**.

168. A POSITA would have understood, or at least found to be obvious that the **memory** in the combination is **for storing trend data on the blood parameters**, *e.g.*, to enable display of this trend information. *See* APPLE-1006 (Burnes), [0065], [0067]. For instance, to display "long term parameter trends," a POSITA would have recognized that trend data relate to previously measured blood parameter values, and would have understood those previously measured values (**trend data**) to be stored in memory such that the trend history can be determined and displayed. APPLE-1006 (Burnes), [0065].

169. It is my opinion that a POSITA would have been motivated to have the combination patient monitor store trend data for at least the following reasons.

170. The first reason why a POSITA would have been motivated to store trend data is to be able to display these trend data, thereby providing the clinician

with additional information about the health of the patient beyond the current values of the patient's blood parameters. For instance, a POSITA would have recognized the clinical benefits that stem from an understanding of trends in the patient's health. As an example, storing a patient's past oxygen saturation measurements enables a clinician to observe patterns in the is parameter, which can provide an early alert to the clinician that the patient's health status may be changing. Naghavi provides another example: storing "a plurality of measurements for patient 1, e.g. serial ECGs," allows those data to be "used for risk stratification and diagnosis of the silent ischemia and myocardial infarction." APPLE-1005 (Naghavi), [0071].

171. The second reason why a POSITA would have been motivated to store trend data is so that such data can be incorporated into the patient's medical record. Indeed, storing past health data (trend data) was well-known and conventional. *See* APPLE-1005 (Naghavi), [0070]-[0071]; APPLE-1006 (Burnes), [0067].

172. The third reason why a POSITA would have been prompted to pursue this implementation is because this combination is just the application of known techniques (specifically, storage and display of patient trends) by a known system (specifically, the combination patient monitor) to yield predictable results (specifically, a patient monitor that stores and displays trends).

173. Moreover, it is my opinion that a POSITA would have expected to be successful in pursuing this combination for at least the following reasons. First, a POSITA would have expected success in storing trend data in the combination patient monitor because the storage of additional, already-collected data in a monitoring system is a predictable endeavor. Second, a POSITA would have expected success because Naghavi already indicates the storage of other types of medical history and trend data, including "clinical information, family history, laboratory data, drug history, a base-line ECG and historical medical history," which can be used "for analysis and future reference." APPLE-1005 (Naghavi), [0070]; *see* [0071] ("Heartfolio database 30 may further comprise a plurality of measurements for patient 1, e.g. serial ECGs for patient 1 which may be used for risk stratification and diagnosis of the silent ischemia and myocardial infarction").

(vi) **Claim 36**

[36] The patient monitor of claim 27, further comprising an alarm corresponding to either of the measured values of the first and second blood parameters falling below predetermined associated threshold values.

174. The replacement of one display layout with another is **an alarm** *e.g.*, because the display change alerts staff of a change in the patient's status and/or of the value of the parameter whose change triggered the display change. *See* APPLE-1006 (Burnes), [0007]-[0008], [0034]-[0035], [0037]-[0039]. In the combination, a parameter that changes to become "out of range" or "near out of

range" causes the display layout change, *e.g.*, triggers the **alarm**. APPLE-1006 (Burnes), [0038]-[0039]. As discussed in [27c], a parameter becoming "out of range" or "near out of range" occurs when its value has "***crossed a predetermined threshold***," *e.g.*, the **alarm corresponds to the measured value of a parameter** crossing a **threshold**. APPLE-1006 (Burnes), [0038].

175. A POSITA would have understood that a parameter that "crosse[s] a predetermined threshold" can either exceed the threshold or fall below the threshold, *e.g.*, depending on the nature of the parameter. For instance, a POSITA would have understood that the threshold for oxyhemoglobin or deoxyhemoglobin concentration—both of which are indicative of oxygen saturation—is a threshold that triggers an alarm if the measured concentration falls below a threshold, *e.g.*, a threshold indicating a low blood oxygen level that warrants clinical observation or intervention. *See* APPLE-1018 (Rantala), [0003] ("Pulse oximeters provide … early warning of arterial hypoxemia"). Thus, a POSITA would have understood that when oxyhemoglobin or deoxyhemoglobin is the second blood parameter, **the alarm** (*e.g.*, the display layout change) **corresponds to the value of the second blood parameter falling below its threshold value**.

(vii) **Claim 37**

[37] The patient monitor of claim 36, wherein the alarm comprises at least one of an audio or visual alarm.

176. *See* my discussion of element [36]. **The alarm is a visual alarm**, *e.g.*, because the change in the display is a **visual** representation, on a display, of the parameter whose value fell below its threshold value. *See* APPLE-1004 (Hochstedler), 1:54-60, 5:26-37, 8:40-65; APPLE-1006 (Burnes), [0038]-[0039].

177. Alternatively or additionally, in the combination, Hochstedler describes that the patient monitor includes an **audio alarm**. *See* FIG. 2, FIG. 9, FIG. 11. A POSITA would have understood, or at least found obvious, that when a parameter falls below its threshold value, an **audio alarm** is sounded in the combination patient monitor, *e.g.*, consistent with Burnes's teachings that a parameter becoming "out of range" "may trigger an alarm." APPLE-1006 (Burnes), [0038]. For instance, a POSITA would have recognized the clinical advantages of sounding an audio alarm to alert medical staff to a potential degradation of the patient's condition, *e.g.*, to attract immediate attention of the clinical staff even if the staff is not located in the patient's room or in the vicinity of a monitor displaying information about the patient.

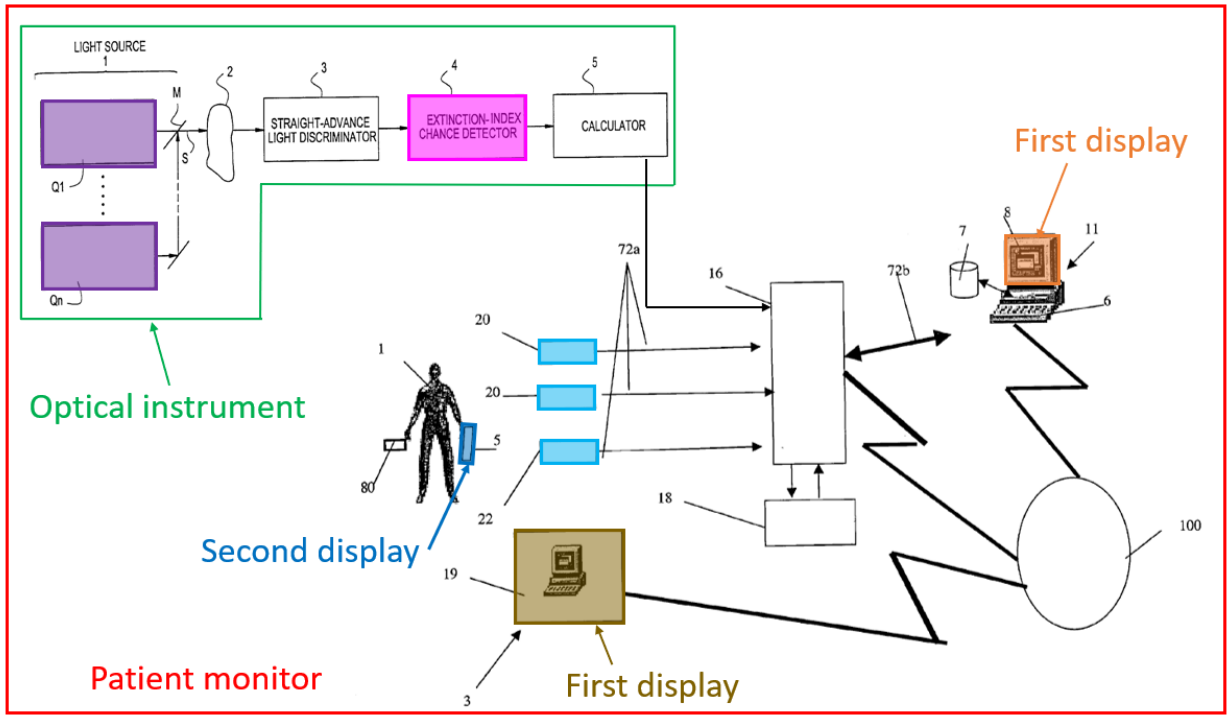
(viii) **Claim 42**

[42] The patient monitor of claim 27, wherein the display comprises a first display and the patient monitor further comprises a second display capable of displaying a pulse rate.

178. In the Naghavi-Hochstedler-Burnes-Hayashi combination, the physical display device (*e.g.*, a display device based on Naghavi's monitor 8 and/or a display of the remote service) has multiple display states, as I discussed for [27b]. To the extent that the first display and second display are satisfied by a single physical display having a first display state (**a first display**) and a second display state (**a second display**), these two displays (*e.g.*, two display states) are capable of displaying data, because this is the nature and purpose of a display. Thus, a POSITA would have found it obvious for one of the display states (**a first display**) to display measured values of blood parameters, as I discussed in [27a]), and for another one of the display states (**a second display**) to be **capable of displaying a pulse rate**.

179. Alternatively or additionally, in the Naghavi-Hochstedler-Burnes-Hayashi combination, the display based on Naghavi's monitor 8 (highlighted in orange in the figure below) and/or a display of the remote service (brown) is **a first display**, *e.g.*, a first display device. Also based on the teachings of Naghavi, an "interactive user control module 5" (dark blue) which can be implemented as "a touch screen," corresponds to **a second display**, *e.g.*, a second display device.

APPLE-1005 (Naghavi), [0035]; *see* [0036]-[0037]. Naghavi describes that this user control module "facilitate[s] interaction between patient 1 and personal healthcare management system 10" and "may be used to facilitate access to one or more predefined functions of personal healthcare management system 10." *Id.*, [0035], [0037].



Naghavi-Hochstedler-Burnes-Hayashi composite figure

180. A display, such as the touch screen implementation of the user control module, is **capable** of displaying data; indeed, this is the nature of displays. Thus, the user control module of the combination (**the second display**) is **capable of displaying a pulse rate**.

181. Claim 42 does not specifically state that the second display actually ***displays*** a pulse rate. However, if claim 42 is interpreted in this way, I still am of the opinion that it is rendered obvious by the Naghavi-Hochstedler-Burnes-Hayashi combination. Specifically, I believe that a POSITA would have understood, or at least found obvious, that the Naghavi-Hochstedler-Burnes-Hayashi combination system detects pulse rate—for instance, that one of the sensors (light blue in the figure above) is a pulse rate sensor.

182. Generally, patient monitors, *e.g.*, pulse oximeters, displaying pulse rate were common as of the Critical Date. *See* APPLE-1010, 1:27-34 ("A pulse oximeter typically provides a… a numerical readout of pulse rate … In addition, the pulse oximeter may display the patient's plethysmograph, which provides a visual display of the patient's pulse contour and pulse rate"); APPLE-1012, 1:28-35 (In "a pulse oximeter," "[p]ulse rate and other parameters may also be detected and displayed"); APPLE-1014, [0062] ("Outputs for display" from "a pulse oximeter" "are, for example, blood oxygen saturation, heart rate, and a clean plethysmographic waveform"). Moreover, Naghavi is flexible with regard to the attached sensors (which are highlighted in light blue in the figure above); Naghavi describes that the system can incorporate or interface with "[a] variety of sensors 22 for obtaining biophysical, biomechanical, physiological, biochemical, and electromechanical parameters … may be used to connect patients to personal

healthcare management system." APPLE-1005 (Naghavi), [0033]. Hochstedler's specific implementation of the user interface is similarly flexible with respect to the type of sensor: "[o]ther sensors could be added to the system or the sensors shown could be removed from the system," *e.g.*, "depend[ing] on the type of activity monitored." APPLE-1004 (Hochstedler), 3:17-19. A POSITA thus would have found obvious to implement one of these sensors as a pulse rate sensor, *e.g.*, given that pulse rate monitoring was conventional and common.

183. With a pulse rate sensor integrated into the combination, a POSITA would have found it obvious for **the second display** (*e.g.*, the second display state of a physical display, or the touch-screen user control module as a second physical device) to **display a pulse rate** to facilitate user access to this basic parameter. For instance, a POSITA would have recognized that pulse rate is a parameter that is simple to understand and thus well suited for display to a user. In the specific example where the second display is satisfied by the user control module, a POSITA further would have recognized that pulse rate, as a simple and easily understandable parameter, is also well suited for display on a device that is specifically designed to "facilitate interaction between" the patient and an otherwise relatively complex system. APPLE-1005 (Naghavi), [0035]. Moreover, a POSITA would have recognized that informing the user of such a simple to understand parameter has clinical utility, *e.g.*, in that it is relatively easy for the

user to observe a change in pulse rate, which may prompt the user to seek medical advice or attention.

