Bi-weekly Random Bits from the Internet

2015-02-28

("THE SPECIAL EDITION FOR COMPUTING")

As We May Think

P2, Vannevar Bush, The Atlantic Jul 01, 1945

The Shape of Things to Come

P20, Ian Parker, The New Yorker Feb 23, 2015 Issue

Ten Years of Google Maps, from Slashdot to Ground Truth

P55, Liz Gannes, Re/code, Feb 08, 2015

Steve Jobs, the Lost Interview

P69, Robert Cringely (Mark Stephens), 1995

As We May Think

Vannevar Bush, The Atlantic Jul 01, 1945

As Director of the Office of Scientific Research and Development, Dr. Vannevar Bush has coordinated the activities of some six thousand leading American scientists in the application of science to warfare. In this significant article he holds up an incentive for scientists when the fighting has ceased. He urges that men of science should then turn to the massive task of making more accessible our bewildering store of knowledge. For years inventions have extended man's physical powers rather than the powers of his mind. Trip hammers that multiply the fists, microscopes that sharpen the eye, and engines of destruction and detection are new results, but not the end results, of modern science. Now, says Dr. Bush, instruments are at hand which, if properly developed, will give man access to and command over the inherited knowledge of the ages. The perfection of these pacific instruments should be the first objective of our scientists as they emerge from their war work. Like Emerson's famous address of 1837 on "The American Scholar," this paper by Dr. Bush calls for a new relationship between thinking man and the sum of our knowledge. —THE EDITOR

This has not been a scientist's war; it has been a war in which all have had a part. The scientists, burying their old professional competition in the demand of a common cause, have shared greatly and learned much. It has been exhilarating to work in effective partnership. Now, for many, this appears to be approaching an end. What are the scientists to do next?

For the biologists, and particularly for the medical scientists, there can be little indecision, for their war has hardly required them to leave the old paths. Many indeed have been able to carry on their war research in their familiar peacetime laboratories. Their objectives remain much the same.

It is the physicists who have been thrown most violently off stride, who have left academic pursuits for the making of strange destructive gadgets, who have had to devise new methods for their unanticipated assignments. They have done their part on the devices that made it possible to turn back the enemy, have worked in combined effort with the physicists of our allies. They have felt within themselves the stir of achievement. They have been part of a great team. Now, as peace approaches, one asks where they will find objectives worthy of their best.

Of what lasting benefit has been man's use of science and of the new instruments which his research brought into existence? First, they have increased his control of his material environment. They have improved his food, his clothing, his shelter; they have increased his security and released him partly from the bondage of bare existence. They have given him increased knowledge of his own biological processes so that he has had a progressive freedom from disease and an increased span of life. They are illuminating the interactions of his physiological and psychological functions, giving the promise of an improved mental health.

Science has provided the swiftest communication between individuals; it has provided a record of ideas and has enabled man to manipulate and to make extracts from that record so that knowledge evolves and endures throughout the life of a race rather than that of an individual.

There is a growing mountain of research. But there is increased evidence that we are being bogged down today as specialization extends. The investigator is staggered by the findings and conclusions of thousands of other workers—conclusions which he cannot find time to grasp, much less to remember, as they appear. Yet specialization becomes increasingly necessary for progress, and the effort to bridge between disciplines is correspondingly superficial.

Professionally our methods of transmitting and reviewing the results of research are generations old and by now are totally inadequate for their purpose. If the aggregate time spent in writing scholarly works and in reading them could be evaluated, the ratio between these amounts of time might well be startling. Those who conscientiously attempt to keep abreast of current thought, even in restricted fields, by close and continuous reading might well shy away from an examination calculated to show how much of the previous month's efforts could be produced on call. Mendel's concept of the laws of genetics was lost to the world for a generation because his publication did not reach the few who were capable of grasping and extending it; and this sort of catastrophe is undoubtedly being repeated all about us, as truly significant attainments become lost in the mass of the inconsequential.

The difficulty seems to be, not so much that we publish unduly in view of the extent and variety of present day interests, but rather that publication has been extended far beyond our present ability to make real use of the record. The summation of human experience is being expanded at a prodigious rate, and the means we use for threading through the consequent maze to the momentarily important item is the same as was used in the days of square-rigged ships.

But there are signs of a change as new and powerful instrumentalities come into use. Photocells capable of seeing things in a physical sense, advanced photography which can record what is seen or even what is not, thermionic tubes capable of controlling potent forces under the guidance of less power than a mosquito uses to vibrate his wings, cathode ray tubes rendering visible an occurrence so brief that by comparison a microsecond is a long time, relay combinations which will carry out involved sequences of movements more reliably than any human operator and thousands of times as fast—there are plenty of mechanical aids with which to effect a transformation in scientific records.

Two centuries ago Leibnitz invented a calculating machine which embodied most of the essential features of recent keyboard devices, but it could not then come into use. The economics of the situation were against it: the labor involved in constructing it, before the days of mass production, exceeded the labor to be saved by its use, since all it could accomplish could be duplicated by sufficient use of pencil and paper. Moreover, it would have been subject to frequent breakdown, so that it could not have been depended upon; for at that time and long after, complexity and unreliability were synonymous.

Babbage, even with remarkably generous support for his time, could not produce his great arithmetical machine. His idea was sound enough, but construction and maintenance costs were then too heavy. Had a Pharaoh been given detailed and explicit designs of an automobile, and had he understood them completely, it would have taxed the resources of his kingdom to have fashioned the thousands of parts for a single car, and that car would have broken down on the first trip to Giza.

Machines with interchangeable parts can now be constructed with great economy of effort. In spite of much complexity, they perform reliably. Witness the humble typewriter, or the movie camera, or the automobile. Electrical contacts have ceased to stick when thoroughly understood. Note the automatic telephone exchange, which has hundreds of thousands of such contacts, and yet is reliable. A spider web of metal, sealed in a thin glass container, a wire heated to brilliant glow, in short, the thermionic tube of radio sets, is made by the hundred million, tossed about in packages, plugged into sockets—and it works! Its gossamer parts, the precise location and alignment involved in its construction, would have occupied a master craftsman of the guild for months; now it is built for thirty cents. The world has arrived at an age of cheap complex devices of great reliability; and something is bound to come of it.

A record if it is to be useful to science, must be continuously extended, it must be stored, and above all it must be consulted. Today we make the record conventionally by writing and photography, followed by printing; but we also record on film, on wax disks, and on magnetic wires. Even if utterly new recording procedures do not appear, these present ones are certainly in the process of modification and extension.

Certainly progress in photography is not going to stop. Faster material and lenses, more automatic cameras, finer-grained sensitive compounds to allow an extension of the minicamera idea, are all imminent. Let us project this trend ahead to a logical, if not inevitable, outcome. The camera hound of the future wears on his forehead a lump a little larger than a walnut. It takes pictures 3 millimeters square, later to be projected or enlarged, which after all involves only a factor of 10 beyond present practice. The lens is of universal focus, down to any distance accommodated by the unaided eye, simply because it is of short focal length. There is a built-in photocell on the walnut such as we now have on at least one camera, which automatically adjusts exposure for a wide range of illumination. There is film in the walnut for a hundred exposures, and the spring for operating its shutter and shifting its film is wound once for all when the film clip is inserted. It produces its result in full color. It may well be stereoscopic, and record with two spaced glass eyes, for striking improvements in stereoscopic technique are just around the corner.

The cord which trips its shutter may reach down a man's sleeve within easy reach of his fingers. A quick squeeze, and the picture is taken. On a pair of ordinary glasses is a square of fine lines near the top of one lens, where it is out of the way of ordinary vision. When an object appears in that square, it is lined up for its picture. As the scientist of the future moves about the laboratory or the field, every time he looks at something worthy of the record, he trips the shutter and in it goes, without even an audible click. Is this all fantastic? The only fantastic thing about it is the idea of making as many pictures as would result from its use.

Will there be dry photography? It is already here in two forms. When Brady made his Civil War pictures, the plate had to be wet at the time of exposure. Now it has to be wet during development instead. In the future perhaps it need not be wetted at all. There have long been films impregnated with diazo dyes which form a picture without development, so that it is already there as soon as the camera has been operated. An exposure to ammonia gas destroys the unexposed dye, and the picture can then be taken out into the light and examined. The process is now slow, but someone may speed it up, and it has no grain difficulties such as now keep pho-

tographic researchers busy. Often it would be advantageous to be able to snap the camera and to look at the picture immediately.

Another process now in use is also slow, and more or less clumsy. For fifty years impregnated papers have been used which turn dark at every point where an electrical contact touches them, by reason of the chemical change thus produced in an iodine compound included in the paper. They have been used to make records, for a pointer moving across them can leave a trail behind. If the electrical potential on the pointer is varied as it moves, the line becomes light or dark in accordance with the potential.

This scheme is now used in facsimile transmission. The pointer draws a set of closely spaced lines across the paper one after another. As it moves, its potential is varied in accordance with a varying current received over wires from a distant station, where these variations are produced by a photocell which is similarly scanning a picture. At every instant the darkness of the line being drawn is made equal to the darkness of the point on the picture being observed by the photocell. Thus, when the whole picture has been covered, a replica appears at the receiving end.

A scene itself can be just as well looked over line by line by the photocell in this way as can a photograph of the scene. This whole apparatus constitutes a camera, with the added feature, which can be dispensed with if desired, of making its picture at a distance. It is slow, and the picture is poor in detail. Still, it does give another process of dry photography, in which the picture is finished as soon as it is taken.

It would be a brave man who would predict that such a process will always remain clumsy, slow, and faulty in detail. Television equipment today transmits sixteen reasonably good pictures a second, and it involves only two essential differences from the process described above. For one, the record is made by a moving beam of electrons rather than a moving pointer, for the reason that an electron beam can sweep across the picture very rapidly indeed. The other difference involves merely the use of a screen which glows momentarily when the electrons hit, rather than a chemically treated paper or film which is permanently altered. This speed is necessary in television, for motion pictures rather than stills are the object.

Use chemically treated film in place of the glowing screen, allow the apparatus to transmit one picture only rather than a succession, and a rapid camera for dry photography results. The treated film needs to be far faster in action than present examples, but it probably could be. More serious is the objection that this scheme would involve putting the film inside a vacuum chamber, for electron beams behave normally only in such a rarefied environment. This difficulty could be avoided by

allowing the electron beam to play on one side of a partition, and by pressing the film against the other side, if this partition were such as to allow the electrons to go through perpendicular to its surface, and to prevent them from spreading out sideways. Such partitions, in crude form, could certainly be constructed, and they will hardly hold up the general development.

