UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

TCL CORPORATION; TCL COMMUNICATION TECHNOLOGY HOLDINGS LTD.; TCT MOBILE LIMITED; TCT MOBILE INC.; and TCT MOBILE (US), INC.,

Petitioner,

v.

TELEFONAKTIEBOLAGET LM ERICSSON

Patent Owner.

Cases IPR2015-01602, IPR2015-01637, IPR2015-01641, IPR2015-01646

U.S. Patent No. RE43,931

DECLARATION OF Jean Renard Ward

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I, **Jean Renard Ward**, declare as follows:

I. QUALIFICATIONS

1. I received an SBEE degree (combined program in Electrical Engineering and Computer Science) from the Massachusetts Institute of Technology as a member of the class of 1973.

2. I am a practicing engineer. For a number of years, I have primarily been doing consulting projects and contract development work under the business name of Rueters-Ward Services. I have worked professionally in the general field of software engineering for approximately 40 years, primarily in pen/touch computing, applications of public-key cryptography, and web development. In recent years, my major projects have concerned pen/touch computing: also referred to simply as pen computing. Pen computing refers to computing that makes use of a pen, stylus (including a finger), or other touch-sensitive tool, and a tablet or touchscreen. This is contrasted with computing that makes use of devices such as a physical keyboard or physical mouse.

3. During and immediately after my university studies, from 1973 to 1977, I worked at Data General Corporation on compilers and source-level emulation tools for a number of programming languages.

4. For the next approximately 17 years, I worked primarily on many aspects of pen computing at a number of development companies. From 1977 to

1987, I was heavily involved in the development of base technology and three generations of pen-computing products of Pencept Inc., a pioneering commercial company for pen-computing technology that I co-founded. Pencept filed for and was granted a number of patents for my work during that time. My contributions included developing novel techniques for gesture and handwriting recognition, new paradigms for pen- and stylus-based user interfaces, two generations of an applicative computer language for gesture and handwriting recognition, and engineering solutions to problems with touchscreens and digitizing tablets.

5. While at Pencept, I participated in the re-engineering of off-the-shelf commercial tablets that detected touch from an electronic stylus; the engineering evaluation of off-the-shelf tablet technologies, including at least one having a m transparent touchscreen sensors that responded both to finger touches and to touch by a specialized stylus; and the design of a custom electronic tablet responsive to an electromagnetic stylus.

6. During that time and in the years following, I authored or co-authored a number of peer-reviewed articles concerning pen-computing, generative models for handwriting variability, and digitizer/touchscreen technologies and error behaviors.

7. These articles are listed in my CV, which is Appendix A to this declaration. I was an invited speaker at an international research conference on

handwriting recognition in Montreal, Canada. I also made presentations concerning gesture input for Pencept and its competitors to the Graphical Kernel System (GKS) and Programmer's Hierarchical Interactive Graphics System (PHIGS) standardization committees for computer graphics systems, and organized and chaired a panel discussion concerning real-world problems of handwriting recognition technology at another academic conference. I was also invited to visit and speak to the research groups in pen computing at a number of major computer technology companies, including IBM in the United States and the AEG-Telefunken Research Center in Germany.

8. In 1989, I joined the Freestyle development group at Wang Laboratories as a Software Architect. Freestyle was a direct-manipulation pen-computing system that integrated stylus- and voice-input and annotations. During my tenurethere, Wang filed for and later was granted U.S. and international patents for my work on simulating virtual keyboard and mouse input from stylus user input on a touch-sensitive tablet. In addition, I was the lead engineer for Wang on a joint hardware project with for a low-power, touchscreen technology using a capacitive stylus for a line of highly-portable handheld computers.

9. In 1991, at the end of Freestyle development, I joined Slate Corporation, a company formed to develop pen-centric applications for both the new Pen-Point (GO Corporation) and Pen Windows (Microsoft) operating systems.

During that time, I was Slate's representative and the co-chair of a number of meetings involving GO Corporation, Microsoft, and other companies concerning the JOT cross-platform storage-level standard for compressed electronic ink data, and was the primary author of the first draft for that standard. I made presentations regarding the history of pen computing to technical groups interested in the topic. I also conducted tutorials on touchscreen/pen interfaces and technology at two annual meetings of the Society for Information Display, the leading engineering society for display technologies.

10. From approximately 1993 onward, my professional work has been primarily as an independent developer and consultant in the areas of applications of public-key cryptography and computer security, in addition to pen/touch computing.

11. A copy of my curriculum vitae with full descriptions of my education, professional achievements, and qualifications is attached to this declaration as Appendix A. It includes a listing of additional relevant industry experience, publications, and presentations.

II. MY STATUS AS AN INDEPENDENT EXPERT WITNESS

12. I have done no work (indirectly or directly) for either Petitioner or Patent Owner until Oblon hired me as an expert witness to work with it on this IPR.

13. I am aware that the named inventors on U.S. Patent No. RE43,931 ("the '931 patent") are Mr. John Joseph Hayes, Jr. and Mr. Curtis Wayne Thornton. I do not recognize Mr. Hayes, Jr.'s name or Mr. Thornton's name, and I believe that I have never met either of them.

14. I have no financial interest in either Petitioner or Patent Owner.

15. Oblon hired me through an expert witness provider named Cahn Litigation Services ("Cahn"). Cahn is being compensated at the rate of $575/hr for my time in connection with this IPR proceeding. Cahn in turn pays me at the rate of $450/hr.

III. MATERIALS CONSIDERED

16. In forming my opinions expressed herein, I considered the following items, in addition to my own personal knowledge and experience:

- The '931 patent and its prosecution history (Exhibits 1001 and 1006);
- Petitions IPR2015-01602, IPR2015-01637, IPR2015-01641, and IPR2015-01646 filed by TCL;
- Exhibit 1201, the Declaration of Dr. Andrew Wolfe;
- All remaining Exhibits cited in the Petitions;
- Exhibit 2003, the April 11, 2016 Deposition of Dr. Wolfe;
- Exhibit 1029, U.S. Patent No. 6,009,338 to Iwata;

- Exhibit 1036, U.S. Patent No. 5,748,185 to Stephan;
- Exhibit 1037. U.S. Patent No. 5,710,844 to Capps; and
- All Exhibits submitted in the concurrent Patent Owner Response submitted by Ericsson.

IV. UNDERSTANDING OF THE LAW

17. For the purposes of this declaration, I have been informed about certain aspects of patent law that are relevant to my analysis and opinions, as set forth in this section of my declaration.

A. A Person Having Ordinary Skill in the Relevant Field During the Relevant Timeframe

18. Counsel has informed me that the disclosures of patents and prior art references are to be viewed from the perspective of a mythical person of ordinary skill in the relevant field (sometimes by lawyers referred to as "the relevant art") at the relevant timeframe (a "POSITA"). Counsel has informed me that, for purposes of this IPR proceeding, I should interpret the term POSITA as referring to a mythical person to whom an expert in the relevant field could have assigned a routine task with reasonable confidence that the task would be successfully carried out.

19. I have been asked to provide my opinion regarding the "level of ordinary skill in the art" at the time of the invention, which I have been told is on or before December 30, 1997.

20. I understand that the hypothetical person of ordinary skill in the art is considered to have the normal skills and knowledge of a person in a certain technical field. I understand that factors that may be considered in determining the level of ordinary skill in the art include: (1) the education level of the inventor; (2) the types of problems encountered in the art; (3) the prior art solutions to those problems; (4) rapidity with which innovations are made; (5) the sophistication of the technology; and (6) the education level of active workers in the field. I also understand that "the person of ordinary skill" is a hypothetical person who is presumed to be aware of the universe of available prior art.

21. I also understand the level of ordinary skill in the art can be evidenced by the prior art. Accordingly, I have also considered the prior art discussed herein in determining the level of ordinary skill in the art.

22. In determining who a POSITA would be, I considered the '931 patent, the types of problems encountered in the art of handheld radio telephone devices and handheld devices, the prior art solutions to those problems, and the educational level of workers active in the field. Based on these factors, I have concluded that a POSITA during the relevant timeframe would probably have had a bachelor's degree in electrical engineering or computer engineering, at least 2-3 years of hands-on experience working with hand held contact-sensitive user interface

devices, and direct knowledge of the types of user interfaces used in mobile phones and handheld devices in 1997.

23. Based on my experience, I have an understanding of the capabilities of a POSITA in the relevant field. I have supervised and directed many such persons over the course of my career. Further, I, myself, had those capabilities at the time the '931 patent was effectively filed. Given my education and extensive industry experience, I exceed the education and work experience levels of a POSITA, but I nonetheless provide my opinions herein from the viewpoint of a POSITA unless I state otherwise.

B. Claim Construction

24. I understand that "claim construction" is the process of determining a patent claim's meaning. I also have been informed and understand that the proper construction of a claim term is the meaning that a POSITA would have given to that term during the relevant timeframe.

25. I understand that claims in IPR proceedings are to be given their broadest reasonable interpretation in light of the specification, which is what I have done when performing my analysis in this declaration.

26. Counsel has also explained to me what the terms "claim" and "specification" mean in this context. While I am not a patent lawyer, I believe that I have a reasonable grasp of those concepts.

C. Anticipation

27. I understand that a patent claim is unpatentable as anticipated if a POSITA during the relevant timeframe would have understood a single prior art reference to teach every limitation contained in the claim. The disclosure in a reference does not have to be in the same words as the claim, but all of the requirements of the claim must be described in enough detail, or necessarily implied by or inherent in the reference, to enable a POSITA looking at the reference to make and use at least one embodiment of the claimed invention.

D. Obviousness

28. I understand that a patent claim is unpatentable as obvious if subject matter within the definition provided by the claim would have been obvious to a POSITA as of the time of the invention at issue. I understand that the following factors must be evaluated to determine whether the claimed subject matter was obvious: (1) the scope and content of the prior art; (2) the difference or differences, if any, between the subject matter defined by the claim of the patent under consideration and what is disclosed in the prior art; (3) the level of ordinary skill in the relevant field at the time of the patent's earliest priority date or, possibly, at an earlier time; and (4) so-called "objective evidence of non-obviousness". However, counsel has told me that, for the present, I can ignore both the possibility that obviousness is to be determined at a date earlier than the patent's earliest priority

date and the possibility that TCL will submit objective evidence of non-obviousness.

29. Counsel has informed me that prior art references can be combined to support a finding that a claim is unpatentable for obviousness when there was an apparent reason for one of ordinary skill in the art, at the time of the invention, to combine the references and that such apparent reasons include, but are not limited to: (A) identifying a teaching, suggestion, or motivation to combine prior art references; (B) combining prior art methods according to known methods to yield predictable results; (C) substituting one known element for another to obtain predictable results; (D) using a known technique to improve a similar device in the same way; (E) applying a known technique to a known device ready for improvement to yield predictable results; (F) trying a small number of identified, predictable potential solutions, with a reasonable expectation of success; and (G) identifying that known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the relevant field.

30. Moreover, I have been informed by counsel that so-called "objective indicia of non-obviousness" (also known as "secondary considerations") like the following can be considered when assessing obviousness: (1) commercial success;

(2) long-felt but unresolved needs; (3) copying of the invention by others in the field; (4) initial expressions of disbelief by experts in the field; (5) failure of others to solve the problem that the inventor solved; and (6) unexpected results. I also understand that evidence of objective indicia of non-obviousness must be commensurate in scope with the claimed subject matter.

V. DESCRIPTION OF THE RELEVANT FIELD AT THE RELEVANT TIMEFRAME

31. I have carefully reviewed the '931 patent and the relevant materials listed above.

32. Based on my review of these materials, I believe that the relevant field for purposes of the '931 patent is user interface technology for hand-held radiotelephones. I have been informed that the relevant timeframe is on or before December 30, 1997.

33. As described in Section IV.A above and as shown in my CV, I have extensive experience in user interface technology, particularly with regard to touchscreens and similar devices, and I have extensive knowledge of user interface technology used in mobile phones. Based on my experience, education, and training (both academic and professional), I am well-versed in the relevant field in the relevant timeframe.

34. When the '931 patent was filed in December 1997, mobile phones primarily used push-button keys and a monochrome display as components of a

user interface. The focus on mobile phone technology was simply allowing the user to perform basic telephone call functionality rather than perform all functions of a computer as we see in the smartphones of today. In these types of phones scrolling was performed by pressing a number, such as pressing the number 2 to scroll up and the number 8 to scroll down. Other phones included softkeys on the side of or directly below the screen, corresponding to up and down arrows. The following graphic illustrates exemplary mobile phones and their approximate dimensions, many made by Nokia, which were commercially available immediately before and after December 1997.

Model	**Nokia 1610**	**Nokia 2160**	**Mitsubishi D203**	**Nokia 8110**	**Nokia 252**	**Nokia 550**
						
Release Date	1996	1996	1997	1998	1998	1998
Phone Dimensions (mm)	168 x 58 x 28	139 x 55 x 25	123 x 40 x 26	141 x 48 x 25	143 x 48 x 21	143 x 48 x 21
Touch screen?	No	No	No	No	No	No

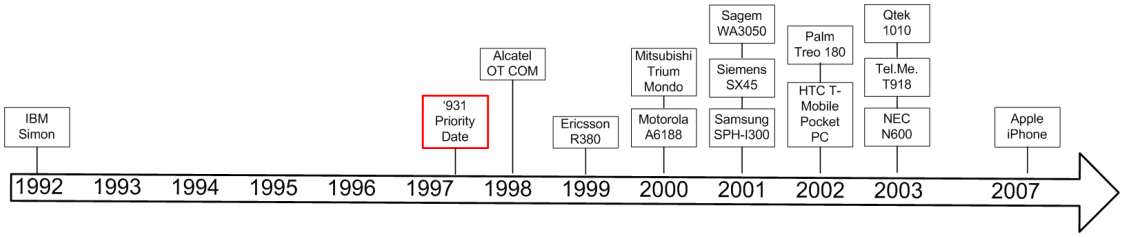
Ex. 2005-2010.

35. The IBM Simon, shown below, first released in 1992 and made available for sale in 1994, is the one mobile phone device I am aware of that was

made commercially available prior to December 30, 1997 and which used a contact-sensitive touchscreen. Ex. 2012.

36. The Simon only spent 6 months on the market and only sold approximately 50,000 units worldwide. *Id*. at 3. The Simon, sometimes referred to as a "brick," was also larger than many of the mobile phones shown above, as it had dimensions of 8 x 2.5 x 1.5 inches and weighed 18 ounces. *Id*. at 2. The Simon primarily received single touch inputs to buttons displayed on the screen, and it did not receive a moving contact input to cause displayed rows of graphical objects to scroll. (Ex. 2013). Rather, the Simon presented users with arrows and buttons on the touchscreen that the user clicked one at a time. *Id*. at 12 and Ex. 2012 at 2-3.

37. The chart below shows a list of mobile phones that I am aware of that were released between 1992 and 2003 which included a contact-sensitive user interface. For perspective, the chart also illustrates that it was not until 2007 that the popular Apple iPhone was released. I am not aware of any commercially available mobile phone, which included a contact-sensitive user interface, other than the IBM Simon, released before December 30, 1997.