184. Specifically, pulse rate monitoring brings several advantages, which I discuss in the following paragraphs, and a POSITA would have been motivated to implement one of the sensors of the combination system as a pulse rate monitor to obtain these advantages.

185. The first reason why a POSITA would have been motivated to implement a pulse rate detector in the combination system is because monitoring and displaying a patient's pulse rate has clinical advantages. A patient's pulse rate often indicates, or even causes, a medical issue: for instance, both high and low pulse rates can prevent the brain from receiving sufficient oxygen. *See* APPLE-1013, [0117] ("Other alarms and indicators that can be included in the systems and methods of the present invention include hypoxia alarms, high respiration rate alarms, high/low pulse rate alarms, and patient monitoring indicators. These alarms and/or indicators can be used to warn the patient that their supplemental oxygen equipment is not operating properly, they are not using it properly, or they are having other problems and need to seek medical treatment."). A POSITA would have recognized that displaying pulse rate in a patient monitoring system enables early warning of the development of such issues. For instance, in the context of a home-based monitoring system, the patient can reach out to clinical staff for

prompt evaluation and treatment, or the remote clinical staff can reach out to the patient to ensure the patient's health and to advise the patient on suitable remedies.

186. The second reason why a POSITA would have been motivated to pursue this implementation is because pulse oximeters are "relatively inexpensive" and thus provide a simple and straightforward way to monitor pulse rate and SpO2. APPLE-1007 (Hayashi), 1:63-65.

187. The third reason why a POSITA would have been prompted to pursue this implementation is because the combination is just the application of known techniques (specifically, pulse rate monitoring) by an already-known system (specifically, the Naghavi-Hochstedler-Burnes-Hayashi patient monitor), and it yields predictable results (specifically, a patient monitor having pulse rate monitoring capability).

188. A POSITA would have expected to be successful because the use of pulse oximeters as an element of a patient monitoring system was common, and because of Naghavi's and Hochstedler's flexibility with regard to sensors and displayed sensor data, as I noted above. *See* APPLE-1010, 1:27-34; APPLE-1012, 1:28-35; APPLE-1014, [0062]; APPLE-1005, [0033]; APPLE-1004, 3:17-19.

(ix) **Claim 43**

[43] The patient monitor of claim 42, wherein the second display is capable of displaying the pulse rate when the first display displays the measured value of the first blood parameter.

189. In the combination, the **second display** (the display of Naghavi's user control module, dark blue in the figure above in [42], or the second display state of the physical display device discussed in [27b]) **is capable of displaying the pulse rate**, as I discussed above for claim [42]. Additionally, the first display (highlighted in orange or brown) displays the measured value of the first blood parameter, *e.g.*, the value of one of the blood analyte concentrations measured by the photoplethysmographic probe. *See* my discussion of element [27a].

190. The first and second displays are two distinct displays. Because the two displays are distinct, a POSITA would have understood that they are capable of displaying different data concurrently, *e.g.*, one display displaying one type of data (*e.g.*, pulse rate) when the other display displays another type of data (*e.g.*, a blood parameter). That is, the second display is capable of displaying the pulse rate when the first display displays the measured value of the first blood parameter.

191. Alternatively or additionally, a POSITA would have found this capability to be obvious, *e.g.*, given advantages of displaying different data concurrently on different displays. For instance, displaying pulse rate on one display and a blood analyte concentration on another display enables a medical

professional to quickly access multiple types of information relevant to patient care. Moreover, a POSITA would have found this capability to be obvious given that displaying different data concurrently on different displays was well-known in the context of patient monitors, *e.g.*, pulse oximeters. *See* APPLE-1010, 6:2-18 ("The MPMS 260 depicted in FIG. 2 has a rack 262 containing a number of modules for monitoring such patient parameters as blood pressure, EKG, respiratory gas, and SpO2. The measurements made by these various modules are shown on a multiparameter display 264 … FIG. 3 depicts the major functions of the UPO 210, including … an optional display 340"), FIGS. 2-3; APPLE-1011, [0003], [0026]-[0030], FIGS. 3-4.

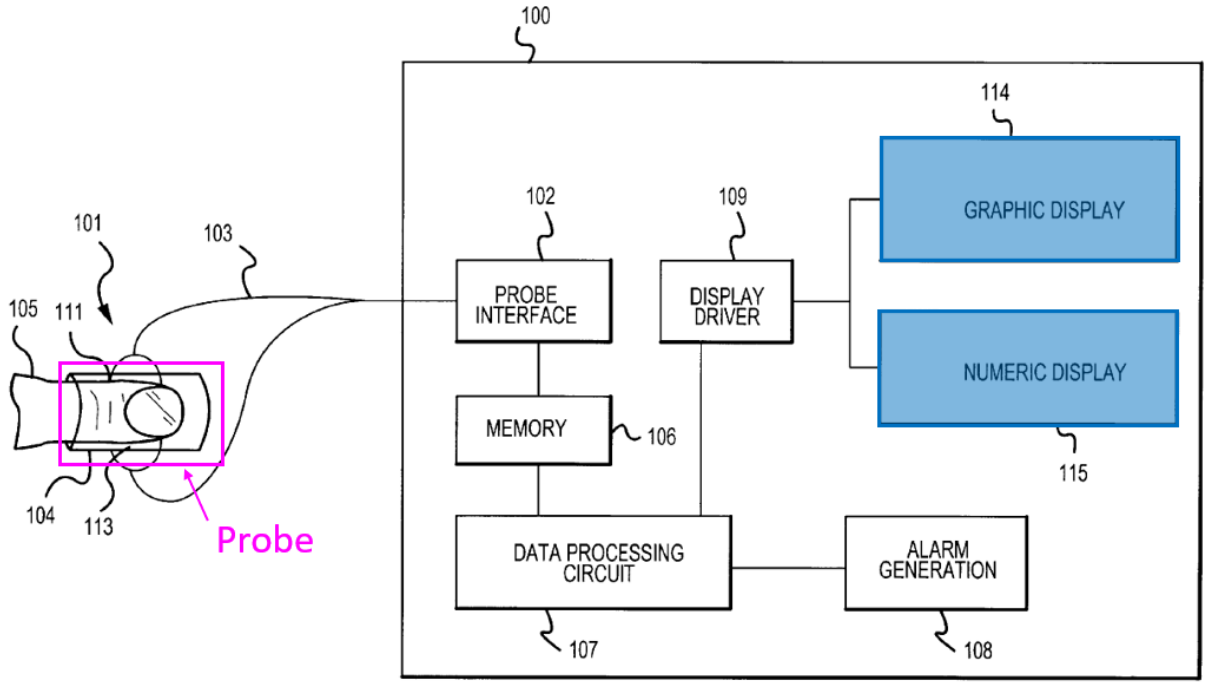
C. [GROUND 1C] – CLAIMS 42-44 ARE OBVIOUS OVER NAGHAVI-HOCHSTEDLER-BURNES-HAYASHI-MORTZ

192. The sections below provide a brief introduction to the Mortz and the Naghavi-Hochstedler-Burnes-Hayashi-Mortz combination.

1. Mortz describes a pulse oximeter having probe-off detection capabilities

193. Mortz describes "pulse oximeters which measure the oxygen saturation of arterial hemoglobin." APPLE-1009 (Mortz), 1:13-14. As shown in FIG. 1, which I have reproduced and annotated below, Mortz's "pulse oximeter system 100" includes "a probe 101," pink, that includes "a pair of light emitting diodes 111, 112 and at least one corresponding light detector 113." *Id.*, 4:51-59.

Signals received from the light detector are processed by data processing circuit 107 "to compute the oxygenation level of the hemoglobin in the arterial blood in tissue 105," as well as "the pulse rate, and a pulsitility index." *Id.*, 5:4-17. "The results of the oxygen saturation computation and pulse rate are displayed numerically (115) via display driver 109 and the associated display 114, 115 [highlighted in dark blue]." *Id.*, 5:17-20.

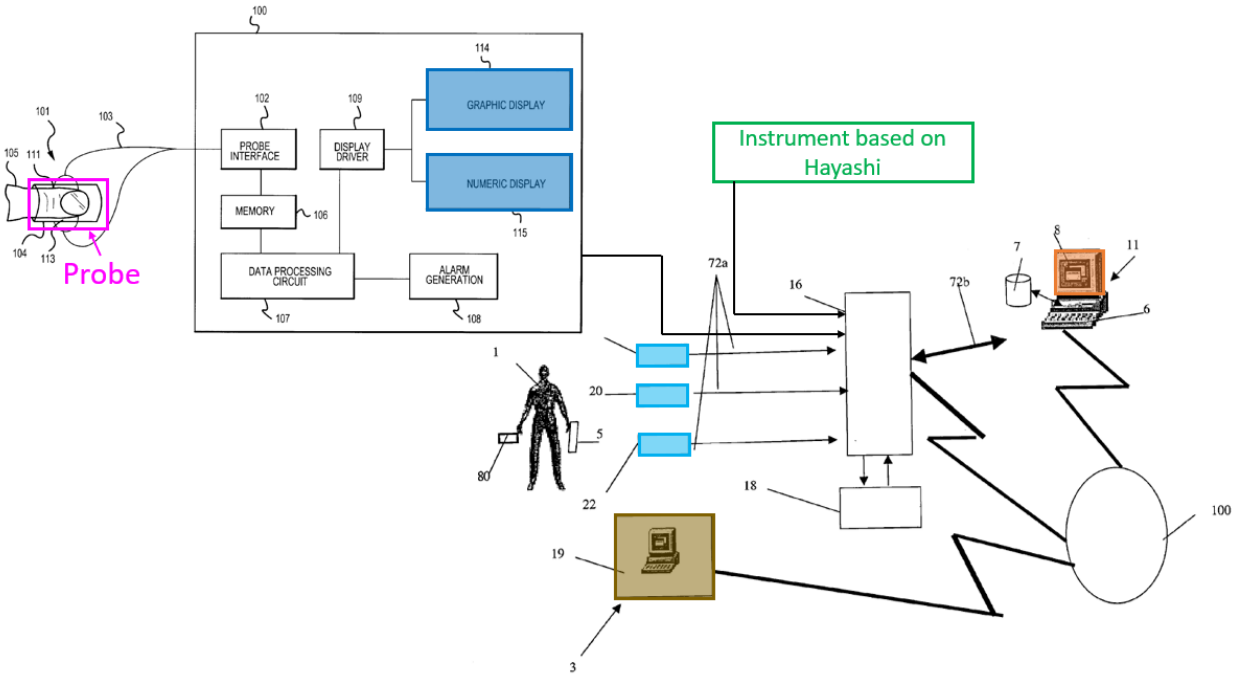


Excerpt from Mortz, FIG. 1 (annotated)

2. The Naghavi-Hochstedler-Burnes-Hayashi-Mortz combination

194. The Naghavi-Hochstedler-Burnes-Hayashi-Mortz combination patient monitor incorporates a probe for pulse rate measurement. An example

implementation of this combination is illustrated in the composite figure below. In this combination system, a probe for pulse rate measurement (highlighted in pink), *e.g.*, based on Mortz, is included in the system, along with the Hayashi-based blood-constituent concentration measuring instrument (depicted in a green outline) and, optionally, one or more other sensors (highlighted in blue) such as those described by Naghavi. *See* APPLE-1009 (Mortz), 4:51-59; APPLE-1007 (Hayashi), 1:10-14; APPLE-1005 (Naghavi), [0029]-[0030], [0032]. Signal data from this probe is digitized and processed by data processing circuitry 107 to determine at least pulse rate, optionally in addition to "the oxygenation level of the hemoglobin in the arterial blood in tissue." *See* APPLE-1009 (Mortz), 5:4-17. The numeric display 115 and/or the graphic display 114 (highlighted in dark blue) of the probe monitor displays the pulse rate measured by the Mortz-based pulse rate probe, and/or the graphic display 114 displays the plethysmographic waveform measured by that probe. *See id.*, 5:17-20. Alternatively or in addition, the touch screen user control module 5 of Naghavi can display the pulse rate measured by the Mortz-based pulse rate probe. *See* APPLE-1005 (Naghavi), [0035]-[0035].



Naghavi-Hochstedler-Burnes-Hayashi-Mortz composite figure

3. Reasons for the combination

195. It is my opinion that a POSITA would have been motivated to implement pulse rate detection and display in the combination for at least the following reasons.

196. The first reason why a POSITA would have been motivated to pursue this implementation is to access the clinical advantages of monitoring and displaying a patient's pulse rate, as I discussed above in addressing claim [42] in Ground 1B.