Like dry photography, microphotography still has a long way to go. The basic scheme of reducing the size of the record, and examining it by projection rather than directly, has possibilities too great to be ignored. The combination of optical projection and photographic reduction is already producing some results in microfilm for scholarly purposes, and the potentialities are highly suggestive. Today, with microfilm, reductions by a linear factor of 20 can be employed and still produce full clarity when the material is re-enlarged for examination. The limits are set by the graininess of the film, the excellence of the optical system, and the efficiency of the light sources employed. All of these are rapidly improving.

Assume a linear ratio of 100 for future use. Consider film of the same thickness as paper, although thinner film will certainly be usable. Even under these conditions there would be a total factor of 10,000 between the bulk of the ordinary record on books, and its microfilm replica. The Encyclopoedia Britannica could be reduced to the volume of a matchbox. A library of a million volumes could be compressed into one end of a desk. If the human race has produced since the invention of movable type a total record, in the form of magazines, newspapers, books, tracts, advertising blurbs, correspondence, having a volume corresponding to a billion books, the whole affair, assembled and compressed, could be lugged off in a moving van. Mere compression, of course, is not enough; one needs not only to make and store a record but also be able to consult it, and this aspect of the matter comes later. Even the modern great library is not generally consulted; it is nibbled at by a few.

Compression is important, however, when it comes to costs. The material for the microfilm Britannica would cost a nickel, and it could be mailed anywhere for a cent. What would it cost to print a million copies? To print a sheet of newspaper, in a large edition, costs a small fraction of a cent. The entire material of the Britannica in reduced microfilm form would go on a sheet eight and one-half by eleven inches. Once it is available, with the photographic reproduction methods of the future, duplicates in large quantities could probably be turned out for a cent apiece beyond the cost of materials. The preparation of the original copy? That introduces the next aspect of the subject.

To make the record, we now push a pencil or tap a typewriter. Then comes the process of digestion and correction, followed by an intricate process of typesetting, printing, and distribution. To consider the first stage of the procedure, will the author of the future cease writing by hand or typewriter and talk directly to the record? He does so indirectly, by talking to a stenographer or a wax cylinder; but the elements are all present if he wishes to have his talk directly produce a typed record. All he needs to do is to take advantage of existing mechanisms and to alter his language.

At a recent World Fair a machine called a Voder was shown. A girl stroked its keys and it emitted recognizable speech. No human vocal chords entered into the procedure at any point; the keys simply combined some electrically produced vibrations and passed these on to a loud-speaker. In the Bell Laboratories there is the converse of this machine, called a Vocoder. The loudspeaker is replaced by a microphone, which picks up sound. Speak to it, and the corresponding keys move. This may be one element of the postulated system.

The other element is found in the stenotype, that somewhat disconcerting device encountered usually at public meetings. A girl strokes its keys languidly and looks about the room and sometimes at the speaker with a disquieting gaze. From it emerges a typed strip which records in a phonetically simplified language a record of what the speaker is supposed to have said. Later this strip is retyped into ordinary language, for in its nascent form it is intelligible only to the initiated. Combine these two elements, let the Vocoder run the stenotype, and the result is a machine which types when talked to.

Our present languages are not especially adapted to this sort of mechanization, it is true. It is strange that the inventors of universal languages have not seized upon the idea of producing one which better fitted the technique for transmitting and recording speech. Mechanization may yet force the issue, especially in the scientific field; whereupon scientific jargon would become still less intelligible to the layman.

One can now picture a future investigator in his laboratory. His hands are free, and he is not anchored. As he moves about and observes, he photographs and comments. Time is automatically recorded to tie the two records together. If he goes into the field, he may be connected by radio to his recorder. As he ponders over his notes in the evening, he again talks his comments into the record. His typed record, as well as his photographs, may both be in miniature, so that he projects them for examination.

Much needs to occur, however, between the collection of data and observations, the extraction of parallel material from the existing record, and the final insertion of new material into the general body of the common record. For mature thought there is no mechanical substitute. But creative thought and essentially repetitive thought are very different things. For the latter there are, and may be, powerful mechanical aids.

Adding a column of figures is a repetitive thought process, and it was long ago properly relegated to the machine. True, the machine is sometimes controlled by a keyboard, and thought of a sort enters in reading the figures and poking the corresponding keys, but even this is avoidable. Machines have been made which will read typed figures by photocells and then depress the corresponding keys; these are combinations of photocells for scanning the type, electric circuits for sorting the consequent variations, and relay circuits for interpreting the result into the action of solenoids to pull the keys down.

All this complication is needed because of the clumsy way in which we have learned to write figures. If we recorded them positionally, simply by the configuration of a set of dots on a card, the automatic reading mechanism would become comparatively simple. In fact if the dots are holes, we have the punched-card machine long ago produced by Hollorith for the purposes of the census, and now used throughout business. Some types of complex businesses could hardly operate without these machines.

Adding is only one operation. To perform arithmetical computation involves also subtraction, multiplication, and division, and in addition some method for temporary storage of results, removal from storage for further manipulation, and recording of final results by printing. Machines for these purposes are now of two types: keyboard machines for accounting and the like, manually controlled for the insertion of data, and usually automatically controlled as far as the sequence of operations is concerned; and punched-card machines in which separate operations are usually delegated to a series of machines, and the cards then transferred bodily from one to another. Both forms are very useful; but as far as complex computations are concerned, both are still in embryo.

Rapid electrical counting appeared soon after the physicists found it desirable to count cosmic rays. For their own purposes the physicists promptly constructed thermionic-tube equipment capable of counting electrical impulses at the rate of 100,000 a second. The advanced arithmetical machines of the future will be electrical in nature, and they will perform at 100 times present speeds, or more.

Moreover, they will be far more versatile than present commercial machines, so that they may readily be adapted for a wide variety of operations. They will be controlled by a control card or film, they will select their own data and manipulate it in accordance with the instructions thus inserted, they will perform complex arithmetical computations at exceedingly high speeds, and they will record results in such form as to be readily available for distribution or for later further manipulation. Such machines will have enormous appetites. One of them will take instructions and data from a whole roomful of girls armed with simple key board punches, and will deliver sheets of computed results every few minutes. There will always be plenty of things to compute in the detailed affairs of millions of people doing complicated things.

4

The repetitive processes of thought are not confined however, to matters of arithmetic and statistics. In fact, every time one combines and records facts in accordance with established logical processes, the creative aspect of thinking is concerned only with the selection of the data and the process to be employed and the manipulation thereafter is repetitive in nature and hence a fit matter to be relegated to the machine. Not so much has been done along these lines,beyond the bounds of arithmetic, as might be done, primarily because of the economics of the situation. The needs of business and the extensive market obviously waiting, assured the advent of mass-produced arithmetical machines just as soon as production methods were sufficiently advanced.

With machines for advanced analysis no such situation existed; for there was and is no extensive market; the users of advanced methods of manipulating data are a very small part of the population. There are, however, machines for solving differential equations—and functional and integral equations, for that matter. There are many special machines, such as the harmonic synthesizer which predicts the tides. There will be many more, appearing certainly first in the hands of the scientist and in small numbers.

If scientific reasoning were limited to the logical processes of arithmetic, we should not get far in our understanding of the physical world. One might as well attempt to grasp the game of poker entirely by the use of the mathematics of probability. The abacus, with its beads strung on parallel wires, led the Arabs to positional numeration and the concept of zero many centuries before the rest of the world; and it was a useful tool—so useful that it still exists.

It is a far cry from the abacus to the modern keyboard accounting machine. It will be an equal step to the arithmetical machine of the future. But even this new machine will not take the scientist where he needs to go. Relief must be secured from laborious detailed manipulation of higher mathematics as well, if the users of it are to free their brains for something more than repetitive detailed transformations in accordance with established rules. A mathematician is not a man who can readily manipulate figures; often he cannot. He is not even a man who can readily perform the transformations of equations by the use of calculus. He is primarily an individual who is skilled in the use of symbolic logic on a high plane, and especially he is a man of intuitive judgment in the choice of the manipulative processes he employs.

All else he should be able to turn over to his mechanism, just as confidently as he turns over the propelling of his car to the intricate mechanism under the hood. Only then will mathematics be practically effective in bringing the growing knowledge of atomistics to the useful solution of the advanced problems of chemistry, metallurgy, and biology. For this reason there still come more machines to handle advanced mathematics for the scientist. Some of them will be sufficiently bizarre to suit the most fastidious connoisseur of the present artifacts of civilization.

The scientist, however, is not the only person who manipulates data and examines the world about him by the use of logical processes, although he sometimes preserves this appearance by adopting into the fold anyone who becomes logical, much in the manner in which a British labor leader is elevated to knighthood. Whenever logical processes of thought are employed—that is, whenever thought for a time runs along an accepted groove—there is an opportunity for the machine. Formal logic used to be a keen instrument in the hands of the teacher in his trying of students' souls. It is readily possible to construct a machine which will manipulate premises in accordance with formal logic, simply by the clever use of relay circuits. Put a set of premises into such a device and turn the crank, and it will readily pass out conclusion after conclusion, all in accordance with logical law, and with no more slips than would be expected of a keyboard adding machine.

Logic can become enormously difficult, and it would undoubtedly be well to produce more assurance in its use. The machines for higher analysis have usually been equation solvers. Ideas are beginning to appear for equation transformers, which will rearrange the relationship expressed by an equation in accordance with strict and rather advanced logic. Progress is inhibited by the exceedingly crude way in which mathematicians express their relationships. They employ a symbolism which grew like Topsy and has little consistency; a strange fact in that most logical field.

A new symbolism, probably positional, must apparently precede the reduction of mathematical transformations to machine processes. Then, on beyond the strict logic of the mathematician, lies the application of logic in everyday affairs. We may some day click off arguments on a machine with the same assurance that we now enter sales on a cash register. But the machine of logic will not look like a cash register, even of the streamlined model.