Ex. 2011, 2014-2024, 2040-2041.

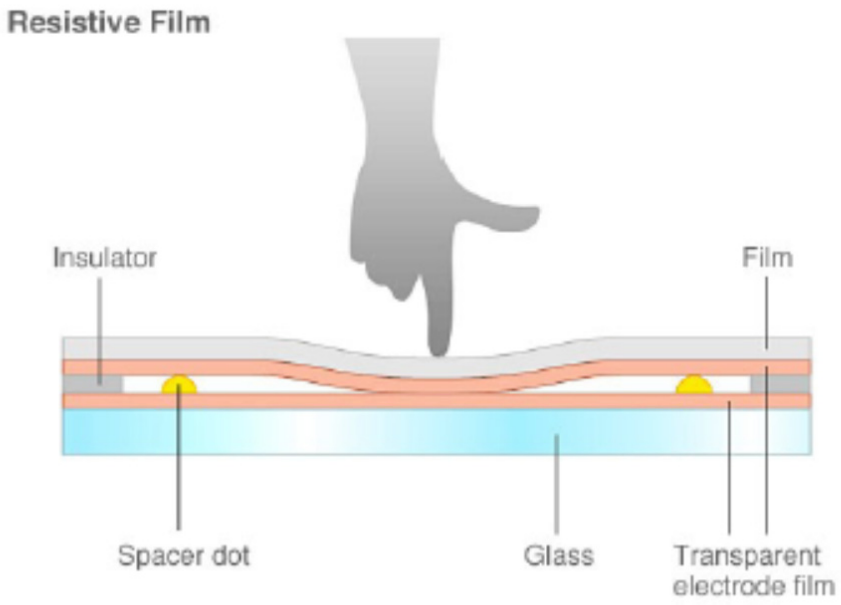
38. An example of a non-radiotelephone hand-held device that was popular prior to December 1997 is the Palm Pilot 1000, shown below with a monochrome resistive touch screen display having an approximately 57 mm (2.25 inches) length and width. Ex. 2026. Scrolling on the Palm Pilot 1000 was done by the user "poking" on two scroll buttons: it did not perform a scrolling operation in response to a moving contact to the touchscreen. Ex. 2042. The Palm Pilot 1000 accepted pen strokes with a stylus in a "Graffiti" area, which is separate from the display screen. *Id.* at 4-5. I suspect that the Graffiti area was kept separate from the display screen since it was a known problem that the stylus causes scratches to the surface of a touchscreen (Ex. 2046 at ¶8-9), and the Graffiti area itself would

accumulate scratches over time (Ex. 2047). While smaller than that of a laptop, the display on the Palm Pilot was noticeably larger than found on cell phones typical of 1997, which are shown in the chart above.

39. There were four common types of touch screen technology known as of December 30, 1997: Resistive, Capacitive (of the type now referred to as "surface capacitive"), Surface Acoustic Wave, and Infrared. Ex. 2027. Hand held devices which included a contact sensitive surface both before and after 1997 primarily used a resistive touch screen or a capacitive touch screen. Ex. 2025. I note that most modern smartphones use a different touchscreen technology referred to as "projected capacitive." Projected capacitive touchscreens use a grid or matrix of sensors or sensor points, and are able to detect and distinguish multiple touches, such as two fingers. Surface capacitive and resistive touch sensors, like those used in the 1997 timeframe, would at best report an

approximately "average" location somewhere between two or more touches, depending also on how firm the touches were, the areas of contact, and other factors. This created a disadvantage known as "palm rejection" or "thumb rejection", if the user accidentally held the device with part of one hand also touching.

40. A resistive touchscreen involves using two layers of film that are separated by a thin gap. The gap was maintained by small "spacers" or "dots", as shown below. One later was resistive, the other was conductive. Generally there was a third non-conductive layer on top to help protect against scratches, as illustrated below.

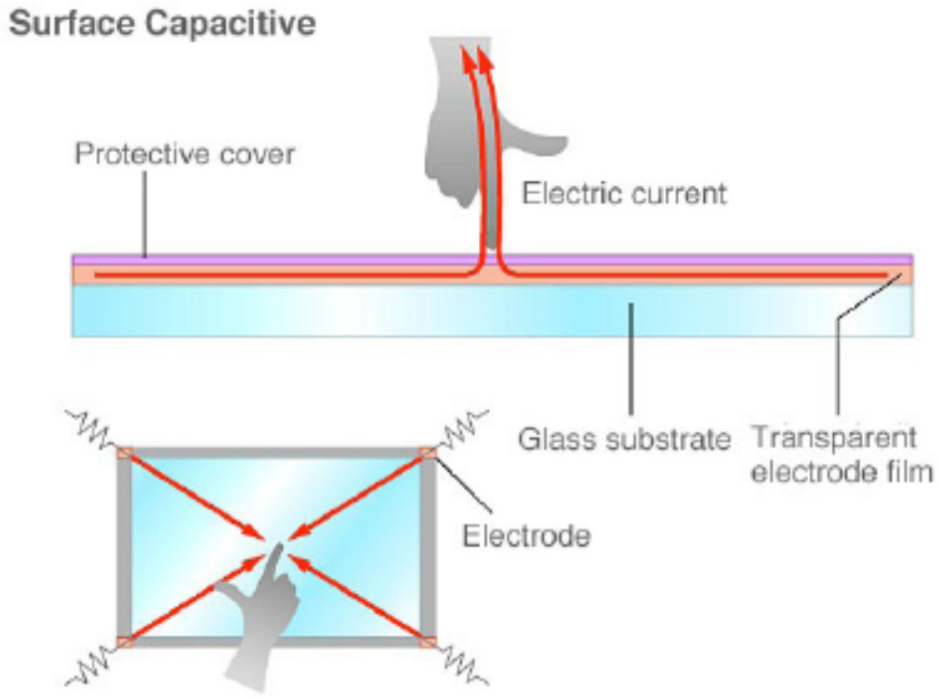


Ex. 2027.

41. A voltage is applied across the resistive layer, and sensed by the conductive layer if the two layers are pressed together. When an object, such as a fingertip or stylus tip, presses down onto the outer surface with sufficient pressure, the two layers touch and make contact around that point. By measuring the voltage on the conductive layer, you can determine how far across the resistive layer the contact is. By rapidly switching the direction of the voltage between vertical and horizontal and measuring appropriately, the X/Y position of the contact on the screen can be determined. *Id.* Disadvantages of resistive touch screens in December 1997 included the need to press down and a risk of damage by sharp objects. (such as a metal stylus or a pen). A further disadvantage is that the more or less force was required when the contact area was larger or smaller. Another disadvantage was that the position detected varied with .the shape of the contact area, angle of pressure, whether the contact is on or near a spacer dot, and other factors. Resistive touchscreens also suffer from poor contrast, due to reflections from the extra layers of material (separated by an air gap) placed over the screen. *Id.*

42. For a single contact (e.g., one fingertip), the position is approximately the centroid of the contact area, but varies with the shape of the contact area, angles of pressure, whether the contact is on or near a spacer dot, and other factors.

43. A capacitive touchscreen involves using a transparent insulator such as glass, coated with a transparent conductor or electrode film on the top surface, as illustrated below.

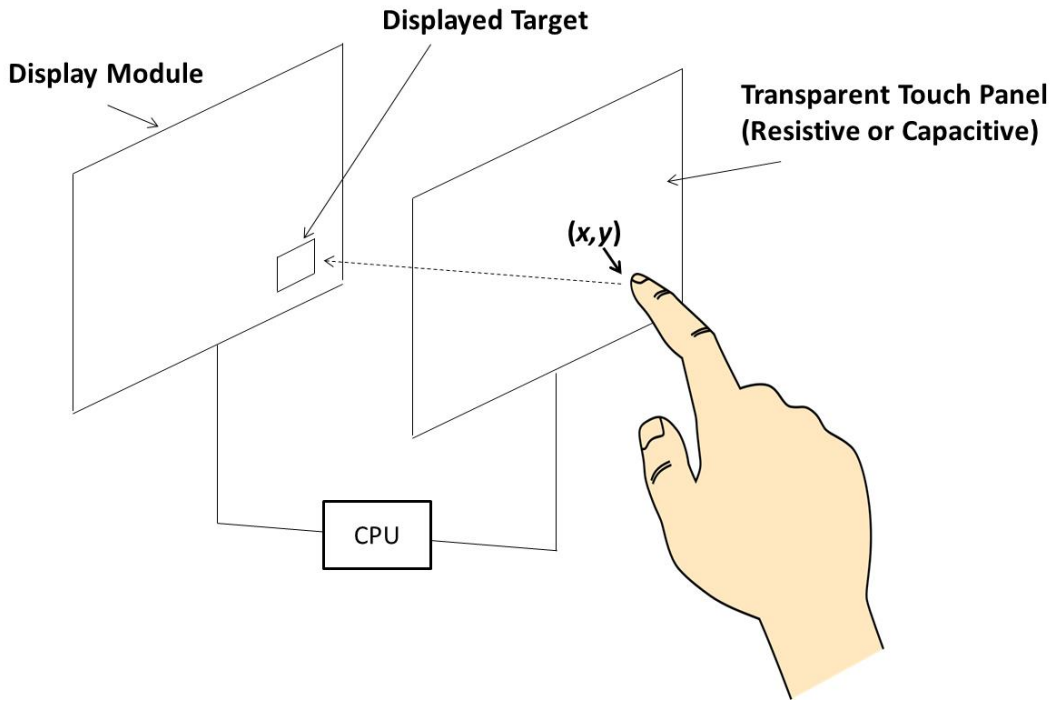


Id.

44. As the human body is also an electrical conductor, touching the surface of the screen results in a distortion of the screen's electrostatic field, measurable as a change in capacitance. *Id.* Different technologies may be used to determine the location of the touch. Typically they involve measurements similar in principle to the horizontal and vertical measurements I have described for a

resistive touchscreen. The location is then sent to a controller for processing. *Id.* A disadvantage of capacitive touch screens in December 1997 is that one cannot use a capacitive touchscreen if attempting to make contact through most types of electrically insulating material, such as a non-conducting stylus or if the user is wearing gloves. *Id.*

45. A resistive or capacitive touch screen display is essentially two devices, a transparent contact sensitive touch panel and a display device (such as an LCD display) overlaid onto each other. Ex. 2002 at 1:8-11 and 2:20-23. An exploded view of this arrangement is illustrated below.



46. As shown above, the contact-sensitive touch panel is transparent which allows the user to view the underlying display panel. A displayed target

(such as a button) may be shown on the display. The user will attempt to activate the "button" by contacting the portion of the transparent touch panel that overlaps the displayed button. If the touch panel and the display module are aligned properly, then a sensed contact at a portion of the touch panel (shown as a coordinate point above) will be transmitted to a processor (CPU) to determine whether the user intended to activate a function corresponding to the displayed button based on the location of the sensed contact.

47. For a single contact (e.g., one fingertip) on a touchscreen, the position of the intended contact is determined to be approximately the centroid of the contact area, but varies based on the multiple factors as described above.

48. A POSITA in December 1997 would know that a problem for a touch screen on a portable hand held device is if a target input region on the touch screen is too small, then a user may not be able to make an intended input to the target region accurately because touching with a fingertip is imprecise (known as the "fat-finger" problem). In addition, the fingertip covered what the user was attempting to touch, making it impossible to see to target (referred to variously as the "occlusion" problem). Ex. 2051 at col. 2. Conversely, if a single target input region is too large then the overall functionality of the touch screen is sacrificed because there is less space on the rest of the display to show information.

49. As of December 1997, there were no commercially available hand held devices of which I am aware that accepted a moving contact, such as a sliding gesture or a swipe, to a contact sensitive surface to deliberately scroll through displayed rows, as separate graphical objects, of content.

VI. THE '931 PATENT

50. The '931 patent provides a novel solution to the problem of having a large list of graphical objects (such as telephone numbers) displayed on a radiotelephone that need to be scrolled through quickly, but the conventional input devices on radiotelephones are "arrow" keys or devices that take up space and have moving parts. Ex. 1001 at 1:39-67.

51. The '931 patent overcomes the afore-mentioned problem by use of a contact-sensitive transducer that accepts a moving contact to scroll displayed rows of items, such as telephone numbers. The use of the contact-sensitive transducer offers numerous advantages. First, by utilizing the contact-sensitive transducer as an input device, the inventors of the radiotelephone of the '931 patent were able to minimize the thickness of the phone "[b]ecause a contact-sensitive transducer may be configured to have a thin profile." (*Id.* at 2:30-31). Second, "[b]ecause characteristic types of contact with the transducer can be detected, such as swiping motions or taps, the transducer may be used to perform display movements such as scrolling or cursor movement, as well as for selection of items displayed on the

display." *Id.* at 2:34-38. Third, the use of contact-sensitive transducer improves the reliability of the input device due to the lack of moving parts in the transducer. *Id.* at 2:38-40.

52. Claims 1, 16, 30, 58, and 64 of the '931 patent each recite:

> Claim 1. A radiotelephone, comprising:
> a housing having a front surface, a rear surface and first and second side surfaces adjoining respective opposite edges of the front surface and extending from the respective opposite edges of the front surface to respective opposite edges of the rear surface, the housing configured to be held in a user's hand such that the rear surface confronts the user's palm;
> a radiotelephone communications transceiver, supported by the housing;
> a display, supported by the housing, that displays an image at the front surface of the housing;
> a contact-sensitive transducer, supported by the housing and having a contact-sensitive surface disposed at at least one of the first and second side surfaces said front surface, which produces an output signal that characterizes in response to moving contact of an object along the contact-sensitive surface of the contact-sensitive transducer; and
> a controller, responsive to the output signal and operatively associated with the display and the radiotelephone communications transceiver, which controls at least one of the display and the radiotelephone communications transceiver according to and which scrolls displayed

rows along an axis of the display based upon the output signal of the contact-sensitive transducer, the controller having a first mode wherein the controller is responsive to contact with the contact-sensitive transducer and a second mode wherein the controller is unresponsive to contact with the contact-sensitive transducer, the second mode being entered in response to an input from a user.

Claim 16. An apparatus, comprising:
a housing having a front surface, a rear surface and first and second side surfaces adjoining respective opposite edges of the front surface and extending from the respective opposite edges of the front surface to respective opposite edges of the rear surface, the housing configured to be held in a user's hand such that the rear surface confronts the user's palm;
a display, supported by the housing, that displays an image at the front surface of the housing;
a contact-sensitive transducer, supported by the housing and having a contact-sensitive surface disposed at at least one of the first and second side surfaces on said front surface, which produces an output signal that characterizes moving contact of an object along the contact-sensitive surface of the contact-sensitive transducer; and
a controller, selectively responsive to the output signal and operatively associated with the display, which is configured to control scroll displayed rows along an axis of the display according to based on the output signal of the contact-sensitive transducer, the controller having a first mode wherein the controller is responsive to contact with the contact-sensitive transducer and a second mode wherein the controller

is unresponsive to contact with the contact-sensitive transducer, the second mode being entered in response to an input from a user.