197. The second reason why a POSITA would have been motivated to pursue this implementation is because of the low cost and simplicity of pulse rate

monitoring in pulse oximeters, as I discussed above in addressing claim [42] in Ground 1B.

198. The third reason why a POSITA would have been motivated to display pulse rate in the combination is because patient monitors such as pulse oximeters that display pulse rate were common as of the Critical Date, as I discussed above in addressing claim [42] in Ground 1B.

199. To the extent the specific data processing approach described by Mortz's is incorporated into the combination, the fourth reason why a POSITA would have been motivated to pursue this implementation is because of the speed and high performance of this particular approach. For instance, Mortz describes that in its approach, "[t]he minimum size of the data set required for high confidence calculations using this apparatus is significantly smaller than the a pulse period and permits faster response to changing input data." APPLE-1009 (Mortz), Abstract. In more detail, Mortz describes that "[t]he minimum size of the measured data set required for high confidence SpO2 calculations is small and therefore permits faster response of the pulse oximeter to changing values of the SpO2. It is not necessary to wait a pulse period to acquire enough samples, and high confidence values can be computed in less than a second." *Id.*, 2:22-26.

200. The fifth reason why a POSITA would have been motivated to pursue this implementation is because it is just the application of known pulse monitoring

techniques in a known system, and yields predictable results, as I discussed above in addressing claim [42] in Ground 1B.

201. Moreover, it is my opinion that a POSITA would have expected to be successful in pursuing this combination for at least the following reasons. First, a POSITA would have expected to be successful in incorporating a pulse oximeter into the combination monitor because the use of pulse oximeters as an element of a patient monitoring system was common. *See* APPLE-1010, 1:27-34; APPLE-1012, 1:28-35; APPLE-1014, [0062]. Additionally, a POSITA would have expected success because of Naghavi's and Hochstedler's flexibility with regard to sensors and displayed sensor data, as I noted above for claim [42] of Ground 1B. *See* APPLE-1010, 1:27-34; APPLE-1012, 1:28-35; APPLE-1014, [0062]; APPLE-1005, [0033]; APPLE-1004, 3:17-19.

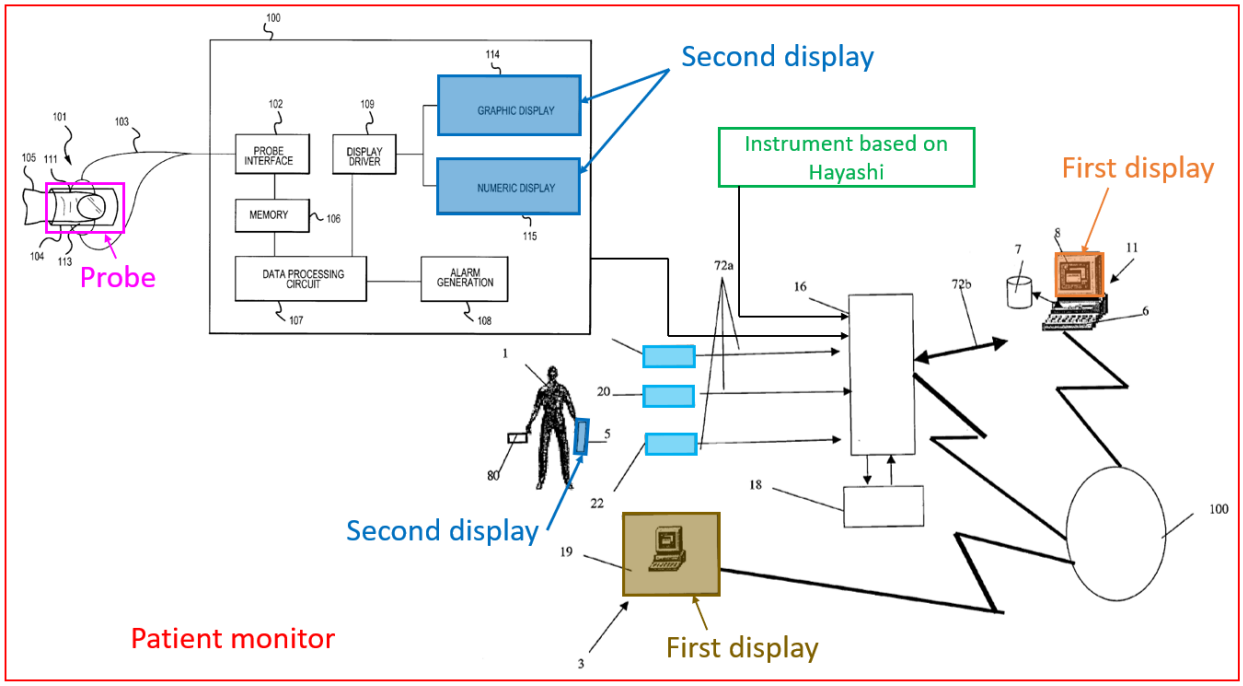
4. Analysis

(i) **Claim 42**

[42] The patient monitor of claim 27, wherein the display comprises a first display and the patient monitor further comprises a second display capable of displaying a pulse rate.

202. In the combination, either or both of the display based on Naghavi's monitor 8 (highlighted in orange) or a display of the remote service (highlighted in brown) is **a first display**. *See* [1a]. The combination patient monitor also includes **a second display** (highlighted in dark blue), *e.g.*, the graphic display 114 or numeric display 115 of the probe monitor 100 based on Mortz and/or the touch

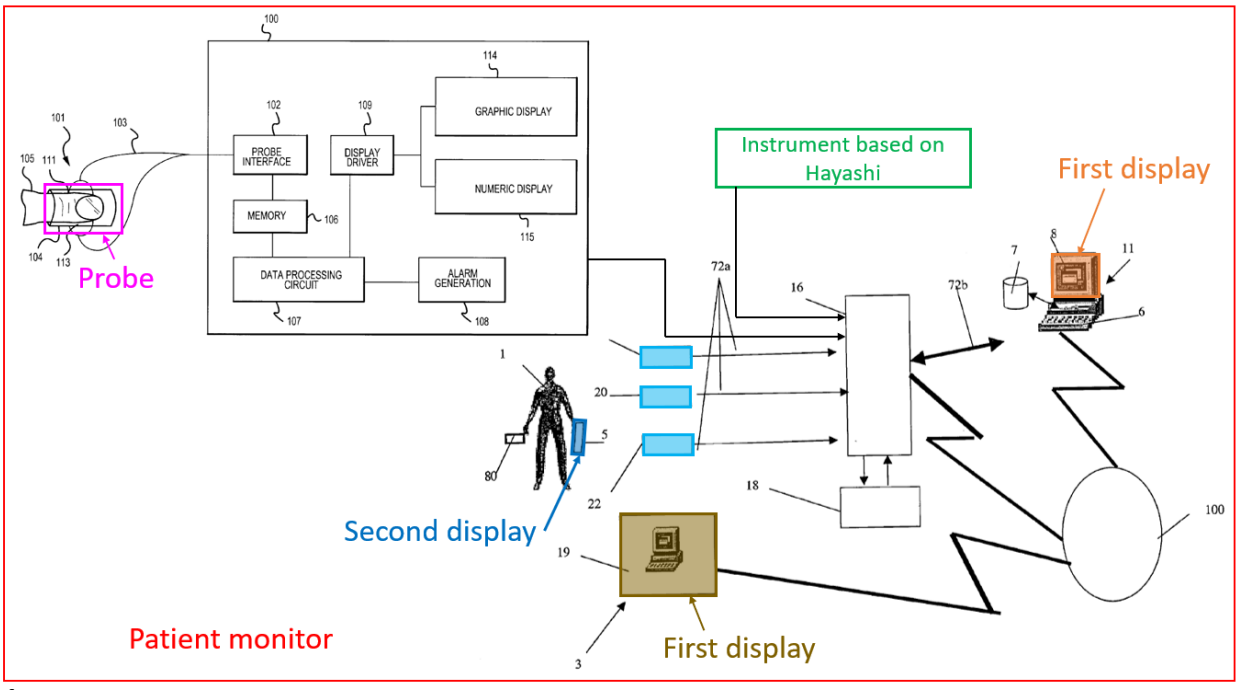
screen user control module 5 described by Naghavi (as I discussed in addressing claim 42 in Ground 1B). *See* APPLE-1009 (Mortz), 5:17-20; APPLE-1005 (Naghavi), [0035]-[0037]. Alternatively or additionally, the first and second displays correspond to different display states of the same physical display device, as I discussed above for element [27b] and claim [42] of Ground 1B.



Naghavi-Hochstedler-Burnes-Hayashi-Mortz composite figure

203. The second display is **capable of displaying a pulse rate**. In the combination, signals, *e.g.*, from a probe (pink) such as that described by Mortz, are processed to determine "pulse rate," and the "***pulse rate [is] displayed numerically (115)*** via display driver and the associated display 114, 115 while the ***plethysmographic waveform is typically displayed graphically*** via display 114," or on the touch screen of Naghavi's user control module. APPLE-1009 (Mortz),

5:17-20; *see* 9:65-66 ("pulse computations and display 115"), FIG. 1. That is, for instance, when the second display is a display of Mortz's probe monitor, the pulse rate is displayed **by the second display**: numerically by the numeric display 115 and/or via the plethysmographic waveform on the graphic display 114 of the combination. Or, when the second display is the touch screen user control module of Naghavi, the pulse rate is displayed on that display. Or still alternatively, when the second display is a second, alternative state of the same physical display device, the pulse rate is displayed when the display device takes on that second state.



Naghavi-Hochstedler-Burnes-Hayashi-Mortz composite figure

(ii) **Claim 43**

[43] The patient monitor of claim 42, wherein the second display is capable of displaying the pulse rate when the first display displays the measured value of the first blood parameter.

204. In the combination, **the second display** (either the display of a monitor based on Mortz, or the display of the user control module based on Naghavi; both highlighted in dark blue in the figures above in conjunction with claim [42]; or the second display state of the same display device) **is capable of displaying the pulse rate**. *See* my discussion of claim [42] above. Additionally, **the first display** (highlighted in orange or brown in the figure above; or a first display state of the same display device) **displays the measured value of the first blood parameter**, *e.g.*, the value of one of the blood analyte concentrations measured by the photoplethysmographic probe. *See* [27a].

205. As I discussed above for claim [42] in Ground 1B, the first and second displays are two distinct displays and thus capable of displaying different data concurrently, meaning that **the second display is capable of displaying the pulse rate when the first display displays the measured value of the first blood parameter**. Indeed, as I also discussed above, a POSITA would have found this to be obvious given the advantages of displaying different data concurrently on different displays.

(iii) **Claim 44**

[44] The patient monitor of claim 42, wherein the second display is capable of displaying indicia identifying the second blood parameter when the first display displays the measured value of the second blood parameter.

206. In the combination, the first display displays the measured value of the first blood parameter. *See* [27a], [43].

207. Also in the combination, Mortz describes that "[b]lood analyte concentrations"—which are indicia identifying the blood parameters—"may then be displayed via … graphic display 114 and/or numeric display 115"—the second display. APPLE-1009 (Mortz), 4:44-46; *see* [27a], [42]. Thus, the second display is capable of displaying indicia identifying the second blood parameter.

208. Alternatively or additionally, a POSITA would have found obvious that the second display (either the display of a monitor based on Mortz, or the display of the user control module based on Naghavi) is capable of displaying indicia identifying the second blood parameter, such as a name or abbreviation of the second blood parameter. For instance, given that multiple blood analyte concentrations are measured, a POSITA would have recognized the importance of providing an identifier of a displayed value, *e.g.*, to inform the user of which blood analyte concentration measurement is displayed. Moreover, a POSITA would have found this capability to be obvious given that displaying indicia identifying parameters in a multi-parameter measurement system was well-known, *e.g.*, such

that the many parameters being monitored concurrently are identifiable when displayed.

209. The first and second displays are two distinct display states of a display device, or alternatively two distinct display devices, and thus a POSITA would have understood, or at least found to be obvious, that they are capable of displaying different data concurrently, *e.g.*, that **the second display is capable of displaying indicia identifying the second blood parameter when the first display displays the measured value of the second blood parameter**. *See* [43].

V. LEGAL STANDARDS

A. Terminology

210. I have been informed by Counsel and understand that the best indicator of claim meaning is its usage in the context of the patent specification as understood by one of ordinary skill. I further understand that the words of the claims should be given their plain meaning unless that meaning is inconsistent with the patent specification or the patent's history of examination before the Patent Office. Counsel has also informed me, and I understand that, the words of the claims should be interpreted as they would have been interpreted by one of ordinary skill at the time of the invention was made (not today). Because I do not know at what date the invention as claimed was made, I have used the earliest

possible priority date of the ’223 Patent as the point in time for claim interpretation purposes (the Critical Date).