So much for the manipulation of ideas and their insertion into the record. Thus far we seem to be worse off than before—for we can enormously extend the record; yet even in its present bulk we can hardly consult it. This is a much larger matter than merely the extraction of data for the purposes of scientific research; it involves the entire process by which man profits by his inheritance of acquired knowledge. The prime action of use is selection, and here we are halting indeed. There may be millions of fine thoughts, and the account of the experience on which they are based, all encased within stone walls of acceptable architectural form; but if the scholar can get at only one a week by diligent search, his syntheses are not likely to keep up with the current scene.

Selection, in this broad sense, is a stone adze in the hands of a cabinetmaker. Yet, in a narrow sense and in other areas, something has already been done mechanically on selection. The personnel officer of a factory drops a stack of a few thousand employee cards into a selecting machine, sets a code in accordance with an established convention, and produces in a short time a list of all employees who live in Trenton and know Spanish. Even such devices are much too slow when it comes, for example, to matching a set of fingerprints with one of five million on file. Selection devices of this sort will soon be speeded up from their present rate of reviewing data at a few hundred a minute. By the use of photocells and microfilm they will survey items at the rate of a thousand a second, and will print out duplicates of those selected.

This process, however, is simple selection: it proceeds by examining in turn every one of a large set of items, and by picking out those which have certain specified characteristics. There is another form of selection best illustrated by the automatic telephone exchange. You dial a number and the machine selects and connects just one of a million possible stations. It does not run over them all. It pays attention only to a class given by a first digit, then only to a subclass of this given by the second digit, and so on; and thus proceeds rapidly and almost unerringly to the selected station. It requires a few seconds to make the selection, although the process could be speeded up if increased speed were economically warranted. If necessary, it could be made extremely fast by substituting thermionic-tube switching for me-

chanical switching, so that the full selection could be made in one one-hundredth of a second. No one would wish to spend the money necessary to make this change in the telephone system, but the general idea is applicable elsewhere.

Take the prosaic problem of the great department store. Every time a charge sale is made, there are a number of things to be done. The inventory needs to be revised, the salesman needs to be given credit for the sale, the general accounts need an entry, and, most important, the customer needs to be charged. A central records device has been developed in which much of this work is done conveniently. The salesman places on a stand the customer's identification card, his own card, and the card taken from the article sold—all punched cards. When he pulls a lever, contacts are made through the holes, machinery at a central point makes the necessary computations and entries, and the proper receipt is printed for the salesman to pass to the customer.

But there may be ten thousand charge customers doing business with the store, and before the full operation can be completed someone has to select the right card and insert it at the central office. Now rapid selection can slide just the proper card into position in an instant or two, and return it afterward. Another difficulty occurs, however. Someone must read a total on the card, so that the machine can add its computed item to it. Conceivably the cards might be of the dry photography type I have described. Existing totals could then be read by photocell, and the new total entered by an electron beam.

The cards may be in miniature, so that they occupy little space. They must move quickly. They need not be transferred far, but merely into position so that the photocell and recorder can operate on them. Positional dots can enter the data. At the end of the month a machine can readily be made to read these and to print an ordinary bill. With tube selection, in which no mechanical parts are involved in the switches, little time need be occupied in bringing the correct card into use—a second should suffice for the entire operation. The whole record on the card may be made by magnetic dots on a steel sheet if desired, instead of dots to be observed optically, following the scheme by which Poulsen long ago put speech on a magnetic wire. This method has the advantage of simplicity and ease of erasure. By using photography, however one can arrange to project the record in enlarged form and at a distance by using the process common in television equipment.

One can consider rapid selection of this form, and distant projection for other purposes. To be able to key one sheet of a million before an operator in a second or two, with the possibility of then adding notes thereto, is suggestive in many ways. It might even be of use in libraries, but that is another story. At any rate, there are now

some interesting combinations possible. One might, for example, speak to a microphone, in the manner described in connection with the speech controlled typewriter, and thus make his selections. It would certainly beat the usual file clerk.

6

The real heart of the matter of selection, however, goes deeper than a lag in the adoption of mechanisms by libraries, or a lack of development of devices for their use. Our ineptitude in getting at the record is largely caused by the artificiality of systems of indexing. When data of any sort are placed in storage, they are filed alphabetically or numerically, and information is found (when it is) by tracing it down from subclass to subclass. It can be in only one place, unless duplicates are used; one has to have rules as to which path will locate it, and the rules are cumbersome. Having found one item, moreover, one has to emerge from the system and re-enter on a new path.

The human mind does not work that way. It operates by association. With one item in its grasp, it snaps instantly to the next that is suggested by the association of thoughts, in accordance with some intricate web of trails carried by the cells of the brain. It has other characteristics, of course; trails that are not frequently followed are prone to fade, items are not fully permanent, memory is transitory. Yet the speed of action, the intricacy of trails, the detail of mental pictures, is awe-inspiring beyond all else in nature.

Man cannot hope fully to duplicate this mental process artificially, but he certainly ought to be able to learn from it. In minor ways he may even improve, for his records have relative permanency. The first idea, however, to be drawn from the analogy concerns selection. Selection by association, rather than indexing, may yet be mechanized. One cannot hope thus to equal the speed and flexibility with which the mind follows an associative trail, but it should be possible to beat the mind decisively in regard to the permanence and clarity of the items resurrected from storage.

Consider a future device for individual use, which is a sort of mechanized private file and library. It needs a name, and, to coin one at random, “memex” will do. A memex is a device in which an individual stores all his books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility. It is an enlarged intimate supplement to his memory.

It consists of a desk, and while it can presumably be operated from a distance, it is primarily the piece of furniture at which he works. On the top are slanting translucent screens, on which material can be projected for convenient reading. There is a

keyboard, and sets of buttons and levers. Otherwise it looks like an ordinary desk.

In one end is the stored material. The matter of bulk is well taken care of by improved microfilm. Only a small part of the interior of the memex is devoted to storage, the rest to mechanism. Yet if the user inserted 5000 pages of material a day it would take him hundreds of years to fill the repository, so he can be profligate and enter material freely.

Most of the memex contents are purchased on microfilm ready for insertion. Books of all sorts, pictures, current periodicals, newspapers, are thus obtained and dropped into place. Business correspondence takes the same path. And there is provision for direct entry. On the top of the memex is a transparent platen. On this are placed longhand notes, photographs, memoranda, all sorts of things. When one is in place, the depression of a lever causes it to be photographed onto the next blank space in a section of the memex film, dry photography being employed.

There is, of course, provision for consultation of the record by the usual scheme of indexing. If the user wishes to consult a certain book, he taps its code on the keyboard, and the title page of the book promptly appears before him, projected onto one of his viewing positions. Frequently-used codes are mnemonic, so that he seldom consults his code book; but when he does, a single tap of a key projects it for his use. Moreover, he has supplemental levers. On deflecting one of these levers to the right he runs through the book before him, each page in turn being projected at a speed which just allows a recognizing glance at each. If he deflects it further to the right, he steps through the book 10 pages at a time; still further at 100 pages at a time. Deflection to the left gives him the same control backwards.

A special button transfers him immediately to the first page of the index. Any given book of his library can thus be called up and consulted with far greater facility than if it were taken from a shelf. As he has several projection positions, he can leave one item in position while he calls up another. He can add marginal notes and comments, taking advantage of one possible type of dry photography, and it could even be arranged so that he can do this by a stylus scheme, such as is now employed in the telautograph seen in railroad waiting rooms, just as though he had the physical page before him.

7

All this is conventional, except for the projection forward of present-day mechanisms and gadgetry. It affords an immediate step, however, to associative indexing, the basic idea of which is a provision whereby any item may be caused at will to

select immediately and automatically another. This is the essential feature of the memex. The process of tying two items together is the important thing.

When the user is building a trail, he names it, inserts the name in his code book, and taps it out on his keyboard. Before him are the two items to be joined, projected onto adjacent viewing positions. At the bottom of each there are a number of blank code spaces, and a pointer is set to indicate one of these on each item. The user taps a single key, and the items are permanently joined. In each code space appears the code word. Out of view, but also in the code space, is inserted a set of dots for photocell viewing; and on each item these dots by their positions designate the index number of the other item.

Thereafter, at any time, when one of these items is in view, the other can be instantly recalled merely by tapping a button below the corresponding code space. Moreover, when numerous items have been thus joined together to form a trail, they can be reviewed in turn, rapidly or slowly, by deflecting a lever like that used for turning the pages of a book. It is exactly as though the physical items had been gathered together from widely separated sources and bound together to form a new book. It is more than this, for any item can be joined into numerous trails.

The owner of the memex, let us say, is interested in the origin and properties of the bow and arrow. Specifically he is studying why the short Turkish bow was apparently superior to the English long bow in the skirmishes of the Crusades. He has dozens of possibly pertinent books and articles in his memex. First he runs through an encyclopedia, finds an interesting but sketchy article, leaves it projected. Next, in a history, he finds another pertinent item, and ties the two together. Thus he goes, building a trail of many items. Occasionally he inserts a comment of his own, either linking it into the main trail or joining it by a side trail to a particular item. When it becomes evident that the elastic properties of available materials had a great deal to do with the bow, he branches off on a side trail which takes him through textbooks on elasticity and tables of physical constants. He inserts a page of longhand analysis of his own. Thus he builds a trail of his interest through the maze of materials available to him.

And his trails do not fade. Several years later, his talk with a friend turns to the queer ways in which a people resist innovations, even of vital interest. He has an example, in the fact that the outraged Europeans still failed to adopt the Turkish bow. In fact he has a trail on it. A touch brings up the code book. Tapping a few keys projects the head of the trail. A lever runs through it at will, stopping at interesting items, going off on side excursions. It is an interesting trail, pertinent to the discussion. So he sets a reproducer in action, photographs the whole trail out, and passes it

to his friend for insertion in his own memex, there to be linked into the more general trail.

8

Wholly new forms of encyclopedias will appear, ready made with a mesh of associative trails running through them, ready to be dropped into the memex and there amplified. The lawyer has at his touch the associated opinions and decisions of his whole experience, and of the experience of friends and authorities. The patent attorney has on call the millions of issued patents, with familiar trails to every point of his client's interest. The physician, puzzled by a patient's reactions, strikes the trail established in studying an earlier similar case, and runs rapidly through analogous case histories, with side references to the classics for the pertinent anatomy and histology. The chemist, struggling with the synthesis of an organic compound, has all the chemical literature before him in his laboratory, with trails following the analogies of compounds, and side trails to their physical and chemical behavior.