Claim 30. An apparatus, comprising:
a housing having a front surface, a rear surface and first and second side surfaces adjoining respective opposite sides of the front surface and extending from the respective opposite sides of the front surface to respective opposite sides of the rear surface, the housing configured to be held in a user's hand such that the rear surface confronts the user's palm;
a display, supported by the housing, that displays an image at a front surface of the housing;
a contact-sensitive transducer, supported by the housing, which produces an output signal that characterizes in response to moving contact of an object along the contact-sensitive surface of the contact-sensitive transducer; and
a controller, responsive to the output signal and operatively associated with the display, which scrolls displayed rows along an axis of the display based on the output signal of the contact-sensitive transducer, the controller having a first mode wherein the controller is responsive to contact with the contact-sensitive transducer and a second mode wherein the controller is unresponsive to contact with the contact-sensitive transducer, the second mode being entered in response to an input from a user.

Claim 58. An apparatus for providing user input to a hand-held electronic device, comprising:

a housing for containing the electronics for performing the intended user functions of the device, said housing having a front surface, a rear surface and first and second side surfaces adjoining respective opposite sides of the front surface and extending from the respective opposite sides of the front surface to respective opposite sides of the rear surface, the housing configured to be held in a user's hand such that the rear surface confronts the user's palm;

a display located on the front surface of the housing for displaying user-interface information for the electronic device, said information including an image of rows of menu selectable items;

a contact-sensitive transducer, supported by the front surface of the housing, which produces an output signal that characterizes moving contact of an object along the contact-sensitive surface of the contact-sensitive transducer; and

a controller, responsive to the output signal and operatively associated with the display, which scrolls displayed rows of said menu selectable items along an axis of the display based upon the output signal of the contact-sensitive transducer to enable selection of a particular item by the user to provide input to the electronic device, the controller having a first mode wherein the controller is responsive to contact with the contact-sensitive transducer and a second mode wherein the controller is unresponsive to contact with the contact-sensitive transducer, the second mode being entered in response to an input from a user.

Claim 64. An apparatus, comprising:

a housing having a front surface and a rear surface, the housing configured to be held in a user's hand such that the rear surface confronts the user's palm;
a display, supported by the housing, that displays an image at a front surface of the housing;
a contact-sensitive transducer, supported by a front surface of the housing, which produces an output signal that characterizes moving contact of an object along the contact-sensitive surface of the contact-sensitive transducer; and
a controller, responsive to the output signal and operatively associated with the display which scrolls displayed rows along an axis of the display based on the output signal of the contact-sensitive transducer, the controller having a first mode wherein the controller is responsive to contact with the contact-sensitive transducer and a second mode wherein the controller is unresponsive to contact with the contact-sensitive transducer, the second mode being entered in response to user input.

53. Each of independent claims 16, 30, 58, and 64 recites certain features that are analogous to those of claim 1 shown above. My opinion regarding claim 1 is applicable to the similar features of independent claims 16, 30, 58, and 64 for substantially similar reasons.

VII. CLAIM INTERPRETATION

54. In proceedings before the USPTO, I understand that the claims of an unexpired patent are to be given their broadest reasonable interpretation in view of

the specification from the perspective of one skilled in the art during the relevant timeframe. I have been informed that the ‘’931 patent has not expired. In comparing the claims of the ‘931 patent to the known prior art, I have carefully considered the ‘931 patent and the ‘931 patent file history based upon my experience and knowledge in the relevant field. In my opinion, the broadest reasonable interpretations of the claim terms of the ‘931 patent are generally consistent with the terms’ ordinary and customary meaning, as one skilled in the relevant field would understand them.

55. I agree with TCL’s interpretation of “contact sensitive transducer” and “graphical object” (Petition at pp. 10-12). Specifically, TCL proposes that the phrase “contact sensitive transducer…which produces an output signal” should be construed as “*a device that converts physical contact of an object with the device to an electrical signal*.” TCL also proposes that the term “graphical object(s)” should be construed as “*visual element(s) including image(s) and/or row(s) of alphanumeric characters*.”

56. It is my understanding that any claims terms that are not construed specifically above are presumed to take on their ordinary and customary meaning.

VIII. DISCUSSION OF RELEVANT PRIOR ART

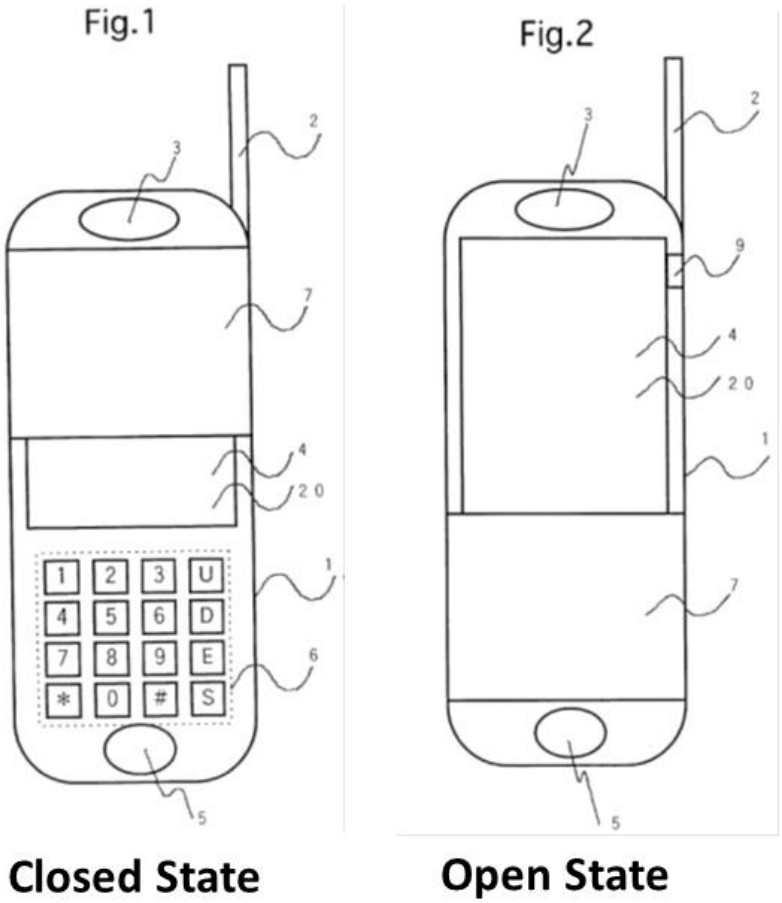
57. I have been asked to consider the teachings of the prior art cited in the petition in view of the knowledge held by one of ordinary skill, and whether the

skilled practitioner would have interpreted or combined the references as applied in the petition.

58. At the outset, it is my opinion that claims 1-12, 15-26, 29, and 58-69 of the '931 patent would not have been obvious over Iwata in view of Stephan and Capps.

A. Summary of Iwata

59. Iwata discloses a mobile telephone configured to function as an electronic note, word processor, and personal computer. Ex. 1029, at Abstract. The mobile telephone shown in Fig. 1 below shows that a cover 7 is at a top position and considered to be in a closed state, and Fig. 2 shows cover 7 at the bottom position in the opened state. *Id.* at 12:35-46. A cover switch 9 detects the opened/closed status of cover 7, and if the cover is in the closed status, telephone mode is set. If the cover is in the opened status, information terminal mode is set and the device is used as an information terminal. *Id.* at 12:48-53.

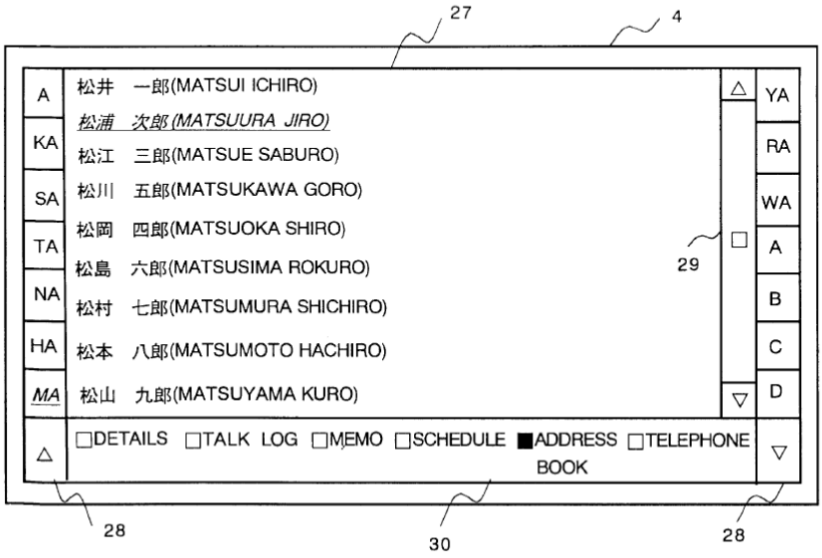


60. The mobile telephone of Iwata has a touch screen 20 as shown in Figs. 1 and 2, which is a transparent tablet on which a coordinate can be input with a pen or by touching it with a finger. *Id.* at 12:29-31.

61. Fig. 6 of Iwata (below) shows an application screen example of an address book. The display screen contains four major areas: (1) a content area 27; (2) a tag area 28; (3) a scroll area 29; and (4) a menu area 30. *Id.* at 14:17-19. Content area 27 displays various instruction information, and the user can (i) select desired information out of the displayed content or (ii) input information. *Id.* at

14:19-21. Tag area 28 displays tags related to the information displayed in content area 27. *Id.* at 14:25-26. Scroll area 29 is used to see the data in the neighborhood of the data displayed in content area 27 so that the next page can be viewed when the whole data cannot be displayed at once in content area 27. *Id.* at 14:14:43-47. Touching the scroll buttons "Δ" and "∇" on the top and the bottom in scroll area 29 allows the hidden information to appear on the screen. *Id.* at 14:46-48.

Fig.6



62. I note that the touch screen of Iwata does not perform any action in response to a moving contact of an object along the surface of the touch screen, except for a brief mention of inputting hand-written characters or diagrams. *Id.* at 15:50-51. It certainly has no teaching or disclosure of scrolling in response to a moving contact. In fact, TCL acknowledges this deficiency by attempting to rely on Stephan for this feature in the following statement:

Fourth, Iwata in view of Stephan renders obvious that the output signal is produced "in response to moving contact of an object along the contact-sensitive surface of the contact-sensitive transducer." (Ex. 1201, 184.) As discussed in Section VII.A.3, it would have been obvious to a POSITA to modify the touchscreen of Iwata by defining moving contact-based scroll regions, as taught by Stephan, or alternatively, to replace the touchscreen of Iwata with the moving contact-based scrolling touchscreen of Stephan. (*Id.*; Ex. 1036, Fig. 13.) Thus, it would have been obvious to have modified or replaced the touchscreen of Iwata with the moving contact-based touchscreen of Stephan (i.e., to define a scroll region), which produces an electrical signal in response to moving contact along the contact-sensitive surface, e.g., by "sliding" a finger "within the scroll control region, and thereby generating a control packet. (Ex. 1036, 9:23-49; Ex. 1201, , 74-76, 184.)

B. Summary of Stephan

63. Stephan is directed in one embodiment to a touchpad (50) as shown in Fig. 2 below having multiple regions that may be linked to various commands or functions within a graphical user interface ("GUI"). Ex. 1036 at Abstract.

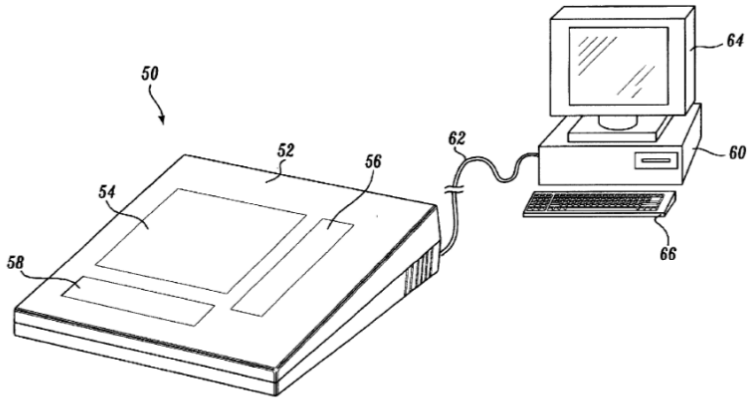


Fig. 2.

64. As shown in the embodiment of Fig. 2, touchpad 50 is connected to a computer 60 by a cable 62. *Id.* at 5:10-15. Touchpad 50 is divided into three regions ((1) cursor control region 54; (2) scroll control region 56; and (3) pan control region 58) from which a user may enter relative movement information that may be linked to different functions or commands within the GUI. *Id.* at 5:22-24 to 6:37 -23.

65. Fig. 3 below shows an exploded view of touchpad 50 shown in Fig. 2. Fig. 3 illustrates that a circuit board 110 is connected to the touchpad member.

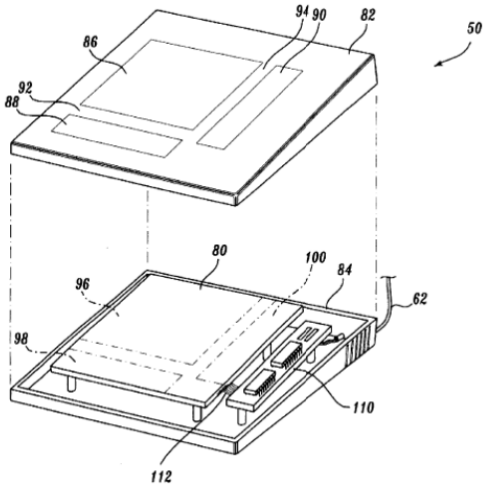


Fig. 3.

66. The circuit board 110 contains a processor, associated circuitry, and a firmware routine to convert the X,Y location and movement for the contact point by the user into the appropriate control packets for transmission to the computer. *Id.* at 7:25-30.

67. With regard to the hardware used to achieve the touchpad 50, Stephan describes the following.

> Dedicated hardware and software is required to interface the three regions of touchpad 50 with the computer's GUI." *Id.* at 6:48-49. In more detail, Stephan describes the following: The force applied to touchpad member 80 generates an electrical signal indicative of the X,Y location where the contact occurred. A circuit board 110 is connected to the touchpad member by a cable 112. Circuit board 110 contains a processor, associated circuitry, and a firmware routine to convert the X,Y location and movement of the contact point by the user into appropriate control packets for transmission to the computer

over cable 62. The control packets contain data corresponding to the user's movement on the touchpad, and are interpreted by the computer to control commands or functions in the GUI. Current computer/user input device interfaces dictate transmitting the control packets over an RS-232 interface at 1200 baud, one stop bit, and no parity bit. The transmission scheme may be varied, however, depending on the particular computer and capabilities of the touchpad.

Id. at 7:23-38.

68. I note that this is the only hardware description provided in Stephan for any of the embodiments. This is significant because TCL relies on the embodiment in Stephan in which the scroll regions and pan regions are integrated with a laptop computer as shown in Fig. 13 below.