B. Legal Standards for Anticipation

211. I have been informed by Counsel and understand that documents and materials that qualify as prior art can render a patent claim unpatentable as anticipated. I am informed by Counsel and understand that all prior art references are to be looked at from the viewpoint of a person of ordinary skill in the art.

212. I am informed by Counsel and understand that a challenged claim is unpatentable as “anticipated” under 35 U.S.C. § 102 if it is determined that all the limitations of the claim are described in a single prior art reference. I am informed by Counsel and understand that, to anticipate a claim, a prior art reference must disclose, either expressly or inherently, each and every limitation of that claim and enable one of ordinary skill in the art to make and use the invention.

213. I have been informed by Counsel and understand that in an *inter partes* review, “the petitioner shall have the burden of proving a proposition of unpatentability,” including a proposition of anticipation, “by a preponderance of the evidence.” 35 U.S.C. §316(e).

C. Legal Standards for Obviousness

214. I have been informed by Counsel and understand that documents and materials that qualify as prior art can render a patent claim unpatentable as

obvious. I am informed by Counsel and understand that all prior art references are to be looked at from the viewpoint of a person of ordinary skill in the art at the time of the invention, and that this viewpoint prevents one from using his or her own insight or hindsight in deciding whether a claim is obvious.

215. I have been informed by Counsel and understand that a claim is unpatentable for obviousness under 35 U.S.C. § 103 (in the pre-AIA form of that statute that applies to the '223 Patent) "if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains." I am informed by Counsel and understand that obviousness may be based upon a combination of references. I am informed by Counsel and understand that the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. However, I am informed by Counsel and understand that a patent claim composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art.

216. I am informed by Counsel and understand that when a patented invention is a combination of known elements, a court must determine whether there was an apparent reason to combine the known elements in the fashion

claimed by the patent at issue by considering the teachings of prior art references, the effects of demands known to people working in the field or present in the marketplace, and the background knowledge possessed by a person having ordinary skill in the art.

217. I am informed by Counsel and understand that a patent claim composed of several limitations is not proved obvious merely by demonstrating that each of its limitations was independently known in the prior art. I am informed by Counsel and understand that identifying a reason those elements would be combined can be important because inventions in many instances rely upon building blocks long since uncovered, and claimed discoveries almost of necessity will be combinations of what, in some sense, is already known. I am informed by Counsel and understand that it is improper to use hindsight in an obviousness analysis, and that a patent's claims should not be used as a "roadmap."

218. I am informed by Counsel and understand that an obviousness inquiry requires consideration of the following factors: (1) the scope and content of the prior art; (2) the differences between the claims and the prior art; (3) the level of ordinary skill in the pertinent art; and (4) any objective indicia of non-obviousness, such as commercial success, long-felt but unresolved need, failure of others, industry recognition, copying, and unexpected results.

219. I have been informed by Counsel and understand that an obviousness evaluation can be based on a combination of multiple prior art references. I understand that the prior art references themselves may provide a suggestion, motivation, or reason to combine, but that the nexus linking two or more prior art references is sometimes simple common sense. I have been informed by Counsel and understand that obviousness analysis recognizes that market demand, rather than scientific literature, often drives innovation, and that a motivation to combine references may be supplied by the direction of the marketplace.

220. I have been informed by Counsel and understand that if a technique has been used to improve one device, and a person of ordinary skill at the time of invention would have recognized that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill.

221. I have been informed by Counsel and understand that practical and common sense considerations should guide a proper obviousness analysis, because familiar items may have obvious uses beyond their primary purposes. I have been informed by Counsel and understand that a person of ordinary skill looking to overcome a problem will often be able to fit together the teachings of multiple prior art references. I have been informed by Counsel and understand that

obviousness analysis therefore takes into account the inferences and creative steps that a person of ordinary skill would have employed at the time of invention.

222. I have been informed by Counsel and understand that a proper obviousness analysis focuses on what was known or obvious to a person of ordinary skill at the time of invention, not just the patentee. Accordingly, I understand that any need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed.

223. I have been informed by Counsel and understand that a claim can be obvious in light of a single reference, without the need to combine references, if the elements of the claim that are not found explicitly or inherently in the reference can be supplied by the common sense of one of skill in the art.

224. I have been informed by Counsel and understand that secondary indicia of non-obviousness may include (1) a long felt but unmet need in the prior art that was satisfied by the invention of the patent; (2) commercial success of processes covered by the patent; (3) unexpected results achieved by the invention; (4) praise of the invention by others skilled in the art; (5) taking of licenses under the patent by others; (6) deliberate copying of the invention; (7) failure of others to find a solution to the long felt need; and (8) skepticism by experts. I understand

that evidence of secondary indicia of non-obviousness, if available, should be considered as part of the obviousness analysis.

225. I have been informed by Counsel and understand that there must be a relationship between any such secondary considerations and the invention, and that contemporaneous and independent invention by others is a secondary consideration supporting an obviousness determination.

226. In sum, my understanding is that prior art teachings are properly combined where one of ordinary skill having the understanding and knowledge reflected in the prior art and motivated by the general problem facing the inventor, would have been led to make the combination of elements recited in the claims. Under this analysis, the prior art references themselves, or any need or problem known in the field of endeavor at the time of the invention, can provide a reason for combining the elements of multiple prior art references in the claimed manner.

227. I have been informed by Counsel and understand that in an *inter partes* review, "the petitioner shall have the burden of proving a proposition of unpatentability," including a proposition of obviousness, "by a preponderance of the evidence." 35 U.S.C. §316(e).

VI. CONCLUSION

228. I reserve the right to supplement my opinions to address any information obtained, or positions taken, based on any new information introduced throughout this proceeding.

229. I declare under penalty of perjury that the foregoing is true and accurate to the best of my ability.

APPENDIX 1

Andy Cockburn
B.Sc.(Hons) Ph.D.

Curriculum Vitae

Full legal name	Andrew Jeremy Gavin Cockburn
University Address	Department of Computer Science and Software Engineering University of Canterbury Christchurch 8140 New Zealand
Telephone	+64 3 369 2119
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Email	andy.cockburn@canterbury.ac.nz
URL	http://www.csse.canterbury.ac.nz/~andy
Consultancy Address	Cockburn Human Interface Consulting Ltd. 20 Gilmour Terrace, Lyttelton 8082 New Zealand
Telephone	+64 21 296 2307
Email	ajc168@snap.net.nz
Date of birth	23rd July 1966
Date	July 1, 2023

Brief Summary

International research reputation

- Over one hundred and ninety publications in international journals and conferences.
- Elected to the CHI Academy (2015), which is an honorary group of individuals who have made substantial contributions to the field of human-computer interaction.
- Recipient of the 2009 Chris Wallace award for the outstanding research contribution to Computer Science (2005-2007) in Australasia.
- Deputy Chair of the national panel for assessing Computer Science and Mathematics research quality (MIST PBRF panel, 2016-2019).
- Technical programme committee chair for ACM CHI 2020; Papers co-chair for ACM CHI 2014 and 2015.
- Editorial Board Member for: ACM Transactions on Computer-Human Interaction (2012-2021); Human-Computer Interaction Journal (2015-); Foundations and Trends in HCI (2015-2023); International Journal of Human-Computer Studies (2004-2013); Interacting with Computers (2003-2013).
- Best paper awards at CHI 2018, 2013, 2012, 2011 (awarded to the top 1% of submissions) and 13 Honourable Mention awards (top 5%) at ACM CHI.
- H-index impact factor of 56 (Google Scholar).

Excellent educator and public speaker

- Long track record of outstanding student evaluations.
- Nominated for the New Zealand National Tertiary Teaching Award, 2010. Recipient of a University of Canterbury Teaching Award (2004) and many nominations for student-elected 'lecturer of the year' award.

Experienced expert witness and consultant

- Testifying expert witness on behalf of industry leaders in various jurisdictions, including the Federal Court of Australia, US Federal Court, US Patent Trials and Appeals Board, and the US International Trade Commission.

Education

Degree	PhD (June 1993)
Discipline	Computer Science — Computer Supported Cooperative Work
Location	University of Stirling, Scotland
Thesis Title	Groupware Design: Principles, Prototypes, and Systems

Degree	BSc(Hons) (July 1988)
Discipline	Computer Science
Location	University of York, England

Employment History

Position	Professor (promoted through lecturer, senior lecturer, associate professor)
Location	University of Canterbury Christchurch New Zealand
Period	June 1993 — current

Research Student Supervision

PhD candidates

Stewart Dowding	2021–	Interaction Pace and User Preferences
Pang Suwanaposee	2020–	Cognitive Biases and the Subjective Experience of Interaction
Sarmad Soomro	2017–2021	Interaction with In-Vehicle Touchscreens
Joshua Leung	2013–2017	Understanding the Noticeability and Distraction of Interactive Highlighting Techniques
Philip Quinn	2012–2016	Economic Behaviour & Psychological Biases in Human-Computer Interaction
Tham Piumsomboon	2011–2015	Adaptive and Multimodal Interfaces for Collaborative Augmented Reality
Joey Scarr	2011–2014	Improving Interaction with Spatial User Interfaces
Stephen Fitchett	2010–2013	Understanding and Improving Personal File Retrieval
Susanne Tak	2008–2011	Improving Interfaces for Window/Task Switching
Jason Alexander	2006–2009	Improving Interfaces for Document Navigation
Joerg Hauber	2004–2008	Understanding Remote Collaboration in Video Collaborative Virtual Environments
Julian Looser	2003–2007	AR Magic Lenses: Addressing the Challenge of Focus and Context in Augmented Reality
Volkert Buchmann (A. sup.)	2004–2008	Haptic Feedback in Augmented Reality
Carl Cook (A. sup.)	2002–2006	Collaborative Software Engineering
Tim Wright	2000–2004	Collaborative and Multiple-Notation Programming Environments for Children
Michael JasonSmith	2000–2006	User Interfaces for Temporal Awareness

M.Sc. candidates

Ben McDonald	2010–2011	Multiuser interaction with large public displays
Dominic Winkler	2009–2011	Interaction Techniques for Cross Context Activities
Taher Amer	2005–2006	Evaluating SwiftPoint
Trond Nilsen	2004–2006	Hybrid Interfaces in Augmented Reality
Joshua Savage	2003–2004	The Calibration and Evaluation of Speed-Dependent Automatic Zooming Interfaces
Ben Schmidt	2001–2002	A Study of Bimanual Interaction
Elizabeth Ng (A. sup.)	1997–1998	Pen-based music input
Aaron Tay	1994–5	End-User Tailorability in Workflow Design

Honours candidates and Honours-level interns

Joel Harrison	2012	Improving Command Selection
Joshua Leung	2012	Improving File Access
Jerome Delamarche	2010	Multiple Trajectory Pointing Methods
Joey Scarr	2010	Improving Expertise Development in User Interfaces
Stephen Fitchett	2009	Improved Mobile Scrolling Interfaces
Philip Quinn	2007	Improving Command Interfaces
Keith Humm	2007	Improving Interfaces for Task Switching
Jason Alexander	2005	Improving Document Navigation with Space-Filling Thumbnails
Philip Brock	2005	An Investigation of Target Acquisition with Visually Expanding Targets in Constant Motor-Space
David Mitchell	2003	Evaluating Focus+Context Screens
Andrew Wallace	2003	Calibrating Speed-Dependent Automatic Zooming
Andrew Barrett	2002	Implementing RSVP as an Image Browser
Julian Looser	2002	3D Games as Motivation in Fitts' Law Experiments
Joshua Savage	2002	Implementing and Evaluating Speed-Coupled Scrolling
Amal Siresena	2002	Mobile Text Entry
Michael Moyle	2001	An Evaluation of Simple Gesture Based Controls
Lee Butts	2001	Mobile Phone Text Entry
Eddie Edwards	2001	Towards Scalable Interfaces Using Spatial Cues
Gene Thomas	1997	Smart Desktop
Olof Eilert	1997	User Interfaces for Object Oriented Literate Programming
Philip Weir	1996	Distortion Oriented Workspace Awareness
Carey Evans	1996	Assisting World Wide Web Navigation
Justin Macfarlane	1995	Mawd: A Collaborative Analysis Tool
Carl Cerecke	1995	TRAIL: An Email Based CSCW Toolkit
Andrew Bryant	1995	Leogo: An Equal Opportunity Programming Environment
Ian Bosely	1994	SPI: A Social Presence Indicator