The historian, with a vast chronological account of a people, parallels it with a skip trail which stops only on the salient items, and can follow at any time contemporary trails which lead him all over civilization at a particular epoch. There is a new profession of trail blazers, those who find delight in the task of establishing useful trails through the enormous mass of the common record. The inheritance from the master becomes, not only his additions to the world's record, but for his disciples the entire scaffolding by which they were erected.

Thus science may implement the ways in which man produces, stores, and consults the record of the race. It might be striking to outline the instrumentalities of the future more spectacularly, rather than to stick closely to methods and elements now known and undergoing rapid development, as has been done here. Technical difficulties of all sorts have been ignored, certainly, but also ignored are means as yet unknown which may come any day to accelerate technical progress as violently as did the advent of the thermionic tube. In order that the picture may not be too commonplace, by reason of sticking to present-day patterns, it may be well to mention one such possibility, not to prophesy but merely to suggest, for prophecy based on extension of the known has substance, while prophecy founded on the unknown is only a doubly involved guess.

All our steps in creating or absorbing material of the record proceed through one of the senses—the tactile when we touch keys, the oral when we speak or listen, the visual when we read. Is it not possible that some day the path may be established more directly?

We know that when the eye sees, all the consequent information is transmitted to the brain by means of electrical vibrations in the channel of the optic nerve. This is an exact analogy with the electrical vibrations which occur in the cable of a television set: they convey the picture from the photocells which see it to the radio transmitter from which it is broadcast. We know further that if we can approach that cable with the proper instruments, we do not need to touch it; we can pick up those vibrations by electrical induction and thus discover and reproduce the scene which is being transmitted, just as a telephone wire may be tapped for its message.

The impulses which flow in the arm nerves of a typist convey to her fingers the translated information which reaches her eye or ear, in order that the fingers may be caused to strike the proper keys. Might not these currents be intercepted, either in the original form in which information is conveyed to the brain, or in the marvelously metamorphosed form in which they then proceed to the hand?

By bone conduction we already introduce sounds: into the nerve channels of the deaf in order that they may hear. Is it not possible that we may learn to introduce them without the present cumbersomeness of first transforming electrical vibrations to mechanical ones, which the human mechanism promptly transforms back to the electrical form? With a couple of electrodes on the skull the encephalograph now produces pen-and-ink traces which bear some relation to the electrical phenomena going on in the brain itself. True, the record is unintelligible, except as it points out certain gross misfunctioning of the cerebral mechanism; but who would now place bounds on where such a thing may lead?

In the outside world, all forms of intelligence whether of sound or sight, have been reduced to the form of varying currents in an electric circuit in order that they may be transmitted. Inside the human frame exactly the same sort of process occurs. Must we always transform to mechanical movements in order to proceed from one electrical phenomenon to another? It is a suggestive thought, but it hardly warrants prediction without losing touch with reality and immediateness.

Presumably man's spirit should be elevated if he can better review his shady past and analyze more completely and objectively his present problems. He has built a civilization so complex that he needs to mechanize his records more fully if he is to push his experiment to its logical conclusion and not merely become bogged down part way there by overtaxing his limited memory. His excursions may be more enjoyable if he can reacquire the privilege of forgetting the manifold things he does not need to have immediately at hand, with some assurance that he can find them again if they prove important.

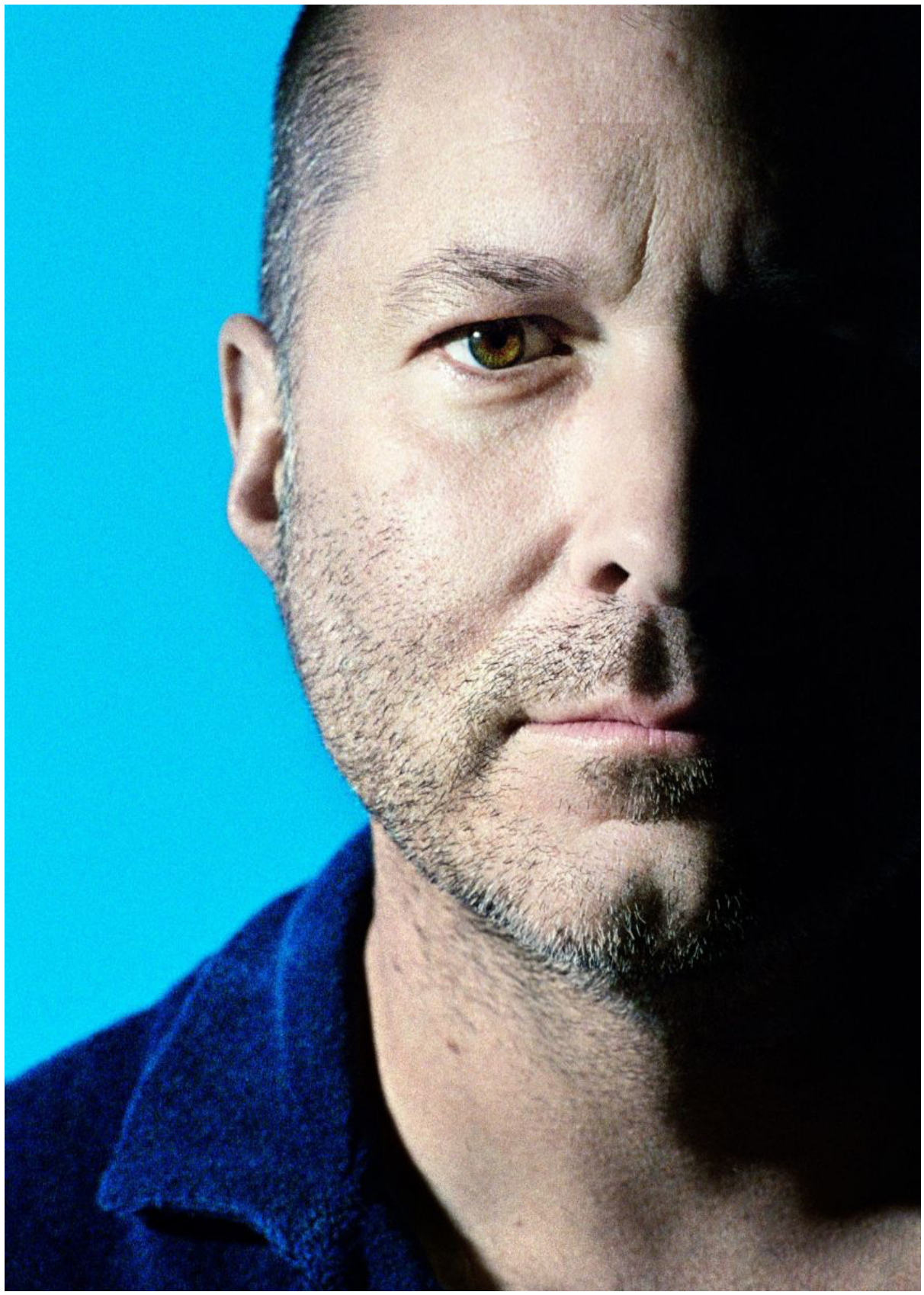
The applications of science have built man a well-supplied house, and are teaching him to live healthily therein. They have enabled him to throw masses of people against one another with cruel weapons. They may yet allow him truly to encompass the great record and to grow in the wisdom of race experience. He may perish in conflict before he learns to wield that record for his true good. Yet, in the application of science to the needs and desires of man, it would seem to be a singularly unfortunate stage at which to terminate the process, or to lose hope as to the outcome.

The Shape of Things to Come

Ian Parker, The New Yorker Feb 23, 2015 Issue

I. Launch Day

In recent months, Sir Jonathan Ive, the forty-seven-year-old senior vice-president of design at Apple—who used to play rugby in secondary school, and still has a bench-pressing bulk that he carries a little sheepishly, as if it belonged to someone else—has described himself as both “deeply, deeply tired” and “always anxious.”



When he sits down, on an aluminum stool in Apple’s design studio, or in the cream leather back seat of his Bentley Mulsanne, a car for a head of state, he is likely to emit a soft, half-ironic groan. His manner suggests the burden of being fully appre-

ciated. There were times, during the past two decades, when he considered leaving Apple, but he stayed, becoming an intimate friend of Steve Jobs and establishing the build and the finish of the iMac, the MacBook, the iPod, the iPhone, and the iPad. He is now one of the two most powerful people in the world's most valuable company. He sometimes listens to CNBC Radio on his hour-long commute from San Francisco to Apple's offices, in Silicon Valley, but he's uncomfortable knowing that a hundred thousand Apple employees rely on his decision-making—his taste—and that a sudden announcement of his retirement would ambush Apple shareholders. (To take a number: a ten-percent drop in Apple's valuation represents seventy-one billion dollars.) According to Laurene Powell Jobs, Steve Jobs's widow, who is close to Ive and his family, "Jony's an artist with an artist's temperament, and he'd be the first to tell you artists aren't supposed to be responsible for this kind of thing."

One morning in September, Ive was talking with a few friends, including Chris Martin, of Coldplay, and Stephen Fry, the British actor and writer, in a courtyard beside a community-college hall, a few miles from Apple's headquarters, in Cupertino. He wore pale, wide pants, cut as if for a chef, and tan suède Clarks shoes, and his hair was cropped. He was maintaining a look captured in a Playmobil figure of him, which his design colleagues made as a Christmas present a few years ago. The seven-inch Ive had on sunglasses and carried an off-white Valextra briefcase. A photograph of the gift is the lock-screen image on Ive's iPhone.

Ive was brushing his hand across the top of his head, and talking quietly. He is impeccably solicitous, with frowns of attention and apologies for lateness or workplace untidiness, and he seems to extend this tone to everyone—including, presumably, to the crew of his twenty-seat Gulfstream GV, which he bought from Powell Jobs after her husband's death, in 2011. He communicates with his friend Paul Smith, the British fashion designer, largely through postcards that, as Smith recently recalled, contain "words like 'lovely,' 'special,' 'so nice'—a language that is particular to his gentleness."