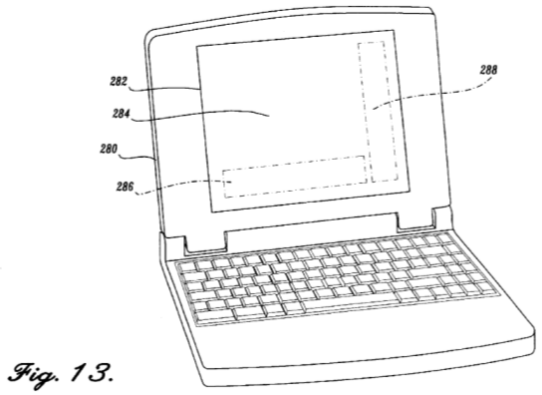


Fig. 13.

69. The only description of this embodiment in the disclosure of Stephan is as follows.

As shown in Fig. 13, a portable computer 280 is provided with a touchscreen 282. The touchscreen contains a separate cursor control region 284, a pan control region 286, and a scroll control region 288.

> The regions may be designated with visual or tactile cues as discussed above. User contact with the touchscreen at the appropriate location allows control of the cursor, panning, or scrolling. *Id.* at 12:38-43. The only description of this embodiment is as follows: Alternatively, the touchpad layout may also be directly incorporated into a touchscreen on a computer.

Id. at 12:35-43.

70. Thus, Stephan discloses only a touchpad, or touchpad sections, with different regions for cursor control, scroll control, and/or pan control in a stand-alone device or as integrated into a laptop, while requiring dedicated software and hardware, such as at least the circuit board 110. Stephan never describes an embodiment directed to a handheld radiotelephone device, such as that disclosed by Iwata and the claims of the '931 patent.

C. Summary of Capps

71. Capps is directed to a method for searching and displaying results in a "pen-based" computer system. Ex. 1037 at Abstract. The pen-based system of Capps is shown below.

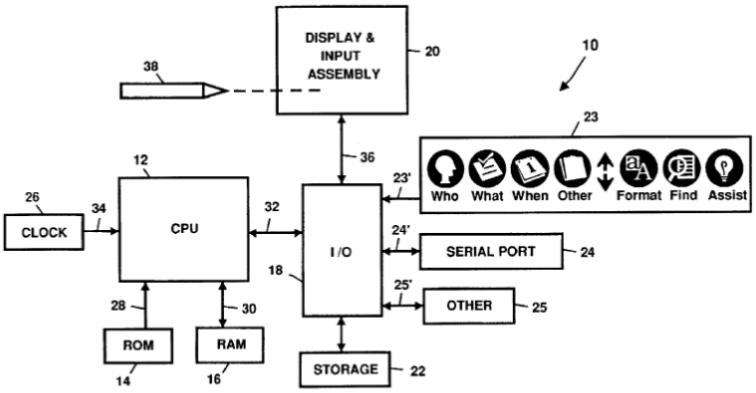


FIG. 1

72. Capps describes that the screen for the display assembly 20 is an LCD, and the input device of display assembly 20 is preferably a thin, clear membrane which covers the LCD display and which is sensitive to the position of a stylus on its surface. *Id.* at 3:34-45. Fig. 2 of Capps shows a screen including an array of input buttons 23 that preferably include a number of dedicated function buttons and a pair of scroll buttons 52, 54. *Id.* at 4:33-42.

D. Claims 1, 2, 15-17, 30, 31, 37-41, 45-52, and 54-69 Are Not Obvious over Iwata in view of Stephan

73. It is my opinion that a POSITA would not have been motivated to modify Iwata based on the teachings of Stephan to achieve the results of Claims 1, 2, 15-17, 30, 31, 37-41, 45-52, and 54-69 of the '931 patent.

74. First, using a distinct and dedicated scrolling region, as described in Stephan, introduces problems with accuracy and display space availability that were well known in the handheld user interface arts in 1997, and even after 1997,

and the type of scrolling region described in Stephan is not suitable for small touchscreens.

75. As described in TCL's exhibit Moore, a "finger contact resolution" is considered to be 1 cm, or 10 mm. Ex. 1012: 3:5-6. Thus, if the scrolling region is smaller than the expected width of a user's finger, which according to Moore is 10 mm, the Iwata phone will not be able to accurately identify whether a user's touch was intended for the scroll region or a selectable object adjacent to the scroll region.

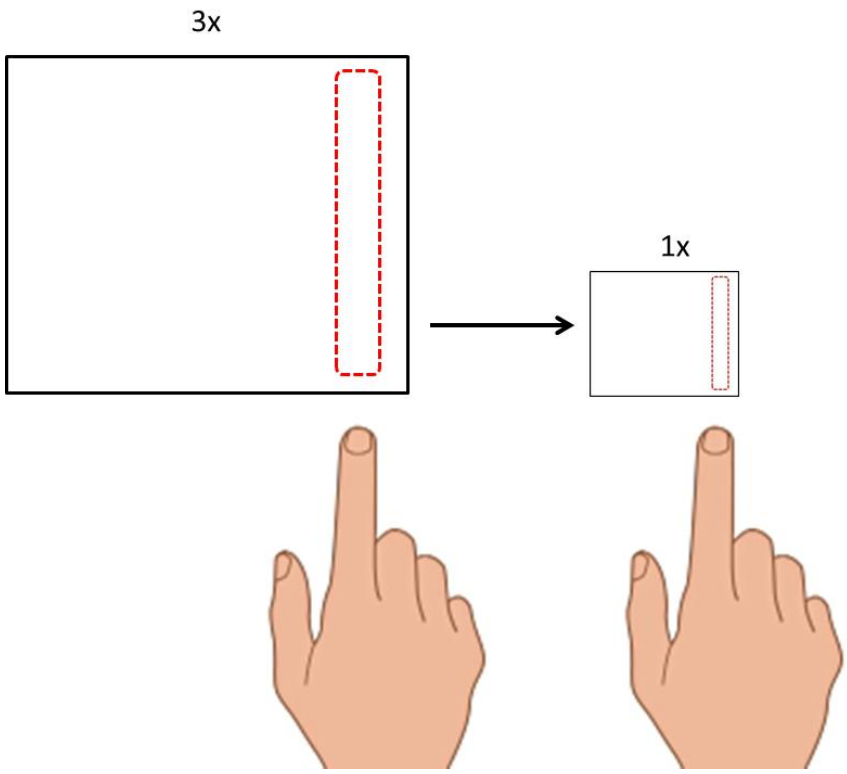
76. Also, including a scrolling region of 10 mm or larger in width is similarly unacceptable, as it will take up too much space on the display of the Iwata phone.

77. It is my opinion that a POSITA would strongly consider the relative sizes of the Iwata touchscreen and the Stephan laptop before attempting a combination of any user interface features. Iwata does not provide dimensions for its touchscreen. However, screen sizes for mobile phones as of the priority date of the '931 patent, with a similar layout as Iwata (display screen on top and keyboard on the bottom), were typically very small compared to modern smartphones as shown in the chart of 1997-era mobile phones above. Conservatively, assume that the Iwata touchscreen (with the cover closed) is intended to be the same size as the larger screen of the Palm Pilot 1000: approximately 57 mm (2.25 inches) by 57

mm. Ex. 2026.

78. Stephan also offers no description of the dimensions of its touchscreen, but assuming a laptop with a 9-inch screen (based on the HP Omnibook), one of the smallest notebook computers as of 1997. Ex. 2028. Thus, even with these conservative assumptions, the touchscreen of Stephan is on the order of ***three times*** the size of the Iwata touchscreen.

79. Additionally, if the scrolling region 288 is assumed to be approximately 10 mm in Stephan, which is a standard assumption for finger size in the art of touch screen devices, and if this scrolling region is scaled down proportionally to the size of the screen in Iwata, then the Iwata scrolling region would be about 3.3 millimeters and thus potentially smaller than a user's finger, as depicted below.



80. Conversely, if Iwata were to use a 10mm scroll region, the scroll region would occupy a disproportionately large percentage of the screen and would either overlap previously existing buttons or force further modifications, restricting the available space for other buttons.

The "Fat Finger" Problem

81. A fundamental objective of any contact-sensitive device is to accurately interpret the user's intent based on the sensed contact. Many touchscreens employed (and still employ) a display indicating an area (such as a button) for receiving contact from a user's finger. On a large touchscreen, the displayed button would be a particular size. If the same display screen is reduced

in full and displayed on a smaller touchscreen, the button itself would necessarily shrink as well.

82. When the object making contact with the touchscreen is a user's finger and the input area or button is smaller than the user's finger, a known problem exists in which the user may intend to provide contact to one input area but is unsuccessful or may even provide accidental contact to another input area or button adjacent to the intended area or button. This is sometimes referred to as the "fat finger" problem, and it is a significant problem on reduced size touchscreens. For instance, the following example shows a touchscreen on a modern tablet including a graphic image of a keyboard for receiving user inputs:

Ex. 2029.

83. The next example shows a touchscreen on a modern smartphone including a graphic image of a keyboard for receiving user inputs:

Ex. 2030.

84. The functionality and objective is the same in both examples: a keyboard is provided on a touchscreen. However, the difference in screen size is a variation that causes a very specific problem: the buttons are too small for reliable accuracy. As described below, this is a well-documented problem and a challenge present well after 1997.

85. For instance, Tomer Moscovich, from the Microsoft Research-INRIA Joint Centre, characterizes this problem well:

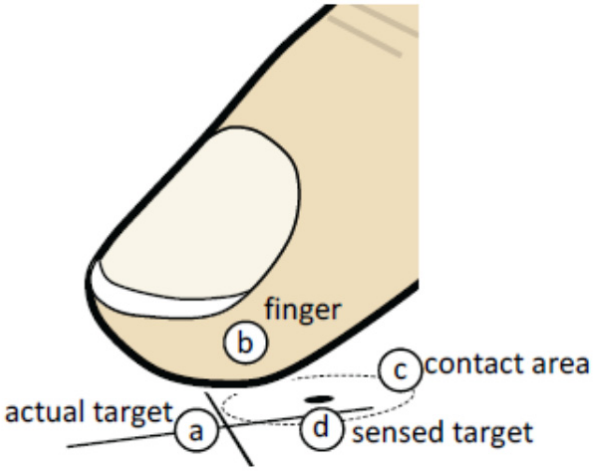
> The graphical control widgets found on today's touchscreens were developed for mouse- and cursor-based systems with very different input properties than those of touchscreens. Cursor-mediated input

> offers separate tracking and dragging states, an unobstructed view of the screen, and precise control of a one-pixel selection point. Touchscreens have none of these qualities, making it hard to manipulate standard control widgets.
>
> Ex. 2031 at co1. 1.

Another study from IBM which conducted experiments on the size of touch targets found that:

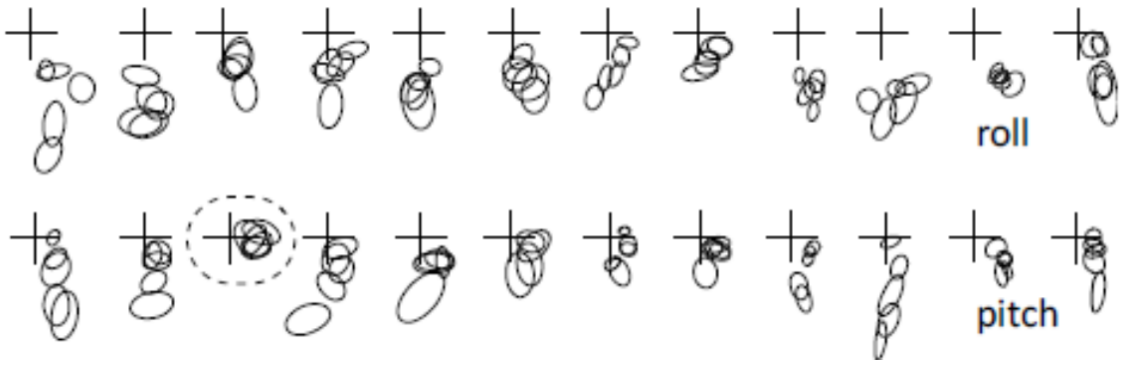
> The results of these two experiments indicate that the size of the tactual recognition field used determines whether the entry system will (a) reliably accept the human touch, (b) unreliably accept the touch (system error of commission to adjacent targets when present), or (c) reject the touch entirely (system error of omission). Touches that the system identifies as being located within the boundaries of the field will be accepted as accurate for the given target, whereas touches identified as being located outside of the boundaries of the field will not be accepted as accurate. Intuitively, large tactual recognition fields would lead to high accuracy rates and small ones would lead to low accuracy rates.
>
> Ex. 2032 at p. 717.

86. The following figure from a study conducted by Christian Holz and Patrick Baudisch of the Hasso Plattner Institute demonstrates the "fat finger" problem, and illustrates that users actually miss an intended target based on the nature of how the target is sensed on a device compared to how users instinctively aim and position a finger to select the target.



Ex. 2033 at col. 3.

87. The result of the study by Holz et al. showed the inconsistency of users attempting to touch a target using different roll pitch conditions, as shown below where the ovals represent the results for 12 different users.



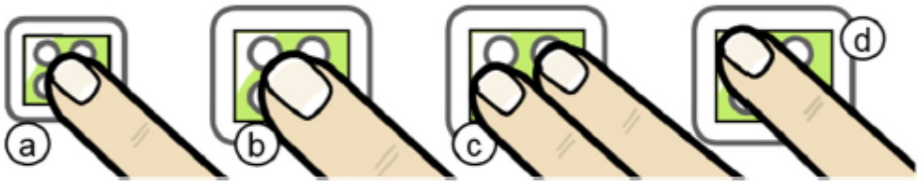
Ex. 2033 at p. 4.

88. Paul Huber, studying media informatics at the University of Munich also analyzed the fat-finger problem, and has the following detailed description of the problem while also suggesting ***a minimum target size between 10.5 mm and 26*** mm to reliably acquire targets.

> This problem emerges not only through "fat" fingers or fingertips, but by finger or fingertips of any size. When selecting targets on a touch device with a finger and the targets are smaller than the size of the finger contact area, users do not know if they hit the desired target (see figure 1). Additionally, the lack of sensing precision can make precise touch screen interactions more difficult and error-prone [4]. In many interfaces touch targets are packed too close together. The result is that a wrong button is touched, which ends up in incorrect input. An example of the problem is using a non-mobile website on your mobile phone. When the interface is developed for a normal mouse interface, some buttons are often just a few pixels wide (e.g. closing windows). Without changing the zoom level it is almost impossible to hit for example the login field because the fingertip is too big to hit the field correct. Another example, that everybody knows who uses a mobile phone, is hitting the wrong character on the keypad while tipping in a message. This happens because the fields of the keypad are too close linked. Researchers have figured out that there is a minimum target size between 10.5mm and 26mm to reliably acquire targets [1].

Ex. 2043 at Section 1.1.

89. Huber also found that it also was caused by occlusion of the screen by the finger, in which the user's fingertip occludes the target on the screen at the critical moment before touching the display as illustrated below.



Id. at Fig. 1.

90. Moreover, Huber also found problems using a stylus to overcome the fat finger problem since it requires more time and a second hand to use the stylus, and hand tremor can make the selection of small targets as difficult as using a finger. *Id.* at Section 2.2.