Postgraduate Thesis Examinations

Katherine Fennedy	PhD	External Examiner	Singapore University of Tech. & Design	2021
Praveenkumar Kanithi	PhD	Chair	University of Canterbury	2020
Ori Gagoni	PhD	Chair	University of Canterbury	2019
Alaeddin Nassani	PhD	Chair	University of Canterbury	2019
Veera Mandalika	PhD	Chair	University of Canterbury	2018
Jessalyn Alvina	PhD	Examiner	Université Paris Sud	2017
Hyungon Kim	PhD	Chair	University of Canterbury	2017
Thomas Young	PhD	Chair	University of Canterbury	2017
Craig Sutherland	PhD	Examiner	University of Auckland	2016
David Thompson	PhD	Chair	University of Canterbury	2016
Philip Quinn	PhD	Supervisor	University of Canterbury	2016
Daniel Bradley	PhD	Examiner	University of Queensland	2016
David Altimera	PhD	Chair	University of Canterbury	2015
Jakub Zlotowsky	PhD	Chair	University of Canterbury	2015
Thammathip Piumsomboon	PhD	Supervisor	University of Canterbury	2015
Robert Schattschnieder	PhD	Chair	University of Canterbury	2014
Hazel Bradshaw	PhD	Chair	University of Canterbury	2014
Amur Al Manji	PhD	Examiner	University of Auckland	2014
Amir Shareghi Najar	PhD	Chair	University of Canterbury	2014
Joey Scarr	PhD	Supervisor	University of Canterbury	2014
Stephen Fitchett	PhD	Supervisor	University of Canterbury	2014
Amali Weeseringhe	PhD	Chair	University of Canterbury	2012
Sayan Ray	PhD	Chair	University of Canterbury	2012
Christina Dicke	PhD	Chair	University of Canterbury	2012
Minkyung Lee	PhD	Chair	University of Canterbury	2010
Jason Alexander	PhD	Supervisor	University of Canterbury	2009
Leah Findlater	PhD	Examiner	University of British Colombia	2009
Judy Bowen	PhD	Examiner	University of Waikato	2008
Joerg Hauber	PhD	Supervisor	University of Canterbury	2008
Julian Looser	PhD	Supervisor	University of Canterbury	2008
Michael JasonSmith	PhD	Supervisor	University of Canterbury	2006
Tim Wright	PhD	Supervisor	University of Canterbury	2005
Beryl Plimmer	PhD	Examiner	University of Waikato	2003
Gorden Paynter	PhD	Examiner	University of Waikato	2000
Gitesh K Raikundalia	PhD	Examiner	Bond University	1997
Ramon Craig Standing	PhD	Examiner	University of Western Australia	1997
Ying Leung	PhD	Examiner	Massey University	1995
Qi Min Ser	Masters	Examiner	University of Canterbury	2016
Taher Amer	Masters	Supervisor	University of Canterbury	2006
Trond Nilsen	Masters	Supervisor	University of Canterbury	2006
Akhil Mehra	Masters	Examiner	University of Auckland	2005
Aparna Krishnan	Masters	Examiner	University of Waikato	2003
Shaun Kaasten	Masters	Examiner	University of Calgary	2001
Boyd Ludlow	Masters	Examiner	University of Waikato	1999
Donald Cox	Masters	Examiner	University of Calgary	1998
Wallace Chigona	Masters	Examiner	Waikato University	1997
Simon Gianoutsos	Masters	Examiner	Waikato University	1997
Jing Deng	Masters	Examiner	Waikato University	1996 and 1997
Aaron Tay	Masters	Examiner	University of Canterbury	1996

Student glory

Pang Suwanaposee	PhD	2022	Google PhD Fellowship Award AUD$15,000.
Pang Suwanaposee	PhD	2021	CHI Honourable Mention award.
Joey Scarr	PhD	2016	John Makepeace Bennett Award for the Distinguished Computer Science PhD thesis in Australasia.
Philip Quinn	PhD	2015	US Patent Awarded (Google Assignee).
Philip Quinn	PhD	2014	US Patent Awarded (Google Assignee).
Stephen Fitchett	PhD	2014	CHI Honourable Mention award.
Philip Quinn	PhD	2013	Google Mountain View Internship.
Stephen Fitchett	PhD	2013	CHI Best Paper award.
Joey Scarr	PhD	2013	CHI Honourable Mention award.
Joey Scarr	PhD	2013	CHI ReplicCHI award.
Joey Scarr	PhD	2012	CHI Best Paper award.
Stephen Fitchett	PhD	2012	CHI Honourable Mention award.
Philip Quinn	PhD	2012	Google Mountainview Internship.
Joey Scarr	PhD	2012	Google Sydney Internship.
Stephen Fitchett	PhD	2011	Outstanding reference from Darren Edge, Microsoft Research Asia.
Joey Scarr	PhD	2012	$3K for 2nd place in University ‘PhD in 3’ competition.
Joey Scarr	PhD	2012	$1K for 1st place in College ‘PhD in 3’ competition.
Stephen Fitchett	PhD	2012	$1K for 3rd place in College ‘PhD in 3’ competition.
Philip Quinn	PhD	2011	Honourable Mention award ACM CHI’11.
Joey Scarr	PhD	2011	Google Sydney Internship.
Susanne Tak	PhD	2010	$5K Google Anita Borg Scholarship
Susanne Tak	PhD	2010	$3K from ACM for participation at CHI’s Doctoral Consortium
Jason Alexander	PhD	2010	PhD Thesis placed on “Dean’s list for excellence” (top 10%)
Susanne Tak	PhD	2009	$2K award for 1st place in College Research Poster competition
Jason Alexander	PhD	2008	$1K award for 2nd place in College Research Poster competition
Jason Alexander	PhD	2008	Michael Sweeney award for best student paper, Graphics Interface ’08.
Mark Hancock	PhD	2007	Best paper nomination at ACM CHI’07.
Josh Savage and Andrew Wallace	M.Sc. Hons	2005	Best paper nomination at ACM CHI’05.
Mike Moyle	Hons	2005	NZ Hi-Tech Young Achiever of the Year Award

Publications

Edited Volumes

EV1 J McGrenere and A Cockburn (Eds.) Proceedings of ACM CHI 2020 Conference on Human Factors in Computing Systems.

EV2 J McGrenere and A Cockburn (Eds.) Extended Abstracts of ACM CHI 2020 Conference on Human Factors in Computing Systems.

EV3 M Billinghurst and A Cockburn (Eds.) Proceedings of the Sixth Australasian User Interface Conference (AUIC2005). Volume 40 of the Conferences in Research and Practice in Information Technology, Australian Computer Society.

EV4 A Cockburn (Ed.) Proceedings of the Fifth Australasian User Interface Conference (AUIC2004). Volume 28 of the Conferences in Research and Practice in Information Technology, Australian Computer Society.

Papers in Refereed Journals and Collections

J1 P Suwanaposee, C Gutwin, and A Cockburn. The Influence of Audio Effects and Attention on the Perceived Duration of Interaction. *International Journal of Human-Computer Studies.* 159. March. 2022.

J2 J Leung and A Cockburn. Design Framework for Interactive Highlighting Techniques. *Foundations and Trends in Human-Computer Interaction.* 14(2-3):96-271. 2021.

J3 AF Mairena, C Gutwin, and A Cockburn. Which Emphasis Technique to Use? Perception of Emphasis Techniques with Varying Distractors, Backgrounds, and Visualization Types. *Information Visualization.* September. 2021.

J4 A Cockburn, P Dragicevic, L Besançon and C Gutwin. Threats of a Replication Crisis in Empirical Computer Science. *Communications of the ACM.* 63(8):70-79. August 2020.

J5 M Claypool, A Cockburn and C Gutwin. The Impact of Motion and Delay on Selecting Game Targets with a Mouse. *ACM Transactions on Multimedia Computing, Communications, and Applications.* 16(2s):73, 1-14. June 2020.

J6 P Quinn and A Cockburn. Loss Aversion and Preference in Interaction. *Human-Computer Interaction Journal.* 35(2):143-190. 2020. (Online from 2018).

J7 A Cockburn, D Masson, C Gutwin, P Palanque, A Goguey, M Yung, C Gris and C Trask. Design and Evaluation of Braced Touch for Touchscreen Input Stabilisation. *International Journal of Human-Computer Studies.* 122:21-37. 2018.

J8 B Lafreniere, C Gutwin, and A Cockburn. Investigating the Post-Training Persistence of Expert Interaction Techniques. *ACM Transactions on Human-Computer Interaction.* 24(4): Article 29 (46 pages). 2017.

J9 A Cockburn, P Quinn and C Gutwin The Effects of Interaction Sequencing on User Experience and Preference. *International Journal of Human-Computer Studies.* 108:89-104. 2017.

J10 J Aceituno, S Malacria, P Quinn, N Roussel, A Cockburn and G Casiez. The Design, Use, and Performance of Edge-Scrolling Techniques. *International Journal of Human-Computer Studies.* 97:58-76. 2017.

J11 J Scarr, C Gutwin, A Cockburn and A Bunt. StencilMaps and EphemeralMaps: Spatially Stable Interfaces that Highlight Command Subsets. *Behaviour and Information Technology.* 34(11):1092-1106. 2015.

J12 S Fitchett and A Cockburn. An Empirical Characterisation of File Retrieval. *International Journal of Human-Computer Studies.* 74:1-13. 2015.

J13 A Cockburn, C Gutwin, J Scarr and S Malacria. Supporting Novice to Expert Transitions in User Interfaces. *ACM Computing Surveys.* 47(2):31:1-36. 2014.

J14 J Scarr, A Cockburn and C Gutwin. Supporting and Exploiting Spatial Memory in User Interfaces. *Foundations and Trends in Human-Computer Interaction.* 6(1):1-84. 2013.

J15 P Quinn, A Cockburn and J Delamarche. Examining the Costs of Multiple Trajectory Pointing Techniques. *International Journal of Human-Computer Studies.* 71(4):492-509. 2013.

J16 S Tak and A Cockburn. Enhanced Spatial Stability with Hilbert and Moore Treemaps. *Transactions on Visualization and Computer Graphics*. 19(1):141-148. 2013.

J17 A Cockburn, D Ahlstrom and C Gutwin. Understanding Performance in Touch Selections: Tap, Drag, and Radial Pointing Drag with Finger, Stylus and Mouse. *International Journal of Human-Computer Studies*. 70(3):218-233. 2012.

J18 J Hauber, A Cockburn, M Billinghurst and H Regenbrecht. The Impact of Collaborative Style on the Perception of 2D and 3D Videoconferencing Interfaces. *Open Software Engineering Journal*. 6:1-20. 2012.

J19 A Cockburn, P Quinn, C Gutwin, G Ramos and J Looser. Air Pointing: Design and Evaluation of Spatial Target Acquisition with and without Visual Feedback. *International Journal of Human-Computer Studies*. 69:401-414. 2011.

J20 E Tanvir, A Bunt, A Cockburn and P Irani. Improving Cascading Menu Selections with Adaptive Activation Areas. *International Journal of Human-Computer Studies*. 69:769-785. 2011.

J21 A Cockburn and C Gutwin. A Model of Novice and Expert Navigation Performance in Constrained Input Interfaces. *ACM Transactions on Computer-Human Interaction*. ACM Press. 7(3):1-38. 2010.

J22 A Cockburn and C Gutwin. A Predictive Model of Human Performance with Scrolling and Hierarchical Lists. *Human-Computer Interaction Journal*. Taylor and Francis. 24(3): 273-314. 2009.

J23 A Cockburn, A Karlson and B Bederson. A Review of Overview+Detail, Zooming, and Focus+Context Interfaces. *ACM Computing Surveys.* ACM Press. 41(1): 1-31. 2008.

J24 J Alexander, A Cockburn and R Lobb. AppMonitor: A Tool for Recording User Actions in Unmodified Windows Applications. *Behavior Research Methods*. Psychonomic Society. 40(2): 413-421. 2008.

J25 G Casiez, D Vogel, R Balakrishnan and A Cockburn. The Impact of Control-Display Gain on User Performance in Pointing Tasks. *Human-Computer Interaction Journal*. Taylor and Francis. 23(3): 215-250. 2008.

J26 S Jones, M Jones, G Marsden, D Patel and A Cockburn. An Evaluation Of Integrated Zooming and Scrolling On Small Screens *International Journal of Human-Computer Studies*. 63(3): 271–303. Elsevier Science. 2005.

J27 A Cockburn and S Brewster. Multimodal Feedback for the Acquisition of Small Targets *Ergonomics*. Taylor & Francis. 48(9): 1129–1150. 2005.

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C112 L Butts and A Cockburn. An Evaluation of Mobile Phone Text Input Methods *Proceedings of Australian User Interface Conference. 2002*, pages 55–59. Australian Computer Society Inc.