Later that morning, Apple was announcing new products and services, at the kind of event that the company, like a fashion house, stages a few times a year. Of a thousand attendees expected, a few dozen had been invited to the backstage courtyard. Among the guests were Rupert Murdoch; Kevin Durant, of the Oklahoma City Thunder; Marissa Mayer, of Yahoo; Jimmy Iovine, the C.E.O. of Beats; and the rapper and entrepreneur Sean Combs. (Fry later referred, fondly, to "Snoop Seany Sean," who was gracious when Fry nearly soaked him with a spilled drink.) That day, a hundred assembly lines in Zhengzhou, China, were turning out still secret new iPhones at a reported rate of seventy-five hundred an hour, and rumors about new Apple products, including a watch, were being posted online at nearly the same pace.

Tim Cook, Apple's C.E.O., was somewhere nearby, preparing to speak to a hall full of enthusiasts and reporters, and to millions online. But Ive's role was limited largely to drinking coffee in misty sunshine. Jobs excused Ive from most public-speaking duties, and he has held on to the dispensation.

"I'm shy," Ive said. His London accent is intact after more than twenty years away. "I'm always focussed on the actual work, and I think that's a much more succinct way to describe what you care about than any speech I could ever make." He sounded calm, but he was fidgeting with his hands, as if trying to flick gum from his fingertips.

Behind Ive, at a distance that suggested self-exile, was Steve Wozniak, who, in 1976, co-founded Apple with Jobs, and who was wearing a black steam-punk watch the size of an ashtray. ("What is that?" Ive later asked, rhetorically, in mock affront at its design.) A colleague told Ive that, overnight, people had formed lines outside Apple stores, wrongly assuming that new devices would become available that day. Ive recalled the first time he encountered a long queue: his parents took him to the Tutankhamun exhibition at the British Museum when he was five.

The day's event included a ten-minute film. Ive's reluctance to speak onstage has been offset by a willingness to appear in scripted videos. These productions—Ive speaking in earnest cadences, his head cocked forward like Pixar's Anglepoise lamp—have become so well known that ikea recently parodied them, in an ad for its catalogue ("a device so simple and intuitive, using it feels almost familiar"). Such videos used to punctuate Jobs's onstage message. In the absence of Jobs, they carry the message. Apple's current leaders aren't without public-speaking skills, but they can't match Jobs's charisma, which was fortified by a hint of menace, and their performances can evoke the awkward informality—the dancing in lanyards—of a corporate retreat. By contrast, the virtual Ive seems to emerge from the same orderly, decontaminated place as an Apple product. He appears "rational" and "inevitable," to use the typical language. On Apple's Web page of executive biographies, fourteen men and women give welcoming smiles; Ive, the in-house outsider, faces the camera with album-cover gravity.

The new film did not show Ive's face, but he had narrated it, and largely directed and edited it. This work was done in Apple's design studio, which has a core team of nineteen industrial designers whose public recognition—even as their work has become unavoidable—has rarely extended beyond mentions in patent filings and affidavits. In a company with inexhaustible marketing resources, Ive's authorship of the film suggested fastidiousness about the seductive display of his work. But it was also an assertion of ownership that Jobs himself might have appreciated. Ap-

ple's designers have long had an influence in the company which is barely imaginable to most designers elsewhere. This power "was anointed to them by Steve, and enforced by Steve, and has become embedded culturally," in the description of Robert Brunner, who gave Ive his first job at Apple, and ran Apple's design group in the first half of the nineteen-nineties, before this culture took hold. Jeremy Kuempel, an engineer who interned at the company a few years ago, and has since launched a coffee-machine startup, told me that when a designer joined a meeting at Apple it was "like being in church when the priest walks in." Now, Brunner believes, "Jony has assumed the creative soul of the company."

J. J. Abrams, the filmmaker and showrunner, is a friend of Ive's, but he could not attend the September launch, because he was shooting "Star Wars: The Force Awakens," in London. He later told me that Ive had shared some of the company's news in advance, and that they had discussed "the fact that we were both working on things that had a level of expectation and anticipation that was preposterous." If Ive has learned to cope with pre-launch media fuss—snatched photographs of components, mockups of imagined goods—Abrams seems to relish it. As the event in California unfolded, he posted an image to Twitter using the hashtag #AppleWatch: a handwritten card ("Why do I suddenly have this desperate need to own a watch? Damn you, Apple!!!") lying on a polished surface that seemed to offer the first glimpse of the interior of a new Death Star.

At my first meeting with Ive, a few weeks earlier, he had worn a Jaeger-LeCoultre watch that he and an old friend, Marc Newson, the Australian-born designer, had customized for an auction benefitting Project Red, the charitable organization co-founded by Bono; they made three watches and kept one each; the third sold for three hundred and sixty thousand dollars. But now, in the courtyard of multimillionaires, Ive had a bare wrist, and it would remain so for a few more hours. He spoke of soon arriving at "this rarest of times—when we're done, and we get to talk about it." He added, "It's pretty strange. Where we're standing, right now, we haven't talked about it, and we can stand here in a couple of hours, and millions and millions of people will know." He went on, "You go from something that you feel very protective of, and you feel great ownership of, and suddenly it's not yours anymore, and it's everybody else's. And it's a very—I think the word 'traumatic' is probably overstated, but it's a really significant point in time." He smiled. "These are very poignant points in time. It's so digital. It's so binary."

Newson had come to the gathering, and for a while Ive whispered affectionately with him and Powell Jobs. Before going indoors, Ive greeted Powell Jobs's twenty-three-year-old son, Reed, whose collar-length hair underscored his resemblance to his father at the same age. Ive held him in a hug, and exhaled: "Ahh!"

Inside the hall, Ive took a front-row seat, with Marc Newson on his left and Chris Martin on his right. Tim Cook came onstage. The audience applauded two redesigned iPhones and a new touchless payment system, which was introduced with a film that—like infomercials showing people in catastrophic interactions with Tupperware or garden hoses—may have overplayed the difficulty of taking a credit card from one's pocket. Then Cook borrowed a phrase of his predecessor's: "One more thing." Before long, jewelry was tumbling through white space, and Ive was talking about "beautiful objects that are as simple and pure as they are functional."

II. The Studio

One morning at Apple's headquarters, a few weeks earlier, Ive recalled how, in 1997, the company seemed to be dying around him. "Every story you'd read, every morning before coming to work, started with the phrase 'The beleaguered computer maker, Apple,' " he said. Ive was then thirty; after five years at the company, he had become its head of industrial design. "There was a Wired cover that had a big Apple logo with a crown of barbed wire, as thorns, and underneath it just said, 'PRAY.' I remember this because of how upsetting it was. Basically saying: either it's going to just go out of business or be bought."

The Wired article appeared that June. The next month, Jobs, who had left Apple twelve years earlier, and gone on to launch Pixar and NeXT, returned as Apple's C.E.O., supplanting Gilbert Amelio. Jobs and Ive had an intense first meeting. Ive said, "I can't really remember that happening really ever before, meeting somebody when it's just like that"—he snapped his fingers. "It was the most bizarre thing, where we were both perhaps a little—a little bit odd. We weren't used to clicking."

Assuming the worst, Ive had a resignation letter in his pocket. Indeed, Jobs's initial instinct had been to hire a new designer. He had approached Richard Sapper, who designed I.B.M.'s ThinkPad—a black cigar box. (Sapper was tempted, he told me, a little ruefully, but didn't want to abandon his I.B.M. contract for a "tiny, tiny company.") Jobs had also met with Hartmut Esslinger, who, as a consultant, was Apple's industrial designer in the eighties. Esslinger, in an e-mail, recalled telling Jobs that Apple's existing team, including Ive, "was very talented and competent if given the right leadership." Esslinger, who has more design-guru swagger than Ive, also takes some credit for what happened next: he said that he encouraged Jobs to refocus the company on "evolving digital-consumer trends."

Jobs visited the design studio and, as Ive recalled it, said, "Fuck, you've not been very effective, have you?" This was a partial compliment. Jobs could see that the studio's

work had value, even if Ive could be faulted for not communicating its worth to the company. During the visit, Ive said, Jobs "became more and more confident, and got really excited about our ability to work together." That day, according to Ive, they started collaborating on what became the iMac. Soon afterward, Apple launched its "Think Different" campaign, and Ive took it as a reminder of the importance of "not being apologetic, not defining a way of being in response to what Dell just did." He went on, "My intuition's good, but my ability to articulate what I feel was not very good—and remains not very good, frustratingly. And that's what's hard, with Steve not being here now." (At Jobs's memorial, Ive called him "my closest and my most loyal friend.")

Ive was sitting in a corner of Apple's first-floor industrial-design studio, in front of a translucent window that gave a view only of the nodding shadows of tree branches. Steve Jobs's top-floor corner office, untouched since his death, is one link away, in the campus's ring of six banal four-story buildings, arranged around a lawn. The campus, on a street named Infinite Loop, was built in the early nineteen-nineties. A covered corridor connects One Infinite Loop (Jobs's office) and Two Infinite Loop (Ive's lab). Just before Ive took me into the studio for the first time, he remarked that all the buildings were similarly linked. A colleague corrected him: this was true only of One and Two. Ive said, "Really?" The error suggested something about the design studio's place in the Apple universe. It also suggested that the layout of a new campus currently being built nearby—a ring-shaped low-rise with a diameter of sixteen hundred feet—might have a largely symbolic connection to workplace togetherness.

An invitation to visit Apple's studio is rare, and is withheld even from most employees. Inside the door, a ten-foot-long internal vestibule, in stainless steel, serves as a visual air lock. One's view is largely restricted to the desk of Harper Alexander, an office manager, who—in a corporate culture ruled by reticence—has an unusually lively Twitter presence. ("Playing counting crows and hootie in the Apple design studio. Everyone in here who loves Euro douchepop just literally died.")

That morning, the douchepop—a mix that included Yaz and The Rapture—was set at low volume, as were the employees, who spoke in murmurs and moved silently on sneakered feet. Later that day, I met Eugene Whang, one of the designers; he referred to a second career as a d.j. and a music promoter, and noted that we were listening to a set that he and a friend had performed at Le Bain, in the Standard Hotel, in New York's meatpacking district. (It is not enough to have co-created the iPhone.) Whang and his colleagues—they include an Austrian-born surfer, Julian Hönig, who used to design Lamborghinis—tend to be as low-key as their boss, and their fame extends barely beyond the studio door. But their multinationalism, and their lives of individual affluence and shared reputation, would be familiar to soccer players on

Europe's grandest teams. Apple employs three recruiters whose sole task is to identify designers to join the group; they find perhaps one a year. Not long ago, Whang posted online a photograph of a handsome white helicopter, captioned, "The new Mori City Air Service from Narita to Tokyo is amazing. 30 mins total travel time. It's pricey, but sometimes definitely worth it. The Hermès edition is upholstered in their classic canvas, with leather trim details and calf leather seats."