91. Lee also described how these problems exist with a stylus: "Pen occlusion and parallax have been reported as major defects of direct pen input…The hand may cover a larger area than the pen. However, the area occluded by the pen is highly probable to contain important information since it is near the pen tip, where the interaction occurs." (Ex. 2052 at p. 2).

92. There have also been many guides and articles written to advise interface designers to account for the problems with small targets on small touchscreens. Microsoft has explicitly provided a guide which advises application developers that for using tablet interface it can be harder to point to and tap small objects, and they recommend increasing the target size to be at least 9 mm when a touch with a finger is being used. Ex. 2045. John Meyer of UX magazine states

"The opposite experience exists when text is too small to read and navigation links are so close together that unintended navigation occurs. This adds time, complexity, and frustration to the navigation experience, which will quickly drive away your visitors." Ex. 2048 at 3. Meyer thus makes his first recommendation to increase the size and margin for buttons and calls-to-action. *Id.* at 5.

93. Finally, Neil McAllister points to the specific problem with scrolling regions on a smartphone, as follows:

> Custom scrollbars are a particularly egregious example. Occasionally designers will want to override the default controls with JavaScript, replacing them with sleek, skinny, and more visually appealing widgets. The problem for tablet users is twofold: Not only are tiny widgets harder to hit with your finger, but tablet users don't scroll using scrollbars anyway; they swipe the screen. Forcing them to use custom controls only hobbles your UI….
>
> Web UI mistake 3: Having too many scrollable areas
> Viewing websites on a small touchscreen often means scrolling around to see the whole page. As I mentioned before, however, remember that tablet users scroll by swiping the screen, not by activating controls. When you divide the page into multiple panes, each of which contains scrollable content, your UI can quickly become an interactivity minefield. One part of the content might scroll with one swipe and another part might scroll with the next, depending on where the user's finger lands on the screen. Best to keep the layout

> as simple as possible, or at the very least, make sure there are good-sized margins to allow the user to choose whether to scroll one pane or the whole page.
> Ex. 2050 at 2.

94. I am perplexed by Dr. Wolfe's testimony on this very topic. When asked about why Moore (Ex. 1012) describes accounting for a 1-centimeter finger resolution at the paragraph starting at col. 3, line 5, he inexplicably says:

> I don't know what it means, that he's taking it into account, because what he's saying is that, even though a finger is 1 centimeter, he can measure ten times more accurately than that. And what I'm telling you is that, in fact, as of 1983, I was building touch sensors that were measuring 100 times more accurate than that, not ten times more accurate. But -- but in either case, the point is that you can make the measurements much more accurately than the width of a finger, and he discloses that.
> (Ex. 2003 at 115:8-18).

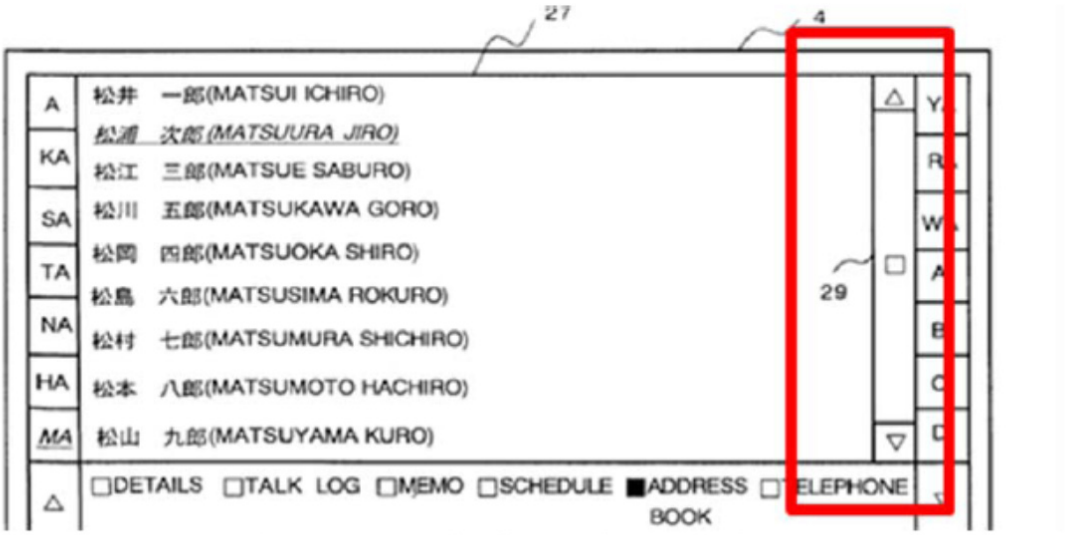
95. Thus, Dr. Wolfe conflates the resolution of a touchscreen (what coordinates it calculates) with the accuracy of touching with a finger. These are two completely different things, as the above discussion of the "fat finger" problem shows. To the extent that Dr. Wolfe or TCL might attempt to argue that using a stylus is less inaccurate than using a fingertip, this admits that his testimony is conflated and incorrect, since the same touchscreen (with the same resolution) is

used in both cases. As noted in this declaration, using a stylus introduces problems not found using a fingertip, such as timing, requirement of a second hand, hand tremor, and scratching the touchscreen surface, and it does not eliminate the fat-finger and occlusion problems.

96. Further, when asked directly about the "fat finger" problem, Dr. Wolfe further misstates that "certain kinds of touchscreen controls, like sliders and scrollbars, don't have that problem." This is clearly not so. A scroll bar's buttons, or it's "thumb" (the drag handle along the scroll bar), are buttons with small-target problems like any other button or target. These points would be well known, and even if not well known, readily appreciated by Dr. Wolfe's POSITA. I am confused by this part of his testimony given the well-known nature of this problem in the art of user-interfaces.

97. Thus, it is my opinion that the "fat finger" problem would exist for scroll regions in a handheld touchscreen. In fact, modern smartphones now omit scrollbars and scroll regions altogether due to the challenges they cause. Ex. 2034.

98. It is also my opinion that the fat finger problem would exist for a dedicated scrolling region in the mobile phone of Iwata. TCL specifically describes modifying a scroll bar such as that shown in Fig. 6 of Iwata, shown below with TCL's annotation:



(Annotated Fig. 6 (Iwata).)

99. Dr. Wolfe verified that he is proposing to modify Iwata so that there would be "a vertical scrolling region over the top of the region that is currently the scroll bar control in Figure 6 or in Figure 10, for example, of Iwata." Ex. 2002, Wolfe Tr. at 50:12-16. Further, as described above, TCL argues that a POSITA would be motivated to use the scroll region to obviate the need for a scroll bar, so the scroll region would be invisible to the user.

100. However, if the scroll region replaces the scroll bar, the resulting scrolling region will be ***directly adjacent*** to the input buttons shown adjacent to region 29 above. This inevitably presents the same "fat finger" issue for any of the other displayed buttons on the screen. If a user intends to provide an input to one of the input buttons adjacent to region 29 above, then there is a strong chance that the contact may inadvertently be sensed in the scrolling region, and vice versa.

Additionally, the border of the scrolling region is adjacent to multiple buttons, so the "fat finger" problem is actually exacerbated in view of the extra length that a scrolling region must occupy. The problem is only further exacerbated by the fact that the scrolling region is supposed to be invisible on the display module to meet Stephan's provided rationale.

101. Commentators in the mobile phone industry have stated that on-screen interface controls, like scrollbars and sliders, are ***not*** known and predictable variations of user interface designs which use gestures for manipulating content. Rather, "[g]estures ***provide a way around*** the need for an on-screen control for every GUI interaction and devote more space to the content itself (quite important on a small screen)." Ex. 2034 at 2. Upon the release of Apple's iPhone, "[s]crollbars were no longer controls, and remained only as a visual indicator of where you were." *Id.*

102. As of the priority date of the '931 patent, desktop computers were used for most processing and computing needs as software on mobile phones was not powerful or robust enough to support multiple functions and applications to be performed by the device. Likewise, a pointing device, such as a scroll wheel mouse or trackball, was used on the computers for sending directional instructions. On the mobile handset front, directional arrows and buttons were routinely used for sending instructions to a touch panel, as screen space was limited on which to

display information, let alone implement a dedicated scrolling region.

103. I am not surprised that TCL could not find a secondary reference with the "moving contact" feature that was embodied in a handheld device as of the priority date of the '931 patent. It would have been known to a POSITA that the solution offered by Stephan would encounter the numerous problems discussed above. In fact, many solutions to the above problems with developing a scrolling technique for portable devices were only developed after 1997, and in particular after the release of modern smartphones such as the iPhone.

104. Smartphones today do not use the technique described in Stephan where there is a dedicated "scrolling region" that a user contacts to scroll rows of items on the display. As already discussed above, McAllister describes the very specific problem with attempting a distinct scrollbar on a smartphone device. Ex. 2050. Rather, what is predominantly used is a method of allowing the user to contact a displayed document or material and allowing the user to "move" the material in a desired direction such that portions of that were previously out of view come into view. Ex. 2035.

105. One version of this technique is more fully described in U.S. Patent No. 6,690,387 to Zimmerman et al. filed in December 28, 2001 (Ex. 2036). In this technique, the amount of time a user's finger is contacting the screen and the distance it travels is used to determine the user's intent to scroll. *Id.* at Fig. 1.

106. Another version of a special scrolling technique for portable devices developed after 1997 is described in U.S. Patent No. 7,469,381 to Ording (Ex. 2037), in which the scroll movement is determined based on speed, velocity (magnitude and direction), and/or an acceleration (including magnitude and/or direction) of the object contacting the screen. *Id.* at 15:6-28.

107. In each of the above cases, a unique solution for scrolling was developed for portable touch screens in which any area of the screen could be used for multiple user intents, such as selecting an object and scrolling. This is not the solution offered by Stephan, in which the scrolling region limits a valuable portion of the touch panel to just one user intent: scrolling. Stephan's solution has been wholly rejected by the industry for the detailed reasons provided above.

108. Stephen Brewster, of the Glasgow Interactive Systems Group in the Department of Computing Science of the University of Glasgow, describes that "[o]ne problem with these [hand-held] devices is that there is very limited amount of screen space on which to display information: the screen cannot physically be made bigger as the devices must be able to fit into the hand or pocket to be easily carried." Ex. 2037 at 189. Further, "[t]he graphical techniques for designing interfaces on desktop systems do not apply well to handheld devices. Screen resources are limited; often screens are black and white to reduce cost and power consumption. Memory and processing power are much reduced from desktop

systems . . . [I]n may cases widgets have been taken straight from standard desktop graphical interfaces . . . and applied directly to mobile devices. This has resulted in devices that are hard to use, with small text that is hard to read, cramped graphics and little contextual information . . . ***It is therefore clear that taking the desktop interface and implementing it on a mobile device does not work well***." *Id.* (emphasis added).

109. Consequently, given the above constraints associated with handheld devices and displaying information, it is my opinion that simply taking the scroll regions from the portable computer interface illustrated in Fig. 13 of Stephan (and relied upon by TCL) and implementing it on the mobile device of Iwata would not work well. As very well described regarding the intricacies of touchscreens, "a good touchscreen experience requires more than just hardware. It requires a bit of design alchemy blending software, engineering and calibration for the perfect feel. Few smartphone makers have managed to get that balance right." Ex. 2039. Accordingly, in my opinion it would not have been obvious to incorporate a moving contact-based distinct scrolling region into the touchscreen of Iwata.

Using Stephan's Scroll Regions Would Not Increase Usable Space on Iwata

110. TCL states that a POSITA would be motivated to combine Iwata and Stephan because Iwata is "the precise type of GUI that Stephan seeks to improve, e.g., by allowing visual representations of scroll bars to be removed." Petition at

18. In support, TCL cites Stephan at 4:11-26, but this excerpt is clearly relevant only to the Stephan touchpad (such as the Fig. 2 embodiment), not the Stephan laptop of Fig. 13. Specifically, this cited portion mentions the following:

> ***Significant advantages arise from the touchpad construction disclosed herein***. . . By linking certain often-used functions, such as scrolling and panning, with designated touchpad regions, the user can accomplish desired functions quickly and efficiently. Moreover, graphic icons or buttons that typically had to be displayed in the GUI may now be removed from 20 the GUI. For example, the scroll and pan bars that are ubiquitous in many current application programs could be removed from the user display. Removing the graphic icons increases the overall workspace accessible by the user, and improves the visual appearance of the interface. ***The disclosed touchpad design*** therefore improves the overall efficiency and user friendliness between a user and a GUI.

111. The Stephan touchpad enables a user to eliminate scroll bars by performing scrolling functions on a touchpad that is distinctly separate from the display, thereby obviating the need to provide a visual cue on the screen, like a scroll bar, with which the user can interact. Thus, the motivation to use an external ***touchpad*** is to eliminate scroll bars. However, this motivation is not relevant to the Stephan laptop of Fig. 13 or the Iwata mobile phone because they would not enjoy that same benefit. The scrolling regions in these implementations would

directly overlap the display and the space in the scrolling region could not be used for any other purpose.

112. For example, in the case of the Stephan touchpad, the entire desktop computer screen can be used to display an excel sheet, such as the excel sheet depicted in Stephan's Figure 1:

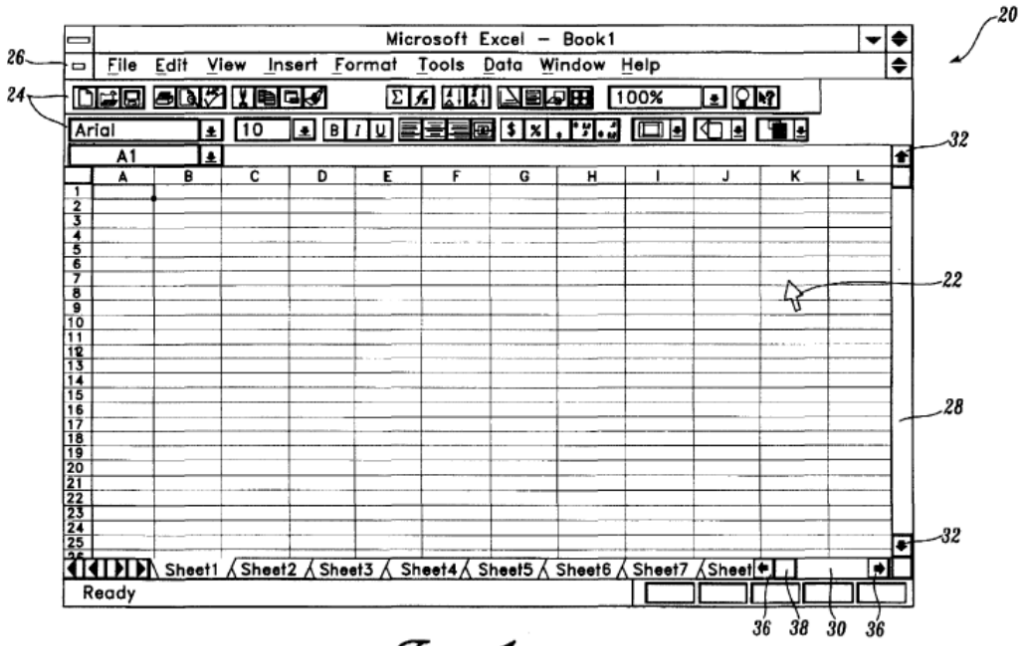
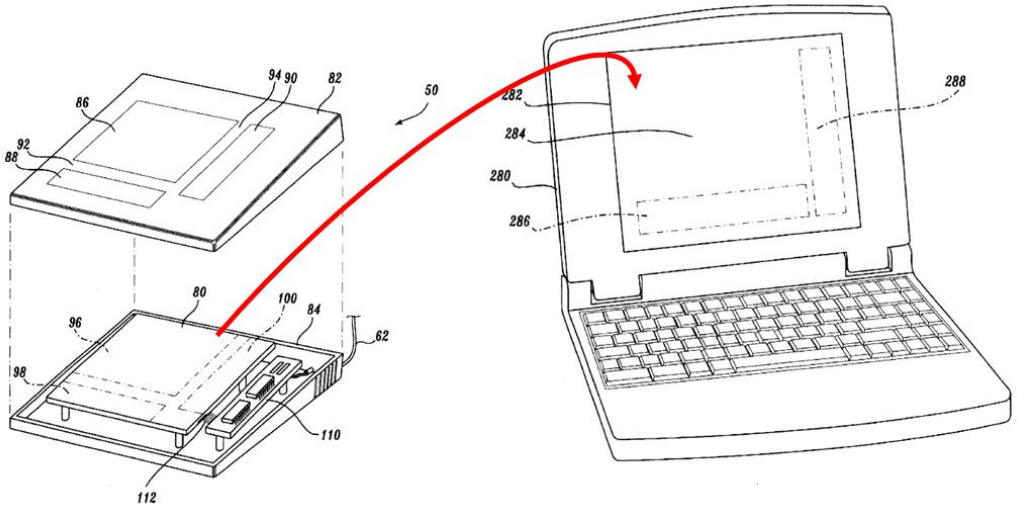


Fig. 1.
PRIOR ART

113. The user no longer needs scroll bar region 28, 30, 32, and 36 because the user can scroll up/down or side to side by using the separate trackpad.