C113 T Wright and A Cockburn. Solo, Together, Apart: Evaluating Modes of CSCL for Learning a Problem Solving Task *Proceedings of ACM Computer Supported Collaborative Learning (CSCL) Conference 2002*. `newmedia.colorado.edu/cscl/06.pdf`

C114 T Bell, A Cockburn, B McKenzie and J Vargo. Flexible Delivery Damaging to Learning? Lessons from the Canterbury Digital Lectures Project *Proceedings of ED-MEDIA'2001: World Conference on Educational Multimedia, Hypermedia and Telecommunications* Tampere, Finland, June 25–30. *2001*, pages 117–122. Association for the Advancement of Computing in Education.

C115 A Cockburn and B McKenzie. 3D or Not 3D? Evaluating the Effect of the Third Dimension in a Document Management System *Proceedings of ACM CHI'2001 Conference on Human Factors in Computing Systems* Seattle, Washington, March 31–April 6. *2001*, pages 434–441. Addison-Wesley. Acceptance rate: 19%, 69 from 353.

C116 B McKenzie and A Cockburn. An Empirical Analysis of Web Page Revisitation *34th Hawaiian International Conference on System Sciences, HICSS34 2001.* IEEE Computer Society Press.

C117 T Wright and A Cockburn. Writing, Reading, Watching: A Task-Based Analysis and Review of Learners' Programming Environments *International Workshop on Advanced Learning Technologies, IWALT 2000*, pages 167–170. IEEE Computer Society Press.

C118 A Cockburn and B McKenzie. An Evaluation of Cone Trees *People and Computers XIV: British Computer Society Conference on Human Computer Interaction 2000*, pages 425–436. Springer-Verlag. Acceptance rate: 27 from 57.

C119 A Cockburn and S Greenberg. Issues of Page Representation and Organisation in Web Browser's Revisitation Tools *OzCHI'99: Australian Conference on Computer-Human Interaction,* Wagga Wagga, November 28–30, 1999, pages 7–14. Acceptance rate: 50%.

C120 A Cockburn, S Greenberg, B McKenzie, M JasonSmith and S Kaasten. WebView: A Graphical Aid for Revisiting Web Pages *OzCHI'99: Australian Conference on Computer-Human Interaction,* Wagga Wagga, November 28–30, 1999, pages 15–22. Acceptance rate: 50%.

C121 S Greenberg and A Cockburn. Getting Back to Back: Alternate Behaviors for a Web Browser's Back Button *5th Conference on Human Factors and the Web, Gaithersburg, Maryland. June 3, 1999*. Acceptance rate: 11 from 27.

C122 P Weir and A Cockburn. Distortion-Oriented Workspace Awareness in DOME *British Computer Society Conference on Human-Computer Interaction. Imperial College, London. 1–4 September, 1998.*, pages 239–252. Springer-Verlag. Acceptance rate: 21 from 89.

C123 E Ng, T Bell and A Cockburn. Improvements to a Pen-Based Musical Input System *OzCHI'98: The Australasian Conference on Computer-Human Interaction. Adelaide, Australia. 29th November to 4th December, 1998. 1998.*, pages 239–252. IEEE Computer Society Press.

C124 A Cockburn and T Bell. Extending HCI in the Computer Science Curriculum *ACM Australasian Computer Science Education Conference ACSE'98. Brisbane, Australia, 8–10 July, 1998,* pages 113–120. ACM Press. Acceptance rate: 28 from 59.

C125 A Cockburn and A Bryant. Cleogo: Collaborative and Multi-Paradigm Programming for Kids *APCHI'98: Asia Pacific Conference on Computer Human Interaction.* Japan. July 15–17, 1998, pages 187–192. IEEE Computer Society Press.

C126 N Churcher, A Cockburn, B McMaster, J Horlor. CUTE—The Design and Evolution of a First Year Programming Environment Software Engineering: Education and Practice '98. Dunedin. January, 1998, pages 142–148. IEEE Computer Society Press.

C127 A Cockburn and T Dale. CEVA: A Tool for Collaborative Video Analysis *ACM Group'97: International Conference on Supporting Group Work* Phoenix, Arizona, November 16–19, 1997, pages 47–55. ACM Press. Acceptance rate: 44 from 104.

C128 A Cockburn and N Churcher. Towards Literate Tools for Novice Programmers *ACM Australasian Computer Science Education Conference ACSE'97.* Melbourne, Australia, 2-4 July 1997, pages 163–169. ACM Press. Acceptance rate: 31 from 46.

C129 N Churcher and A Cockburn. An Immersion Model for Software Engineering Projects *ACM Australasian Computer Science Education Conference ACSE'97.* Melbourne, Australia, 2-4 July 1997, pages 107–116. ACM Press. Acceptance rate: 31 from 46.

C130 A Cockburn and S Jones. Design Issues for World Wide Web Navigation Visualisation Tools *RIAO'97: The Fifth Conference on Computer-Assisted Research of Information.* McGill University, Montreal, Quebec, Canada, 25th-27th June 1997. pages 55–74. Acceptance rate: 35 from 90.

C131 J Anstice, T Bell, A Cockburn and M Setchell. The Design of a Pen-Based Musical Input System. *OzCHI'96: The Sixth Australian Conference on Computer-Human Interaction,* Hamilton, New Zealand, November 24–27, 1996, pages 260–267. IEEE Press. Acceptance rate: 38 from 79.

C132 A Cockburn and A Bryant. Do It This Way: Equal Opportunity Programming for Kids *OzCHI'96: The Sixth Australian Conference on Computer-Human Interaction,* Hamilton, New Zealand, November 24–27, 1996, pages 246–251. IEEE Press. Acceptance rate: 38 from 79.

C133 A Tay and A Cockburn User Interfaces for Workflow Systems: Designing for End-User Tailorability Short paper in *OzCHI'96: The Sixth Australian Conference on Computer-Human Interaction,* Hamilton, New Zealand, November 24–27, 1996, pages 301–302. IEEE Press.

C134 A Cockburn. Collaborative Usability Analysis Using Video Protocols *APCHI'96: The First Asia Pacific Conference Human Computer Interaction,* Information Technology Institute Singapore, 25–28 June, 1996, pages 67–80. Acceptance rate: lower than 50%.

C135 S Greenberg, C Gutwin, and A Cockburn. Using Distortion-Oriented Displays to Support Workspace Awareness. *British Computer Society Conference on Human-Computer Interaction. Imperial College, London. 20–23 August, 1996.* Cambridge University Press. Acceptance rate: 23 from 63.

C136 A Cockburn and S Greenberg. Children's Collaboration Styles in a Newtonian Microworld. In *Companion Proceedings of CHI'96. ACM Conference on Human Factors in Computing Systems* Vancouver, April 13–18 1996, pages 181–182. ACM Press. Acceptance rate: 78 from 335.

C137 S Greenberg, C Gutwin, and A Cockburn. Awareness Through Fisheye Views in Relaxed-WYSIWIS Groupware *Proceedings of Graphics Interface, May 21–24, 1996. Toronto*, pages 28–38. Morgan-Kauffman. Acceptance rate: 29 from 73.

C138 SRA Jones and AJG Cockburn. A Study of Navigational Support Provided by Two World Wide Web Browsing Applications. In *Hypertext '96. Seventh ACM Conference on Hypertext. Washington DC March 16–20, 1996*, pages 161–169. ACM Press. Acceptance rate: 24 from 85.

C139 AJG Cockburn and SRA Jones. Trails, Trials, and Tribulations: Unravelling Navigational Problems in the World Wide Web. In *Proceedings of the 5th Workshop on Information Technologies and Systems (WITS '95). Nijenrode University, The Netherlands. 9–10 December.*, pages 46–55, 1995. Acceptance rate: 24 from 70.

C140 A Cockburn and S Greenberg. TurboTurtle: A Collaborative Microworld for Exploring Newtonian Physics. In *ACM Conference on Computer Supported Cooperative Learning (CSCL '95). Bloomington, Indiana. October 17–20, 1995*, pages 62–66. Lawrence Erlbaum Associates, Inc, October 1995.

C141 AJG Cockburn. TurboTurtle: Educating Children in an Alternative Reality Universe. In *Proceedings of the 1994 Computer Human Interaction Specialist Interest Group of the Ergonomics Society of Australia (OZCHI'94).* November 28 to December 1. *Melbourne.*, pages 99–105, 1994.

C142 A Cockburn and S Jones. Four Principles for Groupware Design. In *Proceedings of the 1994 Computer Human Interaction Specialist Interest Group of the Ergonomics Society of Australia (OZCHI'94).* November 28 to December 1. *Melbourne.*, pages 21–26, 1994.

C143 AJG Cockburn and S Greenberg. Making Contact: Getting the Group Communicating with Groupware. In *COOCS '93. The ACM Conference on Organisational Computing Systems. November 1st to 4th. Milpitas, California.*, pages 31–41, 1993.

C144 AJG Cockburn. Supporting Social Awareness in Distributed Work. In P *et al* Collings, editor, *Proceedings of OZCHI 1993. CHISIG Annual Conference.* Canberra. November., pages 224–241, 1993.

C145 AJG Cockburn and HW Thimbleby. Reducing User Effort in Collaboration Support. In WD Gray, WE Hefley, and D Murray, editors, *Proceedings of the 1993 International Workshop on Intelligent User Interfaces, Orlando, Florida. January 4–7.*, pages 215–218. New York: ACM Press, January 1993.

C146 AJG Cockburn and HW Thimbleby. Automatic Conversational Context: Avoiding Dependency on User Effort in Groupware. In MJ Rees and R Iannella, editors, *Interface Technology: Advancing Human-Computer Communication. Proceedings of OZCHI 1992. CHISIG Annual Conference.* Bond University Australia, Queensland. November 26–27, pages 142–149, 1992.

C147 AJG Cockburn. Reflexive CSCW and Managing Commitments. In *IEE Colloquium on CSCW: Some Fundamental Issues.* London, March 15, number 065 in 1991, pages 9/1–9/5. IEE, 1991.

Patents and Patent Applications

P1 Andy Cockburn, Mark Billinghurst, Dinesh Mandalapu. User Interface Device. US Patent Application Number: PCT/IN2011/000897.

Other: Refereed Videos, Media Reports and Non-Refereed Publications

O1 L Besanon, Y Jansen, A Cockburn, and P Dragicevic. Definitely Maybe: Hedges And Boosters in the HCI Literature. OSF Preprints. https://osf.io/mjg7h/, 2021.

O2 National Science Challenges report. 'Meet the researchers: Andy Cockburn, Turbulent touch'. 22/03/2019.

O3 Marsden update. 'Young researchers experience international science.' (PhD student Stephen Fitchett). February 2012.

O4 Magazine article. New Zealand Listener. "Charge of the tech brigade". Mar 31, 2012.

O5 Newspaper article. The Press. “Conference acceptance a coup”. Dec 22, 2011.

O6 Newspaper article. The Press. “Intuitive Innovations”. Feb 22, 2011.

O7 UC Communications. ‘UC/Microsoft internship opens up world for computer science student.’ Mar 22, 2011.

O8 Marsden update. ‘Highlights of the 2010 funding round.’ November 2010.

O9 Magazine article. ‘Profiling Excellence’. Royal Society of New Zealand. ‘Thirty years of research in a single hit’, March 2010.

O10 Newspaper article. Sydney Morning Herald. ‘Computer mouse still rules, says expert’, Jan 19, 2010. (Widely syndicated through AAP.)

`http://news.smh.com.au/breaking-news-national/computer-mouse-still-rules-says-expert-20100119-mhnp.html`

O11 Newspaper article. Dominion Post. ‘Next-step mouse on its way’, Feb 1, 2010.

O12 Radio Interview (Live). ABC Perth. ‘Drive Time’ program. January 19th, 2010.

O13 Newspaper article. The Press. ‘Boost for Computer Activation Project’, Nov. 5, 2009.

O14 Radio interview (Sweden). ‘Highlights of the INTERACT Conference’, Sept 3 2009. `http://www.sr.se/cgi-bin/p1/program/artikel.asp?ProgramID=406&nyheter=1&artikel=3075930`

O15 Newspaper article. Dominion Post. ‘Kiwi mouse comes out of hiding’, March 10, 2008. `http://www.stuff.co.nz/4433363a28.html`

O16 Newspaper article. Christchurch Press. ‘Fast Kiwi mouse attracts interest from big players’, March 5, 2008. `http://www.stuff.co.nz/4425499a28.html`

O17 Newspaper article. The Age (Australia). ‘Kiwi mouse attracts interest’, March 5, 2008. `http://http://www.theage.com.au/news/biztech/kiwi-mouse-attracts-interest/2008/03/10/1204998342852.html`

O18 Magazine article. Marsden Update. ‘Document Navigation’, December 2008.