Ive, wearing a royal-blue T-shirt, was affable, but there was little trace of English irony. "I think you can reserve that for entertainment," he later said. "And not practice that professionally." In our conversations, his manner could sometimes be unsettling for the way it combined the tender attentiveness of a suicide-prevention volunteer—"I was ever so lucky"; "I do hope you have a good flight"—with a keenness to move the conversation from the particular to the general; his replies, searching for the safe ground of a previously expressed thought, often looped and hedged, or drifted off into a sigh. At first attempt, Ive ran through the first twenty-five years of his life in sixty words; he told me which novel he was reading only after designating the answer off the record.

That morning, Ive told me that, before Jobs replaced Amelio, the studio's work on an iMac-like device "was of no interest to the company." The comment was surprising: Ive tends to be strenuously courteous toward his employers. (In a 1997 book, he was quoted saying, "Gilbert Amelio gives more support to industrial design than any C.E.O. in Apple's history." He also said, "For a designer, there couldn't be a more exciting place to work at this moment than Apple.") His public persona is not merely evidence of corporate fealty; he has a serious man's resistance to perceived trivia, and a genuine discomfort with self-exposure. Yet the effect is the same: in Ive's view, his personal story is barely worth telling. This habit of rhetorical modesty has lately been complicated by an immodest business truth: more than ever, Ive is the company.

After passing through the vestibule, Ive said, "I can't emphasize enough: I think there's something really very special about how practical we are. And you could, depending on your vantage point, describe it perhaps as old-school and traditional, or you could describe it as very effective." To our left was an open kitchen with tables and benches, a vintage Faema espresso machine, and a wall of books that included "100 Superlative Rolex Watches" and a study of Joe Colombo, the designer best known for his round-cornered Kartell storage carts. The kitchen flowed into an area of individual workstations. To our right was a brightly lit room where a dozen oak worktables stood, in tidy formation, on a polished-concrete floor.

The room is about three thousand square feet, though its outsized reputation has

led it to be described as “cavernous.” It ends in a glass wall, behind which stand three eight-foot-high computer-numerical-control (C.N.C.) milling machines that shape plastic and metal to produce models and prototype parts. When Ive designed the space, at the turn of the century, he wanted these machines to be as integrated into the studio as noise and dust pollution allowed. “They make physical objects, and that is what we’re doing,” he told me. Milling machines help turn a studio into a workshop; they reinforce Ive’s view that bad industrial design often starts in ignorance of what a material can and cannot do.

The worktables are higher than a desk but a little lower than the Apple Store tables they inspired. This height—arrived at after much reflection—accommodates seated study and standing visits. (Risking self-parody, Ive later referred to the “simplicity and modesty” of the arrangement.) Samsung Electronics sells vacuum cleaners as well as phones, and employs a thousand designers. Apple’s intentions can be revealed in one room. Each table serves a single product, or product part, or product concept; some of these objects are scheduled for manufacture; others might come to market in three or five years, or never. “A table can get crowded with a lot of different ideas, maybe problem-solving for one particular feature,” Hönig, the former Lamborghini designer, later told me. Then, one day, all the clutter is gone. He laughed: “It’s just the winner, basically. What we collectively decided is the best.” The designers spend much of their time handling models and materials, sometimes alongside visiting Apple engineers. Jobs used to come by almost every day. Had I somehow intruded an hour earlier, I would have seen an exhibition of the likely future. Now all but a few tables were covered in sheets of gray silk, and I knew only that that future would be no taller than an electric kettle.

The cloth covering the table nearest the door was curiously flat. “This is actually complicated,” Ive said, feeling through the material. “This will make sense later. I’m not messing with you at all, I promise.”

In an environment of dust sheets and undecorated walls, a bag of Whole Foods nuts, on a shelf, makes a loud claim for attention. But the room’s minimalism derives from nondisclosure more than from dogma. Ive’s aesthetic is not austere: one could think of the work done here as a reticent man’s idea of exuberance, with rapture expressed in the magnetic click of a power adapter. Richard Seymour, a British designer who has known Ive for years, recently referred to his friend’s “emotionally warm modernism.” Clive Grinyer, a friend and former London colleague of Ive’s, said, appreciatively, “He’s always been a bit bling.” Paola Antonelli, the senior curator of design and architecture at MoMA, who has added many Apple products to the museum’s collection, praised an innovation that indicated when a closed laptop was in “sleep” mode: a light glowed on and off twelve times a minute, like a restful per-

son breathing. “Jony knows that I was transfixed,” she said. “They had to abandon it because it kept people awake when it was on the bedside table.” (Apple disputed this explanation.) “It was round and pulsating and it was just amazing.”

A door briefly opened, and I saw flashes of color pinned to a wall. (This, Ive later explained, was the conference room where the Apple Watch film was being storyboarded.) Then we stopped in Ive’s office, a twelve-foot square separated from the studio by a glass wall. On shelves, Ive had set his Playmobil likeness and similar gifts, along with dozens of custom sketchbooks that had padded blue covers and silver edging. On the floor, behind a Marc Newson desk, was a rugby ball. Overlapping framed images leaned against the wall: a Banksy print of the Queen with the face of a chimpanzee, and a poster, well known in design circles, that begins, “Believe in your fucking self. Stay up all fucking night,” and ends, many admonitions later, “Think about all the fucking possibilities.”

That text could be thought of as a supplement to design principles set down by Dieter Rams, the German designer celebrated for pale, clean-lined, Bauhaus-inspired work, largely at Braun. (Ive greatly admires Rams, but his debt to him has sometimes been overstated, and it’s worth noting a difference of manufacturing scale: Rams’s Braun products sold in the thousands, occasionally the millions; Apple has sold one and a half billion things designed by Ive.) In Rams’s formulation, a new object should be innovative, useful, aesthetic, understandable, unobtrusive, honest, long-lasting, thorough, and environmentally friendly, and feature “as little design as possible.” Ive flicked through a sketchbook, giving me time to see that, like Leonardo da Vinci, he sometimes uses brown ink. There was a little drawing of something that may have been a latch and, in tall, skinny script, the words “pretension” and “smart.” On another page—Apple’s competitors may do with this what they like—Ive seemed to have written the word “Airbug.”

Back in the main room, Ive noted that he’d been watching “Moon Machines,” an old Discovery Channel series about the Apollo program. “There was the realization we needed to develop a spacesuit, but it was hard to even know what the goals should be,” he said. And then he linked the studio’s work to nasa’s: like the Apollo program, the creation of Apple products required “invention after invention after invention that you would never be conscious of, but that was necessary to do something that was new.” It was a tic that I came to recognize: self-promotion driven by fear that one’s self-effacement might be taken too literally. Even as Apple objects strive for effortlessness, there’s clearly a hope that the effort required—the “huge degree of care,” the years of investigations into new materials, the months spent enforcing cutting paths in Asian factories—will be acknowledged.

We walked toward a lower table in the corner of the studio. The young computer-design technicians sitting there realized, after a moment's delay, with nothing said, that they were expected to move. We sat on peculiarly low benches, and two of Ive's designers joined us. Jody Akana, who is in her thirties, is unusual in the group for having a declared specialty: color. Bart André is fifty, and tops the list of Apple employees with design patents. (Neither had ever previously spoken to a journalist.) "I watched the spacesuit one last night," Ive told André.

"They play together, they work together, and they protect each other," Robert Brunner, the former Apple design chief, later said of the team. At one of our meetings, Ive reminded me of a short article that Bono wrote about him in Time. It said, "To watch him with his workmates in the holy of holies, Apple's design lab, or on a night out is to observe a very rare esprit de corps. They love their boss, and he loves them. What the competitors don't seem to understand is you cannot get people this smart to work this hard just for money." Ive, Bono's friend, described these comments as "shockingly perceptive"—which is an unusual response to praise, even shared praise. But the strength, and the professional advantage, of the team's solidarity is one of Ive's recurring themes. He was determined to counter "spiteful," if infrequent, claims that the studio's spirit is not as collegial as it looks. Doug Satzger, who left Apple in 2008, and now runs industrial design at Intel, told Fast Company that "Jony has a very political agenda when it comes to his positioning within the company. He would tell me, 'Anytime you meet with Steve, I gotta know.' " (Satzger declined to comment.)

Ive said that, in fifteen years, only two designers have left the studio—one of them because of ill health. He regards this as a clinching argument about harmoniousness. It isn't: many people put up with unhappy workplaces. But even Satzger's public remarks have been largely admiring. It's easy to imagine that the studio's hushed zeal might strike some as claustrophobic and priggish. And it might be unnerving when, in company negotiations, a designer's composed bearing carries steely intent. (Richard Howarth, a veteran Ive lieutenant, soft-spoken and British, is considered "a badass, in terms of driving things," I was told, half-jokingly. "He's feared.") But it's hard to mount a challenge to the consensus that Ive, however vexed and self-conscious, is a good egg. He has the soreness of a man who took all but one vote in a popularity contest.

Team members work twelve hours a day and can't discuss work with friends. Each project has a lead designer, but almost everyone contributes to every project, and shares the credit. (Who had this or that idea? "The team.") Ive describes his role as lying between two extremes of design leadership: he is not the source of all creativity, nor does he merely assess the proposals of colleagues. The big ideas are often

his, and he has an opinion about every detail. Team meetings are held in the kitchen two or three times a week, and Ive encourages candor. “We put the product ahead of anything else,” he said. “Let’s say we’re talking about something that I’ve done that’s ugly and ill-proportioned—because, believe you me, I can pull some beauties out of the old hat. . . . It’s fine, and we all do, and sometimes we do it repeatedly, and we have these seasons of doing it—”

“I had one last week,” Akana said.

“Which one?” he asked.

“The packaging thing,” she said.

“That’s true,” Ive said, laughing. “It was so bad.”

Akana had proposed that an Ultrasuede cloth inside the box for a gold version of the Apple Watch should be an orangey-brown. Ive had objected with comic hyperbole, comparing it to the carpeting in a dismal student apartment. In the same amused spirit, Akana had then asked, “So you don’t like it?”