114. However, in the case of the Stephan laptop of Fig. 13 or the Iwata mobile phone, the entire screen could not be used to display this excel sheet because the user would be unable to select and interact with the objects that are ***overlapped*** by the scrolling regions. I say "overlapped" because, as described

above, a 1997 resistive or capacitive touch screen involves a transparent touch panel mounted onto the display module. Thus, the portion of the structure which receives and interprets the location of the contact is separate from the display module. In other words, Fig. 13 of Stephan essentially includes a transparent version of the touchpad member in the other embodiments (such as 80 in Fig. 3) and mounts it over a display module (such as an LCD module).

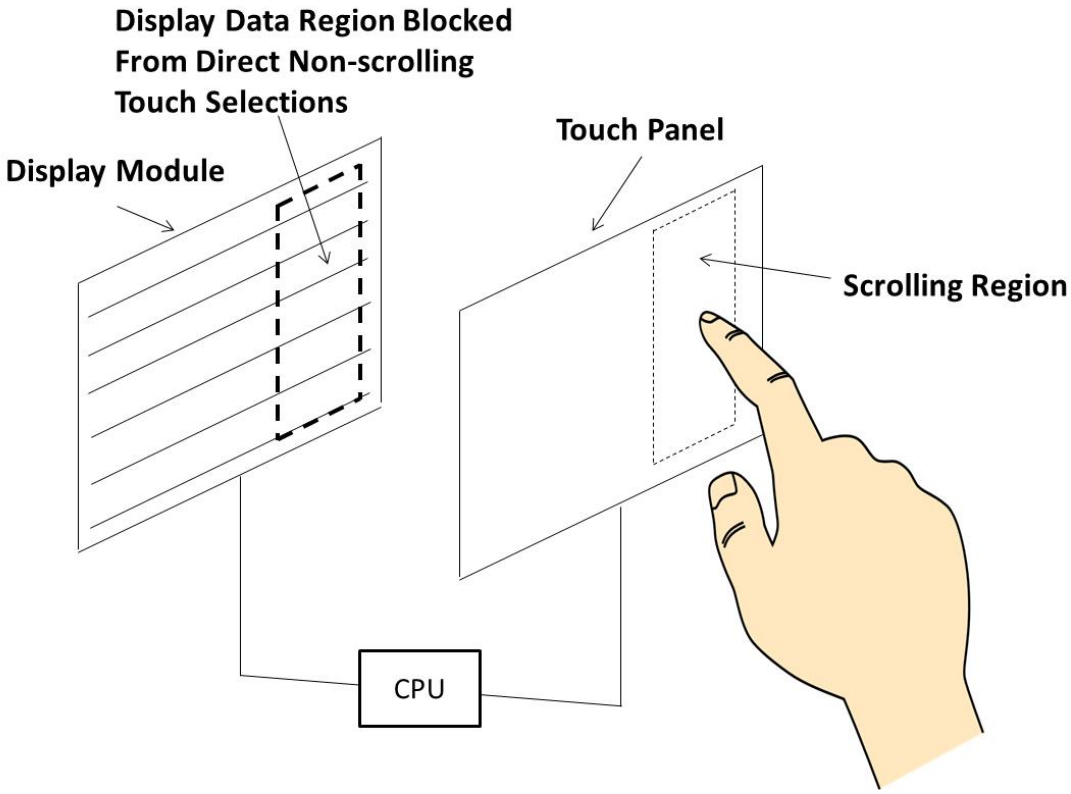


115. Thus, if the Excel spreadsheet of Fig. 1 is displayed on the touchscreen 282 of the portable computer 280 shown in Fig. 13 of Stephan, the scroll control region 288, for example, will ***overlap*** a portion of the Excel spreadsheet, rendering some functions of the GUI inoperable.

116. Therefore, a problem occurs in the embodiment of Fig. 13 of Stephan which does not occur in the embodiment of Fig. 2 of Stephan, in which the scrolling region actually blocks the ability to accept a direct non-scrolling input or

selection to display data which overlaps the scrolling region. An exploded view of this result in Fig. 13 of Stephan is shown below.

Stephan (Fig. 13)



117. This problem is made even more clear as depicted below in the actual Excel example provided in Stephan, a dotted scroll control region 288 is shown to overlap a portion of the Excel spreadsheet, specifically, column L.

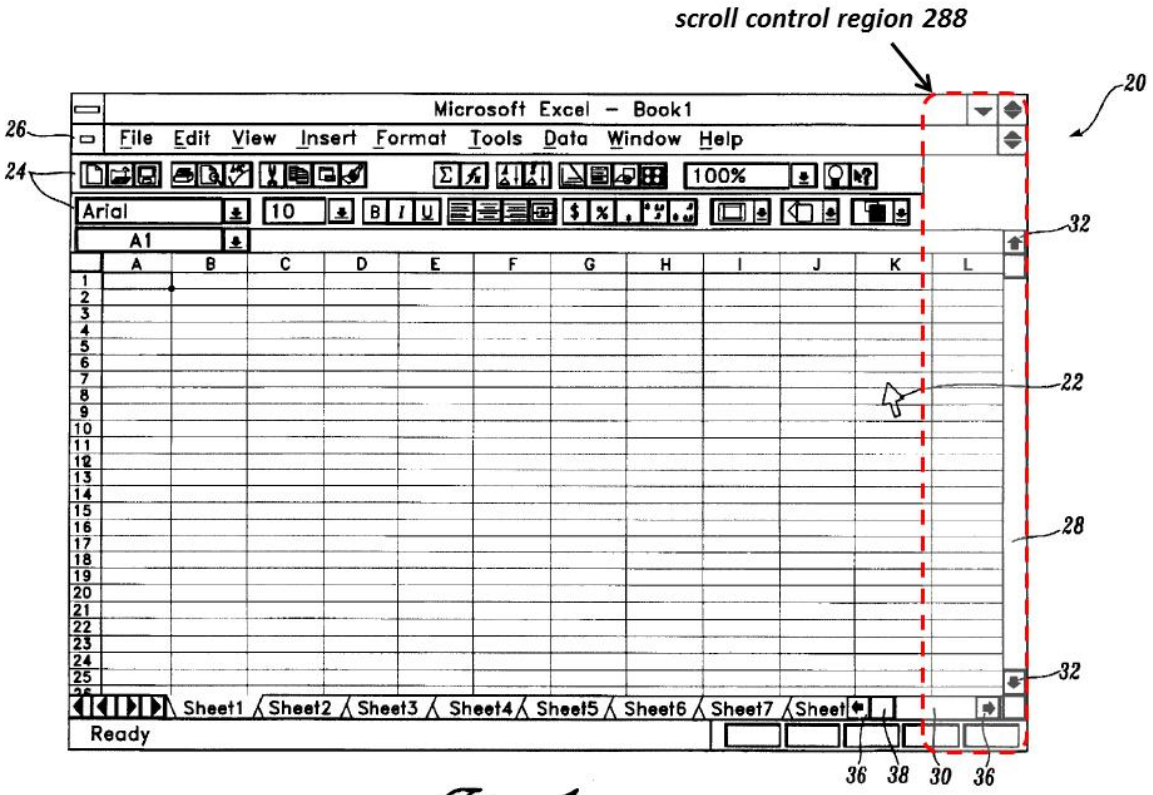


Fig. 1.
PRIOR ART

118. Therefore, incorporating the scroll control region 288 into the GUI of the touchscreen 282 above clearly takes away overall workspace accessible by the user, as the functions of the GUI under the scroll control region 288 are inoperable when the scrolling function is active.

119. I noted that in Dr. Wolfe's deposition, he admitted that one would have to first ***disable the scrolling function*** of the scroll control region 288 in order to make an initial point of contact to, for example, a cell within column L of the spreadsheet shown above. Ex. 2003 at 36:11 to 37:7.

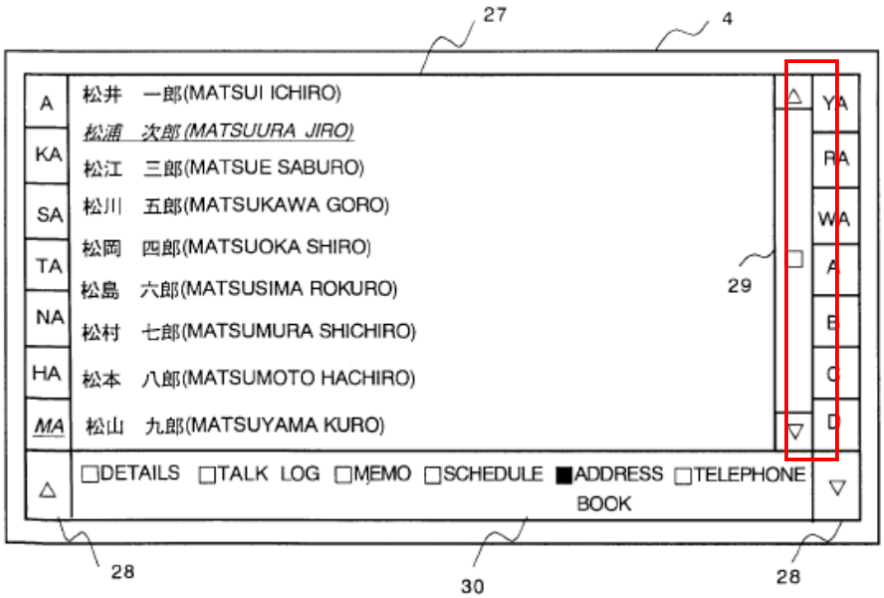
120. Therefore, it is my opinion that a POSITA would immediately recognize that motivation in Stephan relied upon by the Petitioner and the benefits of Stephan highlighted above are not directly applicable to Fig. 13 of Stephan. On the contrary, the obstructing nature of having the Stephan touchpad (in transparent form) overlap the display module itself ends up producing a scrolling region that ***blocks*** direct access to any display data that overlaps the scrolling region that needs to be accessed with a non-scrolling contact.

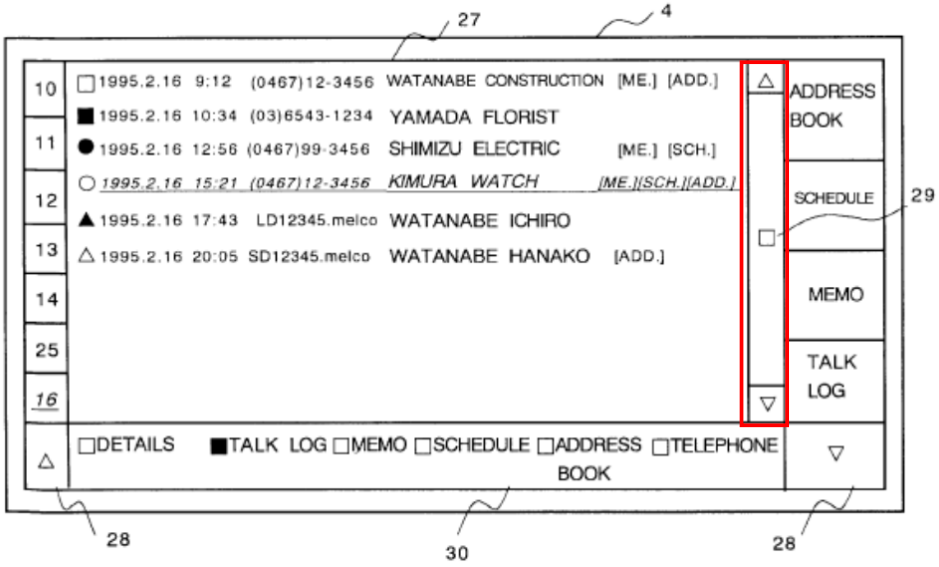
121. Thus, because the space in the scroll region would not become usable space as TCL claimed, a POSITA would not be motivated to replace the Iwata scroll bars with the Stephan scroll regions based on the explicit reasons provided for in Stephan.

A POSITA Would Not Be Motivated to Use Stephan's Fixed Scroll Region in Iwata's Flexible User Interface

122. As described above, touchscreens, like the one used in Iwata, consist of two parts: a touch-sensitive panel that receives user inputs and a display, like an LCD screen. The display generally sits behind the touch-sensitive panel. When a user selects a button on a screen, he does not actually touch the display. The user touches the touch-sensitive panel, which then registers the location of touch. If the location corresponds to the location of a displayed button, then the phone interprets the touch as a selection of that button. This design allows phone designers to

optimize the location of the scroll bars on each displayed screen, as the Iwata designers did for the scroll bars in Figs. 6 and 11 below:





123. Indeed, some screens in Iwata may require no scroll bar at all (*see* Fig. 36, for example).

124. However in Stephan, the scroll regions are ***fixed and permanent in their location,*** because they are allocated within the overlying touch panel and thus unusable in Iwata's flexible interface that uses different scroll regions or no scroll region at all for different displays. This is evidenced by the fact that Stephan does not disclose a single embodiment that allows for movement of the scroll regions. Indeed, because the regions are permanent, Stephan explains that the regions "be designated with visual or tactile cues," as described above. I believe that the Iwata engineers, recognizing this, designed a dynamic user interface that optimizes the location of scroll bars on a case-by-case basis, and in some instances, eliminates scroll bars. A POSITA would not be motivated to use Stephan's ***permanent*** scroll bars in Iwata's flexible user interface.