O19 Interview. IEEE Spectrum. ‘A New Spin on the Computer Mouse’, October 2006. `http://www.spectrum.ieee.org/oct06/4668`

O20 Video. Faster Document Navigation with Space-Filling Thumbnails *Video in the Video Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI2006)* Montreal, Canada, April *2006*. `http://www.cosc.canterbury.ac.nz/~andy/sft.mov`

O21 Video. Tuning and Testing Scrolling Interfaces that Automatically Zoom *Video in the Refereed Video Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI2005)* Portland, Oregon, April *2005*. `http://www.cosc.canterbury.ac.nz/~andy/tuning-n-testing.wmv`

O22 Video. Around the World in Seconds with Speed-Dependent Automatic Zooming *Video and Demonstration at the ACM Conference on User Interface Software and Technology* Vancouver, Canada, November *2003*. `http://www.cosc.canterbury.ac.nz/~andy/uist-sdaz.avi`

O23 Radio Interview. BBC World Service. 'Go Digital' program. January 14th, 2003 http://news.bbc.co.uk/2/hi/technology/2677337.stm

O24 Nature Journal's Science Update. 'Browsers go back to the future' www.nature.com/nsu/021230/021230-3.html

O25 'The Register' in the UK. 'Kiwis redesign the Back button'. http://www.theregister.co.uk/content/6/28729.html

O26 Canadian Broadcast Corporation. Programmers try out alternative to browser's back button. http://cbc.ca/storyview/CBC/2002/12/30/back_button021230

O27 Slashdot. 'Redesigning The "Back" Button' slashdot.org/article.pl?sid=02/12/30/1727206&mode=thread&tid=95

O28 NZOOM's Technology Page. technology.nzoom.com/technology_subcategory/0,1610,113-116,00.html

O29 Newspaper Interview. Christchurch Press. 'Better Going Back', Feb 11, 2003.

O30 University Chronicle. "Taking the frusturation out of the web", Feb 20, 2003.

O31 S Greenberg, C Gutwin, and A Cockburn. Applying Distortion-Oriented Displays to Groupware. Video Programme of the ACM Conference on Computer Supported Cooperative Work. 1996.

O32 S Greenberg, C Gutwin, and A Cockburn. Sharing fisheye views in relaxed-WYSIWIS groupware applications. Technical Report 95/577/29, Department of Computer Science, University of Calgary, Calgary, CANADA., 1996.

O33 S Greenberg, C Gutwin, and A Cockburn. Using distortion-oriented displays to support workspace awareness. Technical Report 96/581/01, Department of Computer Science, University of Calgary, Calgary, CANADA., 1996.

O34 S Greenberg, C Gutwin, M Roseman, and A Cockburn. From awareness to teamrooms, groupweb and turboturtle: Eight snapshots of recent work in the grouplab project. Technical Report 95/580/32, Department of Computing Science, University of Calgary, Canada, December 1995.

O35 A Cockburn and S Greenberg. The design and evolution of turboturtle: A collaborative microworld for exploring newtonian physics. Technical Report tr-cosc.03.95, University of Canterbury, Christchurch. New Zealand, 1995.

O36 AJG Cockburn. Social awareness without mega-bits. In *Proceedings of Uniforum. Rotoroa, New Zealand.*, 1994.

O37 AJG Cockburn. *Groupware design: principles, prototypes, and systems*. PhD thesis, Department of Computing Science and Mathematics, University of Stirling, Scotland. FK9 4LA, 1993. Available from British Libraries, or as Technical Report 107 from the University of Stirling.

O38 SRA Jones and AJG Cockburn. Reducing requirements in computer supported writing tasks, 1993. Paper presented at: 6th UK conference on computers and writing. University of Wales. April 13-15.

O39 AJG Cockburn and S Greenberg. Making contact: getting the group communicating. Technical Report 93/498/03, Department of Computer Science, University of Calgary, Alberta T2N 1N4 Canada, 1993.

O40 AJG Cockburn and HW Thimbleby. Reducing user effort in collaboration support. Technical Report 93, University of Stirling, Stirling, Scotland, FK9 4LA, 1992.

O41 AJG Cockburn and HW Thimbleby. A reflexive perspective of CSCW. *ACM SIGCHI Bulletin*, 23(3):63–68, July 1991.

O42 AJG Cockburn. A user's guide to TELEFREEK: a communication and social awareness environment. Technical Report 105, Department of Computing Science and Mathematics, University of Stirling, Stirling, Scotland, FK9 4LA, 1993.

O43 AJG Cockburn. A user's guide to *mona*: an enhanced email system. Technical Report 97, Department of Computing Science and Mathematics, University of Stirling, Stirling, Scotland, FK9 4LA, 1992.

Grants and industry research/consulting

Project	Source	Date	Amount
Understanding the human experience of intelligent user interfaces	Marsden. (19-UOC-021)	2020-2023	$530,000
Travel expenses	Airbus & U. Paul Sabatier	2018	≈ $7,000
In-Vehicle Touchscreens	NZ Science for Innovation	2017	$200,000
Travel expenses	ACM CHI Steering Committee	2017	≈ $4,000
Travel expenses	Australian National University	2016	≈ $3,000
Travel expenses	Airbus & U. Paul Sabatier	2016	≈ $5,000
Travel expenses	ACM CHI Academy Award (Seoul)	2015	≈ $5,000
Benjamin Meaker Visiting Professorship	University of Bristol	2013	£7,000
Understanding and improving the novice to expert transition with user interfaces	Marsden. (10-UOC-020)	2011-2014	$496,000
Dynamic Multimodal Affordances	HP Innovations Award	2011-2012	US$40,000
Travel expenses	ACM UIST conference	June 2009	≈ $4,000
Postdoctoral Fellow	BuildIT	2011-2012	$116,000
Dynamic Multimodal Affordances	HP Innovations Award	2010-2011	US$40,000
Travel expenses	ACM UIST conference	June 2009	≈ $4,000
Scrolling device studies	Logitech Inc	2010	$10,000
Canadian GRAND project	Canadian Centres of Excellence	2010-2014	C$25,000,000
BuildIT Emerging Researcher Mentoring Fund	BuildIT	2010	$8,000
Pythodogogical	UC Teaching and Learning	2009-2010	$15,000
Dynamic Multimodal Affordances	HP Innovations Award	2009-2010	US$40,000
Travel expenses	ACM UIST conference	June 2009	≈ $4,000
Travel expenses	ACM CHI conference	Nov. 2008	≈ $4,000
Improving document navigation interfaces	Marsden. (07-UOC-013)	2007–2010	$400,000
Accessible AR on Everyday Devices	FRST (UOCX0704)	2007–2011	$1,875,000
Usability training	Jade Software	2007	≈ $2,000
Usability training	AMI	2007	≈ $2,000
Expenses	Logitech Inc., California	April 2007	≈ $5,000
Expenses	Logitech Inc., California	July 2006	≈ $2,000
Grant in aid	University of Toronto	July 2006	≈ $8,000
Grant in aid	University of Saskatoon	June 2006	≈ $6,000
Grant in aid	University of Calgary	May 2006	≈ $3,000
Grant in aid	IBM Almaden Research, California	April 2006	≈ $3,000
NOKIA Pocket (Assoc. with HIT Lab).	Nokia Research Center	2006.	≈$100,000.
Speed-Dependent Automatic Zooming	Computer Science	2003	$3,000
Evaluation of Speed-Coupled Scrolling	Computer Science	2002	$3,000
Multimedia Learning of Graphics (Assoc.)	UoC Teaching and Learning Ctte.	2002	$5,000
Fastap Evaluation	Digit Wireless LLC, MA, USA.	2002	$3,000
Supermedia—The MagicBook Project (Assoc.)	NZ NERF (UOCX0204)	2002	$333,000
Practical Flexible Delivery of Virtual Learning	UoC (U6360)	1999–2002	$40,000
Collaborative Programming for Children	Marsden, Royal Soc. (UOC805)	2000–2002	$135,000
Evaluation of Back/Forward in Web-browsers	Computer Science	2001	$3,000
Interfaces for WWW navigation.	Microsoft Research, USA.	1999	≈ $8,000
HCI and multi-media research lab	Computer Science	1999	$7,400
Video analysis and multi-media lab	UoC (2313728)	1996	$30,000
Collaborative video analysis	Computer Science	1996	$3,000
Collaborative microworlds	Computer Science	1995	$4,000
Asynchronous groupware toolkits	Computer Science	1994	$2,000

Academic Service

External assessor	2019	Promotion to Full Professor: University of Toronto.
External assessor	2018	Promotion to Full Professor: University of Cambridge.
Rapportuer	2018	Habilitation, Dr Eric Lecolinet, Université Paris Sud, France.
Rapportuer	2018	Habilitation, Dr Marcos Serrano, University Toulouse III Paul Sabbatier, France.
External assessor	2017	Promotion application: University of Waterloo.
Chair	2018-2021	Technical program chair for ACM CHI 2020 Conference
Committee member	2016-2020	Steering Committee for the ACM CHI Conference
Rapportuer	2017	Habilitation, Dr Caroline Appert, University Paris-Sud, France.
Chair	2016-2018	CORE Chris Wallace Research Award Panel
Deputy Chair	2016-2018	PBRF Mathematical and Information Sciences Panel
Editorial	2015–	Editorial Board of Foundations and Trends in Human-Computer Interaction.
Editorial	2015–	Editorial Board of Human-Computer Interaction. Taylor and Francis.
Chair	2012–2015	Papers co-chair for ACM CHI 2014 and 2015 (over 2000 submissions).
Service Award.	2014.	ACM SIGCHI Recognition of Service Award.
Editorial	2012–	Editorial Board of ACM Transactions on Computer-Human Interaction. ACM.
Panel member	2011-2012	Member of the Mathematics, Information Sciences and Technology PBRF panel.
Panel member	2008–2009	BuildIT Postdoctoral Award.
Governance board	2008–2010	Elected member of the governance board of BuildIT.
Panel member	2009, 2011	Member of the Mathematics and Information Sciences Marsden panel.
Panel member	2008–2009	BuildIT Postdoctoral Award.
Panel member	2008–2010	BuildIT Emerging Reseacher Travel Fund.
Mentor	2009–2010	BuildIT mentor for early career researchers.
External assessor	2010	Docent application advisor, University of Tampere, Finland.
External assessor	2010	Promotion application for University of Auckland.
External assessor	2007, 2009	Promotion applications for INRIA, University Paris-Sud.
External assessor	2007	Postdoctoral applicants for Ryerson Univerity, Canada.
Editorial	2002–2013	Associate Editor for International Journal of Human-Computer Studies.
Editorial	2002–2013	Member Editorial Board for Interacting with Computers Journal.
Chair	2010–2011	Subcommittee Chair ACM CHI'11.
Senior Reviewing	2004–	Associate Chair (Papers) for ACM CHI'04, CHI'08, CHI'09.
Senior Reviewing	2009	Associate Chair (Papers) for ACM UIST 2009.
Senior Reviewing	2007	Short papers chair for INTERACT 2007
Chair	2004–2005	Papers chair for Australasian User Interface Conferences
Competition judge	2009	Student Research Competition at CHI 2009.
Journal Reviewing	1993–	Communications of the ACM, Human-Computer Interaction Journal, IEEE Transactions on Visualization and Computer Graphics, ACM Transactions on Computer-Human Interaction, Ergonomics, Information and Software Technology, Information Technology and Society, Interacting with Computers, Virtual Reality, Personal and Ubiquitous Computing, Journal of Computer-Mediated Communication, and International Journal of Human-Computer Studies.
Misc.	2003	Organised the 'Masterclass and Symposium on Interacting with and Through Next Generation Computer Systems', held at the University of Canterbury.
Organising committees	1996, 1998	OzCHI
Doctoral consortium	2008	CHI 2008
Other reviewing	Ongoing	Graphics Interface 2009, 2010, 2011; UIST Demos 2009; ACM CHI 2007, 2006, 2005, 2004, 2003, 2002. AICCS-07; ACM UIST 2007, 2006, 2005, 2003; InfoVis 2006; BEyond time and errors: novel evaLuation methods for Information Visualization (BELIV'06); ACM Advanced Visual Interfaces (AVI) 2006; IEEE Tencon'05; CHINZ'05; Interact'05; MobileHCI'05; ACM CSCW 2004; ACM UIST 2003; INTERACT 2003; Australasian User Interface Conference, 2000–2003; The Active Web, '99; ACM Conference on Data Communications 1994; ACM Conference on Human Factors in Computing Systems 1996; OZCHI'94-97; APCHI'96 & '98; ACM Hypertext '97; Graphics Interface '97; InterAct '97; ACM Group '97.