Jobs’s taste for merciless criticism was notorious; Ive recalled that, years ago, after seeing colleagues crushed, he protested. Jobs replied, “Why would you be vague?,” arguing that ambiguity was a form of selfishness: “You don’t care about how they feel! You’re being vain, you want them to like you.” Ive was furious, but came to agree. “It’s really demeaning to think that, in this deep desire to be liked, you’ve compromised giving clear, unambiguous feedback,” he said. He lamented that there were “so many anecdotes” about Jobs’s acerbity: “His intention, and motivation, wasn’t to be hurtful.”

Even if Jobs had rescued him from vagueness, it was odd for Ive to bring this up now, immediately after I’d learned how to reject a color without causing injury. “I’ve seen Jony deeply frustrated, but I’ve never seen him rant and rave,” Laurene Powell Jobs said, and she added, laughing, that she would not have said the same of her husband. (And it’s hard to imagine Ive using a disabled-parking spot, as Jobs often did, long before he was unwell.) Ive likes to be liked; the story seemed to be a preëmptive defense of Jobs veiled as self-criticism. It was also an indirect response to Walter Isaacson’s 2011 biography of Jobs, which, though not hostile, included examples of unkindness. In a later conversation, Ive said that he’d read only parts of the book, but had seen enough to dislike it, for what he called inaccuracies. “My regard couldn’t be any lower,” he said, with unusual heat.

Ive went off to make some calls, and André described his own routine: he tends to arrive at five or six in the morning, and often then designs geometrically complex objects that he asks the machinists to mill. He called it a hobby, but, as Akana explained, "We'll have a meeting about a speaker-hole pattern, or something, and Jony will say, 'Bart, can you get your box of patterns?' "

André agreed to fetch, from his desk, something that he had been using as a coaster. Made of hard white ABS plastic—the material of Legos, and of thousands of Apple studio models a year—it was a disk punctured by evenly arranged holes. Or, as André put it, "There's a hexagon pattern of negative shapes that are subtracted from the material from one side, and then there's the same pattern, subtracted from the material from the other side. But it's offset, so that the intersection between the two subtractions makes interesting shapes." He rubbed it on his shirt, to remove coffee stains, before passing it to me.

III. Managing Newness

Three years ago, Ive's responsibilities expanded to include software as well as hardware. He took charge of what Apple calls Human Interface: typefaces, icons, swipes, taps. In 2013, the company released the iOS7 operating system for the iPhone and the iPad, and the overhaul included a new range of sounds for incoming calls, texts, and e-mails. Before, the alerts had mostly a strained, jokey relationship with the real world, as suggested by such names as Duck, Choo Choo, and Doorbell. iOS7 introduced refined snatches of electronica created, in part, by Hugo Verweij, a Dutch sound designer who, before being hired by Ive, had a Web site selling "minimalist ringtones." (On his blog, Verweij had expressed bafflement with Apple's "loud and crappy" sounds.) Some Apple customers may have found the new tones unappealing—too modish, or too European—and they may have switched back to the goofy, "classic" sounds that had been relegated to a lower-rung menu. But others may have had the thought, or the half-thought, that the sounds made the phones more coherent—a more natural accompaniment to glass, aluminum, and Helvetica Neue.

Ive manages newness. He helps balance the need to make technological innovations feel approachable, so that they reach a mass market—Choo Choo—with the requirement that they not be ugly and infantile. Apple has made missteps, but the company's great design secret may be avoiding insult. Antonelli, of MoMA, described Apple's design thoughtfulness as "a sign of respect," and added, "Elegance in objects is everybody's right, and it shouldn't cost more than ugliness."

"So much of our manufactured environment testifies to carelessness," Ive said, as he and I were driven, early one evening, from the flat sprawl of Cupertino to a hilltop

in central San Francisco, where he lives in a two-bedroom house with his British wife, Heather, a former arts administrator, and their ten-year-old twin boys, who pronounce "aluminum" in the English way, and have strict rules about screen time. (A few years ago, the Ives bought a nineteen-twenties mansion in Pacific Heights, with striking views, and Ann Getty and Larry Ellison as neighbors. The house is undergoing a seismic renovation. The Ives also own a beach house on the Hawaiian island of Kauai.)

We were in the fast lane of I-280, in squinting low sunshine. When I asked for examples of design carelessness, Ive cranked the conversation back to Apple. He has the discipline to avoid most indiscretions, but not always the facility to disguise the effort. "At the risk of sounding terribly sentimental, I do think one of the things that just compel us is that we have this sense that, in some way, by caring, we're actually serving humanity," he said. "People might think it's a stupid belief, but it's a goal—it's a contribution that we can hope we can make, in some small way, to culture."

Ive acknowledged that he and Marc Newson, who recently joined Apple as a London-based employee, could "incite ourselves to a sort of fever pitch" of design distress; they'll complain about things "developed to a schedule, to a cost," or "developed to be different, not better." He and Newson are car guys, and they feel disappointed with most modern cars; each summer, they attend the Goodwood Festival of Speed, where vintage sports cars are exhibited and raced in the South of England. "There are some shocking cars on the road," Ive said. "One person's car is another person's scenery." To his right was a silver sedan with a jutting lower lip. Ive said, quietly, "For example." As the disgraced car fell behind, I asked Ive to critique its design: "It is baffling, isn't it? It's just nothing, isn't it? It's just insipid." He declined to name the model, muttering, "I don't know, I don't want to offend." (Toyota Echo.)

We were in Ive's black Bentley, which is as demure as a highly conspicuous luxury car can be. The hood barely sloped, and it met the car's front end at a tightly curved corner that mirrored the iPhone 6 in Ive's left hand. We were in the back seat: Ive has reluctantly accepted the services of a driver. Ive said to him, "It's just over a year, isn't it, Jean?"

Ive would prefer an unobserved life, but he likes nice things. He also has an Aston Martin DB4. He acquired his first Bentley, a two-door model, ten years ago, after an inner zigzag between doubt and self-justification. "I've always loved the big old-school square Bentleys," he said. "The reasons are entirely design-based. But because of the other connotations I resisted and resisted, and then I thought, This is the most bizarre vanity, because I'm concerned that people will perceive me to be this way—I'm not. So I'm going to—" A pause. "And so I am uncomfortable about it." Jeff

Williams, Apple's senior vice-president of operations, drives an old Toyota Camry. Ive's verdict, according to Williams, is "Oh, God."

The view from the Bentley was of dry, yellow fields. "Isn't this beautiful?" Ive said. "Long shadows, and the sun just tripping over the tops of the trees." He spoke of landscapes in Marin County, north of San Francisco, that evoke the southwest of England: "Like Devon, some of it, isn't it? Cornwall. Exmoor."

Ive's parents now live in that part of England, and Ive, too, once had a house there, but he grew up in Chingford, in London's middle-class northeastern suburbs. There was a Rams-designed Braun MPZ 2 Citromatic juicer in the kitchen. "No part appeared to be either hidden or celebrated," he later wrote. He was exposed early to tools. "I was so incredibly lucky to grow up in the context of workshops," he told me. He acquired "a natural understanding that everything here"—highways, bridges, Toyotas—"is made, and is the consequence of multiple decisions." His roots are working class: his paternal grandfather and great-grandfather were skilled metalworkers. His father, Michael, now retired, was a secondary-school teacher of design and technology, and then a government adviser on design education. Ive's mother was a theology teacher and, later, a therapist; his younger sister became a consultant for nonprofits in London. Marc Newson sees an economic similarity between Ive's upbringing and his own. "Neither of us came from particularly privileged backgrounds," he said, when we met. "A lot of what I've done has been an effort to try to have the things that I didn't own when I was a child." Newson was carrying a six-thousand-dollar Louis Vuitton backpack, of his own design. Ive, the owner of a jet, was twenty-one before he experienced air travel.

Michael Ive said that the scale of his son's talent manifested itself in childhood. He recalled an ingenious obstacle course, in wood and cardboard, for a pet hamster, and a drawing of a scuba diver that was "so accurate in its perspective, with an astonishing sense of movement." When Jonathan was thirteen, the family moved to Stafford, in the Midlands. At this age, Ive said, he was nicknamed Tiny, because "I was as big as I am now." He was selected to play rugby for his county. When necessary, he has been able to access aggression. "You don't play politely," Ive later explained, laughing. "But you play as a team, and if you don't play hard your team's going to get hurt." At school, he met Heather Pegg, his future wife, and wore his hair in a post-punk mullet.

In 1985, Ive began studying industrial design at Newcastle Polytechnic (now Northumbria University). He had the profound experience of using a Mac for the first time: "I had a sense of the values of the people who made it." He had two half-year internships at a London design firm, and his adeptness was embarrassingly evi-

dent: according to Clive Grinyer, who met him in that office, Ive was given some of the company's most important work. Grinyer recalled visiting Ive in Newcastle: "I stayed the night in his living room, surrounded by hundreds of foam models—all white, of course. There was that little tiny difference between each one." He called Ive "the most focussed human being I've come across." This is also Ive's description of Jobs.

Ive told me that, since childhood, he has been "consumed with work." It's unrewarding to question him about the movies, books, and night clubs of his youth, although at some point he acquired an abiding taste for dance music, and he has since become friends with John Digweed, the British d.j., and the members of Massive Attack. (He is also a friend of Yo-Yo Ma.) In the summer of 1987, midway through college, he married Heather, who was studying English literature at Newcastle University.

He won a national student design competition two years running, once for a white desk phone that had a handset with a long handle, like a lorgnette. He pooled two travel scholarships and, in the summer of 1989, after he had received the highest category of degree, he travelled in the United States. Robert Brunner had recently founded a design consultancy, Lunar, in San Francisco. He wanted to hire Ive moments after meeting him: Ive was "a sweet, enthusiastic guy," and his portfolio was extraordinary, in part because "he had figured it all out." Although people may think of industrial design "as the concept and renderings and models and all the creative stuff," Brunner said, it's ultimately about "delivering something." Ive had brought a model of his desk phone, which he took apart to show how the internal components coexisted. The model's outer casing was the exact thickness that it would be in a finished phone. "You never see that from a student," Brunner said.

Ive could not move to California; he had already committed to work at the company where he had interned. A little later, he became the third partner in Tangerine, a London design consultancy co-founded by Grinyer. His projects included a long-toothed barber's comb embedded with a level, for cutting flattops. "I think I'm just a dreadful businessperson," Ive said, on our drive: a consultant is forever hustling for new work, and can never have the same impact on a company's design direction as an in-house practitioner. And the work may feel purposeless: as Ive had put it, "I don't think the world needs another microwave oven."