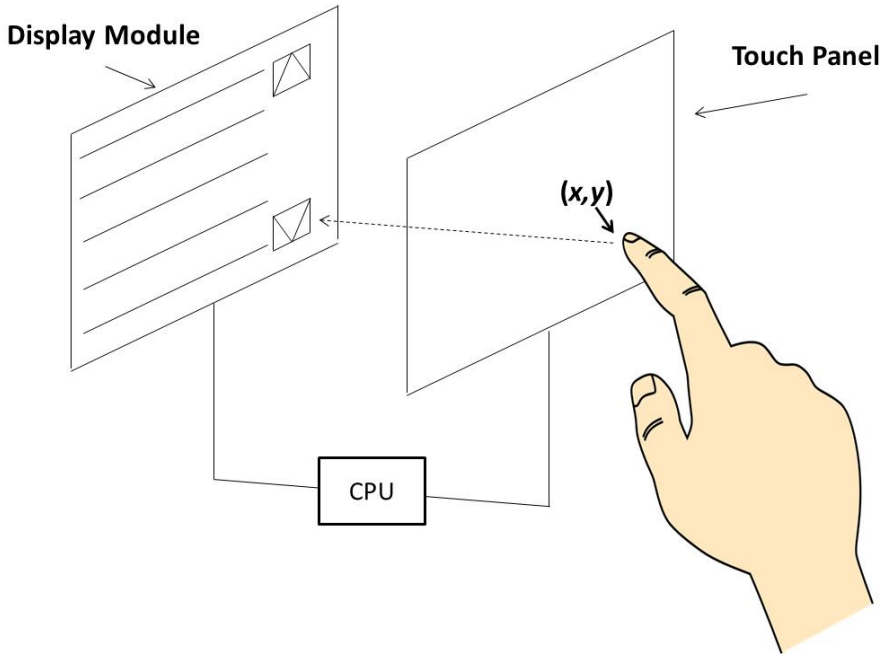
The Embodiment of Fig. 13 of Stephan is Fundamentally Flawed and Diminishes the User Experience

125. There are fundamental flaws in the embodiment of Fig. 13 (*i.e.*, laptop computer with permanent scroll regions and pan regions) which would be immediately apparent to the POSITA.

126. For instance, Iwata teaches a touchscreen 20 which is a combination of a transparent touch-sensitive panel overlaid onto a display device, such as an LCD display as depicted below.

Iwata

- **Scroll buttons are displayed by display module when needed**
- **Coordinates of single touch on touch panel are provided to processor (CPU) to determine if user intended to activate displayed scroll button**



127. Iwata employs scroll button arrows that are visually displayed by the display module. The touch panel itself is transparent and is designed to have an overall area that coincides and is aligned with the overall area of the underlying display module. If the user wishes to perform a scroll operation, the user will touch the portion of the touch panel that overlaps the display module where the display button is specifically displayed. The touch panel itself registers a location of where contact from the user is sensed on the touch panel. For simplicity, this could correspond to a single "x,y" coordinate point being determined in the two-

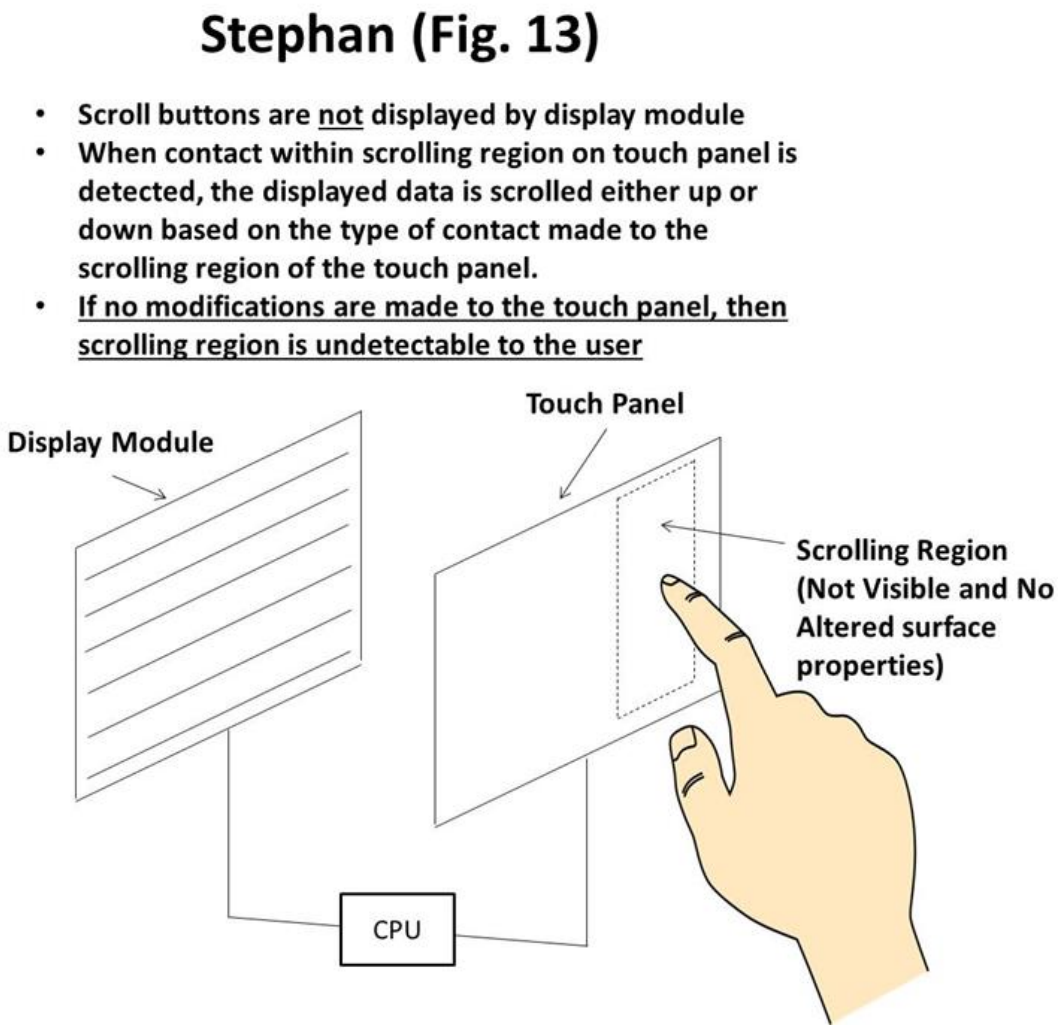
dimensional plane.

128. Stephan takes a significantly different approach towards scrolling compared to Iwata, because it uses ***dedicated regions in the touchpad or touch panel*** itself for scrolling, panning, and cursor control functionality. This is readily apparent in the embodiments of Figs. 2 and 6-11 of Stephan where an external touch pad is used that allows scrolling and panning independent of a visual target on the screen.

129. I am perplexed by Dr. Wolfe's deposition testimony on his understanding of Stephan. In Dr. Wolfe's deposition testimony (CITE page 33, lines 16..20; page 44 lines 19..22) he states that in his combination the cursor control region 284 would behave "like a mouse". Ex. 2003 at 44:19-20. However, as was well-known to Dr. Wolfe's POSITA, a mouse uses relative motion (the user "pushes" the cursor around – the actual location of the mouse on the desk has no fixed or "isomorphic" relation to the location of the cursor), while one of the advantages of a touchscreen or tablet is that it uses an absolute position of touch (the location of the touch matches a fixed location on the display). Ex. 2053. This distinction between the absolute positioning of a touchscreen vs. the relative positioning of a touchpad is explicitly described Dr. Wolfe's declaration as well. Ex. 1201 at 75.

130. With regard to the Fig. 13 embodiment, the following exploded view

is provided where no modifications are made to the clear touch panel that overlays the display module.



131. In the above depiction, an immediate problem becomes apparent. ***The scrolling region is not displayed on the display module to act as a target*** for the user to use when contacting the touch panel, as is the intended stated purpose in Stephan, and thus the scrolling region is essentially invisible and undetectable to the user on the transparent touch panel which overlays the display module.

132. There is absolutely no ***rational*** reason to create an undetectable scrolling region in a touchscreen because the drawbacks are immediately apparent: the user is strictly guessing where to touch on the touch panel to activate scrolling assuming that the user even knows that this functionality is available to them.

133. Stephan appears to recognize this problem, as it states with regard to Fig. 13: "[t]he regions may be designated with visual or tactile cues as discussed above." Ex. 1036 at 12:40-41. Stephan appears to be referencing a discussion on col. 12, lines 4-15, which states the following:

> A portion of the touchpad member is designated by visual markings as a scroll control region 254 and a pan control region 256. Each region is spaced from the margins of the touchpad member, and includes arrows printed within each region indicative of the region function. The surface of the touchpad member that forms the scroll control region 254 and pan control region 256 is also textured. Texturing the surface of the scroll and pan regions differently from the cursor control region 252 provides tactile feedback to the user about the region in which they are operating.

134. I note that this description is provided specifically with respect to the embodiment of Fig. 11 of Stephan shown below.

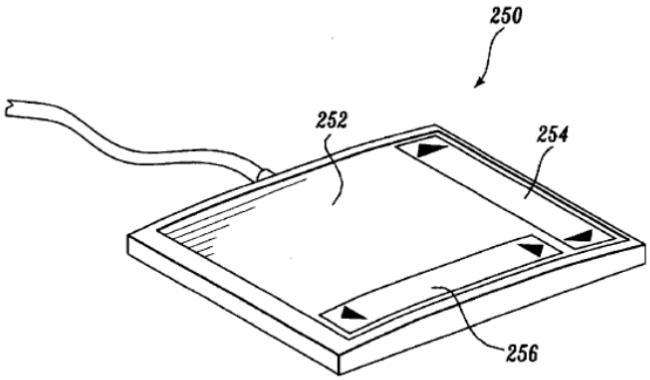
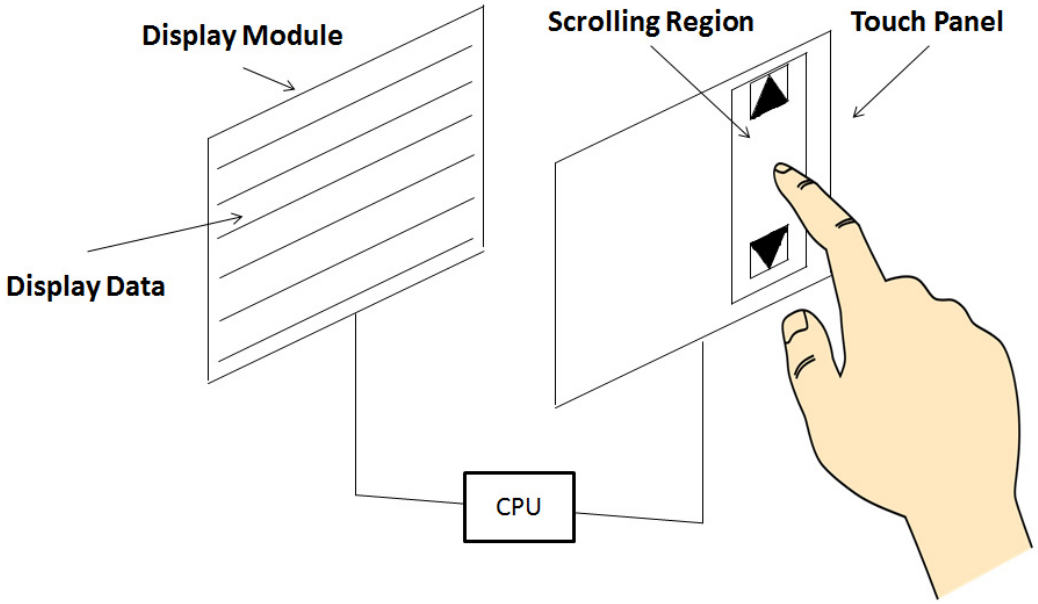


Fig. 11.

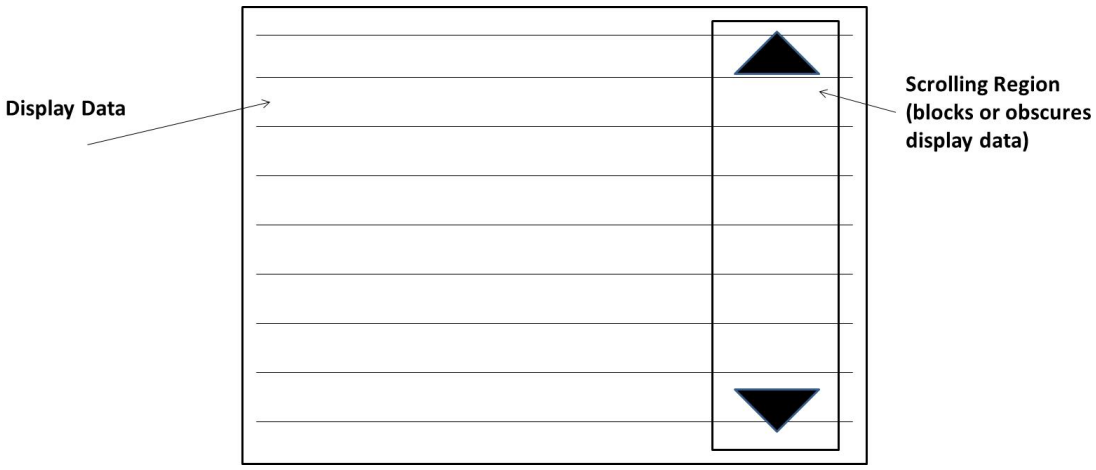
135. Thus, Stephan initially describes adding permanent visual markings or permanent surface texture to the scroll and pan regions of a touchpad that is external to the user computer and not overlaid with a display screen. While Stephan briefly mentions that these same permanent visual markings or texture modifications can be used in the embodiment of Fig. 13 as noted above, Stephan has either not thought this through, or is ignoring the obvious drawbacks to this modification. However, a POSITA would immediately understand the fundamental flaw in this teaching. The below example illustrates the result of adding visual cues in the embodiment of Fig. 13.

Stephan (Fig. 13)

- **With visual cues permanently added to touch panel**



136. In the exploded view shown above, it can be seen that the visual markings (such as the arrows similar to arrows depicted in Fig. 11 of Stephan) are ***permanently added to the transparent touch panel*** that overlays the display module. Accordingly, the user would actually see the following result.



137. The result of adding the visual markings to the touch panel in the Fig. 13 embodiment of Stephan are clearly detrimental to the user's ability to see all of the underlying display data. A similar or even worse result would occur if the texture of the touch panel in the scrolling region were to be modified (such as with surface roughness, ridges, bumps, or the like) because this would undoubtedly increase the opacity of the touch panel in the scrolling region. Even if a mere rectangle were used as the markings added to the touch panel, this would still be a distraction since the user is trying to view the display beneath the markings.

138. Moreover, as already discussed above, the scrolling regions in the touch panel of the Fig. 13 embodiment of Stephan are permanent. Thus, the solution of Fig. 13 of Stephan precludes moving the location of a scrolling region.