Invited seminar presentations outside the University of Canterbury

Keynote address, ACM Interactive Surfaces and Spaces Conference, Wellington, NZ.	November, 2022.
Keynote address, INTERACT Conference, Mumbai.	September, 2017.
Dean's Colloquium, ANU, Australia.	August, 2016.
Engineering & Computer Science, ANU, Australia.	August, 2016.
Institute of Advanced Studies, University of Bristol, UK.	August, 2013.
Department of Computer Science, University of Glasgow, UK.	August, 2013.
Colloquium Polaris, INRIA, Lille, France.	July, 2013.
Department of Computer Science, University of Manitoba, Canada.	August, 2010.
Department of Computer Science, University of Manitoba, Canada.	August, 2010.
Department of Computer Science, University of British Colombia, Canada.	August, 2010.
Keynote address, Australasian Computer Science Week.	January, 2010.
Department of Computer Science, University of British Colombia, Canada.	July, 2009.
Department of Computer Science, University of Calgary, Canada.	July, 2008.
Department of Computer Science, Swansea University, UK.	September, 2008.
INRIA, Universite Paris-Sud, France.	September, 2006.
Department of Computer Science, Swansea University, UK.	August, 2006.
Logitech Inc., California.	July, 2006.
Department of Computer Science, Dalhousie University, Nova Scotia.	July, 2006.
Digital Graphics Project Lab, University of Toronto.	June, 2006.
Department of Computer Science, University of Saskatoon.	June, 2006.
Department of Computer Science, University of Calgary.	April, 2006.
IBM Almaden Research Centre.	March, 2006.
Digital Fusion Inc..	February, 2006.
Usability Professionals Association (UPA), Canterbury Innovation Incubator.	November, 2005.
Usability Professionals Association (UPA), Canterbury Innovation Incubator.	November, 2004.
Department of Computer Science, University of Calgary, Canada.	November, 2003.
Human-Computer Interaction Lab, Univ. of Maryland, College Park, USA.	October 2003.
Department of Computer Science, University of Glasgow.	September, 2003.
Department of Psychology, University of York.	September, 2003.
Interaction Centre, University College London.	September, 2003.
Department of Computer Science, University of Southampton.	September, 2003
New Zealand Computer Society, Christchurch.	June, 2003.
Department of Computer Science, University of Waikato.	December, 2002.
Allied Telesyn Research.	November, 2002.
Department of Computer Science, University of Calgary, Canada.	October, 2001.
Institute for Info. Tech., National Research Center, Ottawa, Canada.	October, 2001.
Grouplab, University of Calgary, Canada.	October, 2001.
Department of Computer Science, University of Saskatchewan, Canada.	October, 2001.
Department of Computer Science, University of Cape Town, South Africa.	September, 2001.
Department of Computer Science, Victoria University of Wellington.	July, 2000.
Inaugural ACM SIGCHI_NZ meeting. Massey University.	June 2000.
Department of Computer Science, University of Waikato.	May, 2000.
Department of Computer Science, University of Calgary.	March, 1999.
Center for LifeLong Learning and Design, University of Colorado, Boulder.	November, 1998.
Norsk Regencentral (Norwegian Research Centre), Oslo, Norway.	August, 1998.
Department of Computer Science, University of Calgary.	January, 1996.
Department of Computer Science, Massey University.	January, 1993.
Department of Computer Science, University of Waikato.	January, 1993.

Visiting academics

I have attracted many world leaders in Human-Computer Interaction to the department. Most of them have presented several seminars while at Canterbury, including numerous 'Science Prestige Lectures' and Ben Sheiderman's Royal Society Evening Lecture.

Prof. Joanna McGrenere	University of British Columbia, Vancouver, Canada.	One month, 2023.
Prof. Carl Gutwin	University of Saskatchewan, Saskatoon, Canada.	Two months, 2023.
Dr. Philip Quinn	Google Research, Mountain View, California.	One year, 2020-2021.
Prof. Carl Gutwin	University of Saskatchewan, Saskatoon, Canada.	Four weeks, 2020.
Prof. Carl Gutwin	University of Saskatchewan, Saskatoon, Canada.	Seven weeks, 2015-2016.
Prof. Wolfgang Stuerzlinger	University of Waterloo, Canada	Three months, 2011-2012
Prof. Kari-Jouko Raiha	University of Tampere, Finland	Nine months, 2009-2010
Dr. Saila Ovaska	University of Tampere, Finland	Nine months, 2009-2010
Dr. David Ahlstroem	Klagenfurt University, Austria.	Eighteen months, 2008-2010.
Prof. Carl Gutwin	University of Saskatchewan, Saskatoon, Canada.	Three months, 2008.
Prof. Karon MacLean	University of British Colombia, Canada.	Six months, 2007-2008.
Prof. Bob Kraut	Carnegie Mellon University.	Erskine Visitor. Three months, 2008.
Prof. Andrew Monk	University of York, UK.	Three months, 2008.
Dr. Gonzalo Ramos	University of Toronto, Canada.	One month, 2007.
Prof. Carl Gutwin	University of Saskatchewan, Saskatoon, Canada.	Erskine Fellow. Four months, 2007.
Prof. Alistair Sutcliffe	University of Manchester, UK.	One month, 2007.
Prof. Carl Gutwin	University of Saskatchewan, Saskatoon, Canada.	One week, 2005.
Prof. Ben Bederson	University of Maryland, Maryland, USA.	One week, 2004.
Prof. Ben Shneiderman	University of Maryland, Maryland, USA.	Erskine Fellow. One month, 2003.
Prof. Jenny Preece	University of Maryland, Baltimore County, Maryland.	Erskine Fellow. One month, 2003.
Prof. Stephen Brewster	University of Glasgow, UK.	Erskine Fellow. Six months, 2003.
Prof. Gerhard Fischer	University of Colorado, Boulder.	One year, 2002–2003.
Prof. Bob Spence	Imperial College London.	Erskine Fellow. One month, 2002.
Prof. Gerhard Fischer	University of Colorado, Boulder.	Erskine Fellow. One month, 2000.
Prof. Harold Thimbleby	Middlesex University, UK.	Erskine Fellow. One month, 1997.
Dr Allen Cypher	Apple Research, Cuppertino, California.	One week, 1996.
Dr Akihiko Machizawa	Communications Research Laboratory, Japan.	Three years, 1996–1998.
Professor Brian Wyvill	University of Calgary, Canada.	Erskine Fellow. Two months, 1996.
Professor Saul Greenberg	University of Calgary, Canada.	Erskine Fellow. Six months, 1995.
Carl Gutwin	University of Calgary, Canada.	Two months, 1995.
Dr Steve Jones	University of Abertay, Dundee.	Six months, 1995.

Expert Witness Consulting

Role	Expert witness for Finnegan, Henderson, Farabow, Garrett & Dunner, counsel for Samsung. (analysis).
Case	Smith Interface Technologies v. Samsung. *Eastern District of Texas.* 2:22-cv-00290-JRG
Dates	November 2022 – June 2023

Role	Expert witness for Morrison Foerster, counsel for Apple. (analysis, reports, deposition).
Case	Firstface Co. Ltd. v. Apple Inc. *Northern District of California.* 3:15-cv-02245-JD.
Dates	June 2022 –

Role	Expert witness for Finnegan, Henderson, Farabow, Garrett & Dunner, counsel for Samsung. (analysis).
Case	Village Green Technologies v. Samsung. *Eastern District of Texas.* 2:21-cv-00323-JRG-RSP
Dates	January 2022 – March 2022

Role	Expert witness for Desmarais, counsel for IBM. (analysis, reports, deposition).
Case	Chewy, Inc. v. IBM. *Southern District of New York.* 1:21-cv-01319-JSR.
Dates	August 2021 – Jan 2023

Role	Expert witness for Farella, Braun & Martel, counsel for Google. (analysis, reports, testimony at trial).
Case	Profectus Technology versus Google. *Western District of Texas.* 6:20-cv-101-ADA.
Dates	March 2021 – October 2021

Role	Expert witness for Latham & Watkins and Allen & Overy, counsel for Facebook/Meta. (analysis, reports, deposition).
Case	Facebook/Meta Platforms *et al.* versus Wrinkl Patent Trial and Appeals Board. IPR2021-00882, -00883
Dates	February 2021 – November 2022

Role	Expert witness for Morrison & Foerster, counsel for Renesas. (analysis).
Case	Neodron versus Renesas Electronics Corp. *Western District of Texas.* 6:20-CV-00529.
Dates	December 2020 – August 2021

Role	Expert witness for DLA Piper, counsel for Samsung. (analysis, declaration).
Case	Neonode versus Samsung. *Western District of Texas.* 6:20-CV-00507.
Dates	September 2020 –

Role	Expert witness for DLA Piper (counsel for Apple, Microsoft and ASUS), Morrison & Foerster (counsel for Amazon), Finnegan, Henderson, Farabow, Garrett & Dunner (counsel for LG), O'Melveny & Myers (counsel for Samsung), Vasquez Benisek & Lindgren (counsel for ASUS). (analysis).
Case	Neodron versus Apple, Microsoft, Amazon & others. *US International Trade Commission.* 337-TA-1193.
Dates	May 2020 – November 2020.

Role	Expert witness for Desmarais, counsel for IBM. (analysis, reports).
Case	IBM versus Zillow Group. *Central District of California.* 8:19-CV-01777.
Dates	October 2019 – May 2020.

Role	Expert witness for DLA Piper (counsel for Microsoft, HP, Lenovo), Morrison & Foerster (counsel for Amazon), Finnegan, Henderson, Farabow, Garrett & Dunner (counsel for Motorola and Lenovo), Alston & Bird (counsel for Dell), O'Melveny & Myers (counsel for Samsung). (analysis, reports, deposition).
Case	Neodron versus Microsoft, HP, Amazon, Samsung, Dell, Motorola, Lenovo. *US International Trade Commission.* 337-TA-1162.
Dates	August 2019 – December 2020.

Role	Expert witness for Jones Day, counsel for Google and Huawei. (analysis).
Case	American Patents versus Huawei.
Dates	April 2019 – July 2019

Role	Expert witness for Gilbert+Tobin, counsel for Aristocrat Technologies. (reports, testimony at trial).
Case	Aristocrat Technologies versus Commissioner of Patents. *Federal Court of Australia.* NSD 1343/2018.
Dates	September 2018 – June 2020

Role	Expert witness for Williams & Connolly and Alston & Bird, counsel for Google and ASUS Inc. (reports, deposition).
Case	Koninklijke Philips versus ASUS. *Northern District of California* 4:18-cv-01885-HSG.
Dates	March 2016 – March 2020

Role	Expert witness for Williams and Connolly, counsel for Google Inc. (reports, deposition).
Case	Google versus Philips. *Patent Trial and Appeal Board.* IPR2017-00386/387/388/389.
Dates	March 2016 – March 2020

Role	Expert witness for DLA Piper, counsel for Apple Inc. (reports, deposition, testimony at trial).
Case	Immersion versus Apple. *US International Trade Commission.* 337-TA-1004 and 337-TA-990 (consolidated).
Dates	June 2016 – May 2017

Role	Expert witness for DLA Piper, counsel for Apple Inc. (reports).
Case	Apple versus Immersion. *Patent Trial and Appeal Board.* IPR2016-01777.
Dates	June 2016 – May 2017

Role	Expert witness for Wilmer Cutler Pickering Hale and Dorr, counsel for Apple Inc. (analysis).
Case	Core Wireless Licensing S.a.r.l. v. Apple Inc. *Eastern District of Texas.* 6:14-cv-00751 and 6:14-cv-00752.
Dates	August 2015 – June 2016

Role	Expert witness for Weil, Gotshal & Manges, counsel for Apple Inc.

(analysis).

Case Motorola Mobility Inc. versus Apple Inc.
Southern District of Florida. 10-CV-23580-RNS-TEB and 12-CV-20271-RNS-TEB.
Dates October 2013 – March 2014

Role Expert witness for Gibson, Dunn & Crutcher, counsel for Apple Inc.
(reports, deposition, testimony at trial).
Case Apple Inc. versus Samsung Electronics Co. Ltd.
Northern District of California. 12-CV-0630-LHK.
Dates June 2013 – June 2014

Role Expert witness for Herbert Smith Freehills, counsel for Apple Inc.
(reports, testimony at trial).
Case Apple Inc. versus Samsung Electronics Co. Ltd.
Federal Court of Australia. NSD 1243 of 2011.
Dates September 2011 – May 2013

Other

- Member of the Association of Computing Machinery (ACM).
- Member of the ACM Special Interest Group of Computer-Human Interaction.