139. Therefore, the hardware changes to Iwata required by Stephan's teaching, especially with the modified touch panel in the embodiment of Fig. 13 of Stephan, clearly introduce several detrimental results, which make it clear that

replacing the scrolling region buttons 29 in Iwata with a scrolling region permanently defined in the overlaying touch panel as taught by Stephan would clearly diminish and frustrate the user experience compared to the flexible user interface originally disclose in Iwata.

It Would Not Have Been Obvious to Incorporate the Dedicated Hardware and Software of Stephan Into Iwata

140. It is also my opinion that a POSITA would not attempt to combine the dedicated hardware and software, that Stephan states is required, with Iwata. They have not provided any explanation be motivated to incorporate Stephan's "dedicated hardware" required to implement the scroll regions into the handheld Iwata device without a clear understanding of the hardware requirements of the specific Stephan solution. Stephan explains that ***"[d]edicated hardware and software is required*** to interface the three regions of touchpad 50 with the computer's GUI." Ex. 1036 at 6:48-49. The dedicated hardware and software includes a circuit board that contains a processor, associated circuitry, and a firmware routine to convert the X,Y location and movement for the contact point by the user into the appropriate control packets for transmission to the computer. Id. at 7:25-30. TCL provided no explanation as to how a POSITA would implement Stephan's dedicated touchpad or laptop hardware and software into Iwata's handheld mobile-phone, while maintaining a handheld device, and without

this teaching being clear from Stephan, it is my opinion that a POSITA would not attempt the combination.

IX. CLAIMS 1-12, 15-26, 29, AND 58-69, ARE NOT OBVIOUS OVER IWATA IN VIEW OF STEPHAN AND CAPPS

141. Claims 3-12, 18-26, 29, and 53 each depend from independent claims addressed above. As described above, Capps is directed to a pen-based computer system. Fig. 2 of Capps below shows an operation screen which includes scroll buttons 52 and 54. Ex. 1037 at 4:40-42.

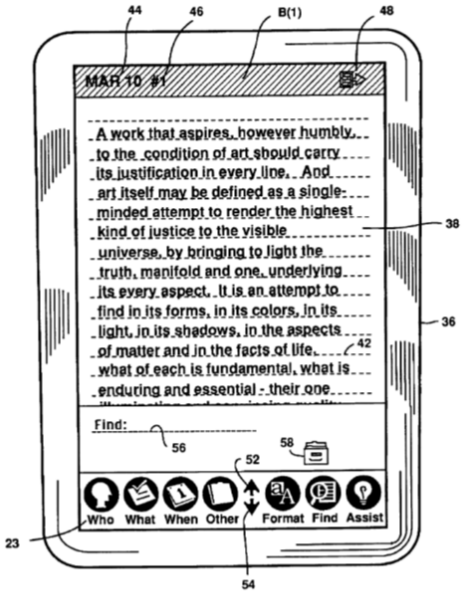


FIG. 2

142. However, the scroll buttons are merely similar to the scroll buttons shown in Fig. 6 of Iwata, in which a single touch operation on the scroll buttons causes the scrolling operation. *Id.* at 4:33-40. Similar to the deficiency of Iwata, Capps does not describe performing the scrolling by way of a ***moving contact*** of

an object along the surface of the touch screen.

143. Therefore, it is my opinion that Capps does not disclose or suggest anything to remedy the deficiencies of combining Iwata and Stephan discussed above. As such, Iwata, Stephan, and Capps fail to render obvious claims 3-12, 18-26, 29, and 53.

X. AVAILABILITY FOR CROSS-EXAMINATION

144. In signing this declaration, I recognize that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross examination in the case and that cross examination will take place within the United States. If cross examination is required of me, I will appear for cross examination within the United States during the time allotted for cross examination.

XI. RIGHT TO SUPPLEMENT

145. I reserve the right to supplement my observations in the future to respond to any arguments that the Petitioner raises and to take into account new information as it becomes available to me.

XII. JURAT

146. I, Jean Renard Ward, declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the

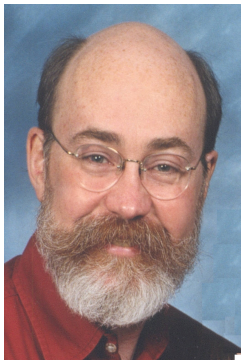
knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on 9-May-2016 Jean Renard Ward

Jean Renard Ward

APPENDIX A



Jean Renard Ward
Rueters-Ward Services
350 Massachusetts Avenue PMB 210
Arlington, MA 02476-7737
Voice: 781-267-0156
jrward@alum.mit.edu
jrward@ruetersward.com

Technical and software development consultant, February 1993 to present.
Currently doing business as Rueters-Ward Services.
Prior to 1993, positions as noted.

2008-present
Consulting/development for multiple clients:

- Laboratory information processing for biomedical drug-discovery company
- Digital audio HW/SW Agile verification automation for massive VOIP technology.
- Consulting/development for TV-band datacasting architecture.
- Technical consulting, review, development for web-based collaborative work systems.
- Prior-art research and source-code analysis in patent litigations (confidential).
- Technical assistance to Boston-area attorney in solo practice (patent prosecution only).

2012-2015

Declarations in support of petitioner Samsung for *Inter Partes* Review of U.S. Patent 6,610,917 and related patents, concerning touchscreen hardware (February 2016).

Expert witness for plaintiff GO Computer in *GO Computer Inc. v. Microsoft,* CGC-05-442684 in Superior Court, State of California/San Francisco. Report and Deposition August 2015. Settled September 2015.

Expert witness for defendant Google in *ContentGuard Holdings, Inc. v. Google Inc*., Case No 2:14CV0061, (Eastern District of Texas, Marshall Division), concerning Digital Rights Management and Secure Systems. Deposition June 2015, trial September 2015.

Expert witness for defendant Lenovo in *MAZ Encryption Technologies LLC v Lenovo Inc.*, Case No 13-303-LPS (District of Delaware), concerning encryption/decryption in conjunction with smartcards. Deposition April, 2015.

(Non-expert deposition as subpoenaed fact witness in *Flatworld v. Samsung Electronics Co. LTD. et al,* Case No 12-804-LPS, District of Delaware, April 2015.)

Declaration/report in support of petitioner Google Inc. for *Inter Partes* Review of U.S. Patent 6,121,960, concerning rendering of transparency in graphics images and touch screen user-interface methods (May 2014), Depositions February and May, 2015.

Consulting expert for two patents concerning touchscreen gestures on a virtual keyboard, and layered display of information.

Expert witness for defendant Samsung in *Apple Inc. v Samsung Electronics Co. Limited, Proceeding No. NSD 1243 of 2011, Federal Court of Australia*, concerning multi-touch hardware. Two reports, testimony at trial (June 2013).

Consulting expert for patent concerning transparent graphical displays.

Consulting expert for patent concerning rotation of window views in touchscreen devices.

2012
Expert witness for defendant Motorola in *Certain Mobile Devices Incorporating Haptics*, case number 337-2875, in the U.S. International Trade Commission, concerning touch haptics (settled).

2011-2012
Expert witness for defendant Motorola Corporation in *Motorola Mobility, Inc. v. Microsoft Corporation,* Case No. 10-24063-CIV-MORENO (Southern District of Florida) concerning touchscreen gestures in smartphones. Two reports, testimony at deposition, one affidavit in re-exam.

2010-2011
Expert witness for defendant Nokia in *Nokia Corporation v. Apple, Inc*., Case No. C.A. 09-791-GMS, (District of Delaware). Prior art and other research on multiple patents regarding touch user-interfaces, color rendering, touchscreen integration, and development tools for hand-held devices. Settled shortly before reports due.

2006-2008
Expert witness for plaintiff Lucent Technologies in *Lucent Technologies, Inc., v. Gateway, Inc. et al.*, Case No. 02-CV-2060-B (WMC), consolidated with Case No. 03-CV-0699-B (WMC) and Case No. 03-CV-1108-B (WMC) (S.D. Cal.), concerning gesture user interfaces and hardware integration in tablet-type computers. Three expert reports, testimony in three depositions and at trial.

2007 Bluesocket Inc., Burlington Massachusetts
Software development and engineering process (with QA Director and VP Eng.) for a distributed wireless network controller product with integrated security, verification of SSL/TLS and VPN features in multiple hardware devices. Agile/Jira.

2005/2006: (Staff: Principal Engineer) Cylant Security, Burlington Massachusetts
Computer security technology: Multi-platform product for malware/virus detection, including techniques of behavioral analysis. Two patent filings on novel techniques (violation of invariant conditions) for detection of rootkits and malware

2004:
Expert witness for defendant in patent case *Anoto AB v. Sekendur*, Case 03-C-4723, Northern District of Illinois, optical (video) stylus digitizer hardware and firmware. Expert report and deposition .

2003/2004: Digimarc, Burlington Massachusetts
Consultant: Application of PKI technology in fabrication and production of secure identity documents and manufactured items. One patent filing regarding PKI signatures to ensure authenticity and track unauthorized issuance of security documents such as passports.

2002/2003:
Three projects involving secure Web development in high-availability, high-performance applications, and international certification of a life-critical annunciation system.
Prior-art research for two clients: pen-computing hardware and handwriting recognition.

2001:
Expert witness for defendant in *Shumer v. LCS* involving hardware controllers and virtual devices for digitizing tablets (WINTAB).

1999/2002: (Staff: PKI Systems Architect) CertCo Incorporated, Cambridge Massachusetts
Development of distributed web applications involving proprietary PKI in e-commerce.
Three patent filings regarding PK infrastructure for distributed electronic signing.

1998 to 1999: Siemens-Nixdorf USA, LCP Business Unit, Burlington Massachusetts
Design and development of cryptographic PKI/security technology for electronic DRM licensing of documents and materials distributed without restriction over the public Internet.

1996 to 1998: (Staff: Dev. Group Leader) e-parcel.com, Newton Massachusetts
Division of Mitsubishi Electronics America,
Secure, encrypted document and software delivery systems for automatic dissemination and delivery over the public Internet. Instituted engineering tracking and QA process.

1995/1996: FAX International, Burlington MA
Automated Email-to-FAX gateway, routing of fax traffic over private TCP/IP network.

1994/1995: DEC/Digital VXT Division, Marlboro, MA
WindowsNT-based graphics/applications terminal product using ALPHA technology.

1994: DMR Group, Waltham, MA
Proprietary application scripting language, associated compilers, debuggers, and tools.

1993/1994: Phoenix Technologies Ltd., PAGE Division Cambridge, MA
Firmware for a multiple-language, multiple-resolution network printer (PostScript/PCL).

1993: Termiflex Corporation, Merrimac, NH
Compiler, linker, interpreter, and related tools for an object-based programming language for applications in a hand-held touchpad industrial controller terminals.

Prior to 1993

1992, 1993:
Session chair and instructor for tutorial seminars on touchscreen/pen interfaces and digitizer technology at the 1992 and 1993 annual conferences for the Society for Information Display.
Consultant to various clients on digitizer technology and pen computing interfaces

1991 to 1993: Developer, Slate Corporation, Newton MA
Development of tablet and pen computing applications products for the Microsoft PenWindows and GO/PenPoint pen-computing operating systems.
Company representative and technical co-chair of an industry standardization effort ("JOT") for electronic ink data format and compression applications.

1989 to 1991: Senior Software Architect Wang Laboratories, Lowell MA
Lead developer for digitizer and controller/driver software to provide enhanced functionality to a portable computer as part of the "Freestyle" digitizer-based computer applications family.
Company technical representative to early Pen Windows discussions with Microsoft. Hardware design of an electrostatic tablet digitizer. Patents on novel pen-based UI involving virtual devices.

1987 to 1989: Dir. of Software Eng., Teledyne/TAC, Woburn MA
Software group leader for computer-controlled industrial automation for IC wafer testing.

1979 to 1987, Lead Engineer, Pencept Inc., Waltham MA
Group leader for Pencept's handwriting recognition, and pen-computing digitizers and hardware controllers through three generations of products.
Patents related to pen-computing UI and pen-computing digitizers.

1977 to 1979, Senior Engineer/Analyst, Dynatron Corporation, Waltham, Massachusetts
Early work as consultant for Penverter Partners (predecessor to Pencept).
Specialized implementation tools for real-time digital audio signal processing and testing.

1974 to 1977, Senior Systems Programmer, Data General Corp., Westboro Massachusetts
Compiler development.

Partial list of published patent applications

US Published Patent Application 20070169192, June 19, 2007
"Detection of system compromise by per-process network modeling"

US Published Patent Application 20070067623, March 22, 2007
"Detection of system compromise by correlation of information objects"

US Published Patent Application 20050132194, June 16, 2005
"Protection of identification documents using open cryptography"

US Published Patent Application 20030163686, August 28, 2003
"System and method for ad hoc management of credentials, trust relationships and trust history in computing environments"

European Patent Application Publication EP1421464 A1, May 26, 2004
"System and method for trust in computer environments"

Partial list of granted patents

US 5,491,495
"User interface having simulated devices"

European Patent Application EP693724A1
"A method of reconfiguration of a simulated keyboard device in a computer system"

US 5,148,155
"Computer with tablet input to standard programs"

US 4,608,658
"Method and apparatus for removing noise at the ends of a stroke caused by retracing"

US 4,562,304
"Apparatus and method for emulating computer keyboard input with a handprint terminal"

US 4,534,060
"Method and apparatus for removing noise at the ends of a stroke"

Partial list of On-line publications

"Annotated Bibliography in On-line Character Recognition, Pen Computing, Gesture User Interfaces and Tablet and Touch Computers ", available at http://www.ruetersward.com/biblio.html

"History of Pen-Based Computing - March 1992, Jean Renard Ward",
available at http://www.youtube.com/watch?v=4xnqKdWMa_8
(Posted 2013 by Dan Bricklin, http://bricklin.com)

Partial list of presentations and publications as author or co-author

"Under the Hood: Digitizer Technology and Pen Computing", BYTE Magazine, January, 1993.

"UNIX as a development tool for a non-UNIX microprocessor", CommUNIXations, Vol. V No. 5, August/September 1985.

"Interactive Recognition of Handprinted Characters for Computer Input", IEEE Computer Graphics and Applications, Vol. 5 No. 9, September 1985.

"Digitizer technology: Performance characteristics and the effects on the user interface", IEEE Computer Graphics and Applications, April 1987.

Panel organizer: "Issues in the validity of testing protocols and criteria for on-line recognition of handwritten text", presented at the 3rd International Conference on Handwriting and Applications, July 1987.

Organizer for multi-company presentation to PHIGS standardization committee on pen computing and gesture-recognition input devices, 1986.

"A model for variability effects in hand-printing, with implications on the design of on-line character recognition systems", IEEE Trans. on Systems, Man, and Cybernetics, May 1988.

"One view of outstanding problems in handwriting recognition systems", 3rd International Conference on Handwriting Recognition and Applications, Montreal, Quebec, April 1990.

"Pen computing -- fad or revolution?," Information Display, pp. 14-19, March 1992.

Education

S.B. in Computer Science and Electrical Engineering
M.I.T., Cambridge, Massachusetts 1974

Independent Study, Philipps-Universität
Marburg, Germany 1972

Other Skills

Fluent in German.

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