In the early nineties, near the end of his time at Tangerine, Ive worked with two key clients. Ideal Standard, a British bathroom-ceramics manufacturer, commissioned a sink, a toilet, and a bath. In the Bentley, Ive drew the sink in my notebook: a half-oval atop a column that, as it tapered down, angled away from the wall. "It was a

very, very simple bowl, and the rim was thick but it twisted," he said. "It was sort of tipped open at the front."

Ive also designed a tablet computer. In 1989, Brunner had joined Apple, to lead its design team; by 1991, the company was close to releasing its first laptop, the PowerBook 100. In a commission whose true purpose was to persuade Ive to take a job at Apple, Brunner asked Tangerine to explore other concepts in mobile computing.

Ive visited the headquarters of Ideal Standard and Apple, and recognized the contrast in his tasks. In the case of the sink, "the form wasn't following the function," he told me. "The form was the function. It functioned as a washbasin because of the shape." Ive made this sound equally restricting and ennobling. "You had a real sense of your grounding in ancient history," he said. "There was such a purity to the problem."

At Apple, "the products were incredibly complex, and you realized that you had this dizzying liberty," he said. "Of course, you were trying to figure out an architecture, and form, that addressed certain issues of function." But an Apple product could take many different shapes, some of which would be "completely unhelpful in helping you understand what the object was." Although there had long existed tools and machines whose function might puzzle a non-specialist, the integrated circuit had introduced a new level of inscrutability, where "people could look at an object and have not the first clue what it was and how it worked." His tablet concept, the Macintosh Folio, had a stylus and an adjustable angled screen, and carried the suggestion of a drawing board.

In the spring of 1992, before a general election that the Labour Party was expected to win, after thirteen years of Conservative Party rule, Tangerine presented its bathroom at Ideal Standard's headquarters, in Hull. Grinyer is still annoyed that the company rejected it. One complaint, he recalled, was that if the sink's column fell it might kill a child; he thought that the column shared this attribute with other big ceramic objects.

The Tangerine partners then visited Apple in California. When they landed back in London, they were greeted by the news that the Conservatives had won. "It was fucking depressing," Grinyer recalled. "And Jon does like nice weather."

Ive moved to San Francisco that September. Not long afterward, he bought a yellow Saab convertible. In Silicon Valley, he responded to "a completely unaffected, completely authentic optimism." He told Stephen Fry that he had discovered, in America, "a conspicuous lack of cynicism, and skepticism."

The sun had set by the time we reached his house. “Thanks ever so much, Jean,” Ive said. He unlocked a wooden gate, apologizing for the darkness.

Since joining Apple, Ive has occasionally taken on outside projects. In 2001, he created a white polystyrene box to house a book by Paul Smith. In 2013, an aluminum desk that Ive and Newson designed for the Project Red auction sold for $1.7 million. And Ive once sat next to J. J. Abrams at a boozy dinner party in New York, and made what Abrams recalled as “very specific” suggestions about the design of lightsabres. Abrams told me that “Star Wars: The Force Awakens” would reflect those thoughts, but he wouldn’t say how. After the release of the film’s first trailer—which featured a fiery new lightsabre, with a cross guard, and a resemblance to a burning crucifix—I asked Ive about his contribution. “It was just a conversation,” he said, then explained that, although he’d said nothing about cross guards, he had made a case for unevenness: “I thought it would be interesting if it were less precise, and just a little bit more spitty.” A redesigned weapon could be “more analog and more primitive, and I think, in that way, somehow more ominous.”

Over the years, Laurene Powell Jobs has consulted Ive about eyeglasses, flatware, and the proper height of countertops. “He’s so good on proportion and dimension,” she said. “Really, if you ever need buttons for things designed, for doors or lights, you should just stay in touch with him.” We were in the offices of the Emerson Collective, her education-oriented nonprofit, in Palo Alto. She protected an Arne Jacobsen conference table with two felt coasters: one for her coffee cup, and the other for its plastic lid.

Steve Jobs, like Ive, grew up with a father who could build things. The son became a discriminating, difficult critic of his manufactured environment. Powell Jobs, who has an open, amused manner, said, “I never thought about a sconce before I met Steve. Steve would have a definite point of view about this ceiling. And I learned about mullions.” She was looking at the window. “These mullions are quite thick, and probably overly so.”

For years, the family’s Palo Alto home was underfurnished; Jobs tore photographs of things he liked out of magazines or books, but didn’t buy them. He often complained—“You don’t want to know,” Powell Jobs said—about one or other switch ruining the experience of his Mercedes. He craved products that didn’t force adjustments of behavior, that gave what Powell Jobs called a “feeling of gratitude that someone else actually thought this through in a way that makes your life easier.” She added, “That’s what Steve was always looking for, and he didn’t find it until he worked with Jony. . . . They were really happy, they relished each other.”

Toward the end of his life, Jobs told Walter Isaacson, "If I had a spiritual partner at Apple, it's Jony. Jony and I think up most of the products together and then pull others in and say, 'Hey, what do you think about this?' He gets the big picture as well as the most infinitesimal details about each product. And he understands that Apple is a product company. He's not just a designer. That's why he works directly for me. He has more operational power than anyone else at Apple except me." Richard Seymour, the British designer, described the bond between Jobs and Ive as one "between a savant-level aesthete and an incredible craft-capable practitioner." According to Powell Jobs, "Steve wasn't someone who sketched stuff. So he never felt that he actually designed everything. But I think that they both felt like things were made possible because of the two of them." (Jobs and Ive had different dispositions, but perhaps shared a lack of social smoothness, and it seems fitting that one of their great joint achievements was to give digital distractions to people forced to ride in elevators with nodding acquaintances.)

I had previously asked Ive about the rounded corners and edges that have long helped distinguish an Apple product from a ThinkPad or a book. (As Apple's product range has narrowed to a series of flat rectangles, these transitions have become a surviving zone of pure industrial design.) On a day when Ive was so exhausted that it seemed possible he might fall asleep while talking, he became animated when describing the "primitive" design geometry that was usual before the computer era—essentially, two straight lines joined by a fragment of a circle. He then spoke of the opportunities that now exist, if the material permits, to take a more elegant path from one line to another; he talked of tangency breaks and Bézier surfaces. When I mentioned this to Powell Jobs, she cried out, "Yes! That is such a breakthrough, I forgot about that." For each product, Jobs and Ive would discuss corners "for hours and hours." She later noted that she and Ive share a taste for Josef Frank, the Austrian-Swedish designer of rounded furniture and floral fabrics, who once announced, in a lecture, "No hard corners: humans are soft and shapes should be, too."

Clive Grinyer visited Cupertino in the mid-nineties, before Jobs returned. Ive "was detailing printer lids," he said. "He was close to leaving. And, good Lord, if he had actually left, the world would be entirely different." Recalling this time, Michael Ive said, "Part of me thought, Oh, good, we'll see him at home again." Jonathan Ive has little appetite for discussing this period. He worked so hard that Brunner worried about his health; his designs—notably, the second iteration of the Newton personal organizer and, later, the Twentieth Anniversary Mac—were, in Brunner's admiring description, "somewhat expressive, but still fairly tight and fairly crisp." At the start of 1996, Brunner left Apple for Pentagram, the international design firm. He recommended Ive as his successor, but, later, he also tried to tempt him away. "I would

have loved to have him as a partner at Pentagram, and I told him that," Brunner said. "But he was 'I've got to wait this out and see where it goes.' "

Ive had been in charge for two and a half years when the iMac appeared, in the summer of 1998. Jobs later took much of the credit for its conception, although most other accounts, including Ive's, suggest that the studio had come up with something quite like the iMac before his return. According to Ive, Jobs said, "Make it lickable." (Craig Federighi, the senior vice-president of software engineering, attended a meeting where executives were shown a late iMac prototype. "Jony was showing off the case," he recalled. "Steve was poking at the seams, and turning to Jony: 'Maybe we could do something with the edge.' ") The computer's design had the giddiness of a pardoned prisoner. At Braun, Dieter Rams had relieved consumer electronics of the need to pose as furniture. A radio could be a box. Apple's instinct, at this moment, was to do the reverse: to domesticate a machine still largely associated with technical tasks and the workplace. (A few years earlier, in a concept design for an all-in-one computer, Ive had hidden its screen behind credenza doors, which is about as close as hardware comes to a quacking ringtone.) The computer, first sold in food-dye blue, had a handle, and curves that cheerfully acknowledged its unwieldy main component, a cathode-ray tube.

The iMac, relaunching Apple, fully launched Ive. For more than a decade, Jobs and Ive lunched and travelled together. Jobs liked to tease him for what he saw as Britain's imperial delusions—"All hat and no cattle," in Powell Jobs's summary—but Ive told me that, on one visit to the U.K., he and Jobs spent a morning with Prince Charles, at Highgrove, his country house. Bob Mansfield, a former senior hardware engineer at Apple, who is now semi-retired, recently described the pique that some colleagues felt about Ive's privileged access. As he put it, "There's always going to be someone vying for Dad's attention." But Mansfield was grateful for Ive's cool handling of a C.E.O. who was "not the easiest guy to please." Mansfield's view was "Jony puts up with a lot, and, as a result of him doing it, people like me don't have to."

Ive's dominance wasn't immediate. Michael Ive recalled a conversation he had with his son in 2001: " 'It'll have a thousand songs, Dad.' I said, 'Who wants a thousand songs?' He said, 'You'll see.' " Tony Fadell, a former Apple engineer who can take much of the credit for the iPod's functionality, was recently quoted by Fast Company as saying, "We gave it to Jony to skin it." That is, Ive's contribution was to combine, as elegantly as possible, elements decided largely by engineers and others: a battery, a disk drive, an L.C.D. screen, a track wheel. Fadell went on to found Nest, which was later bought by Google; he recently took charge of Google Glass. His phrase may have been strategically irreverent—"We've never skinned anything," Tim Cook told me in response—but it contained at least a partial truth. Ive gave the music

player an irresistible white-and-silver form, causing a generation of designers to endure clients asking for the "iPod version" of this or that. (Richard Seymour, in London, recalled a meeting about the iPod of moisturizers.) But the industrial-design studio was not yet the company's central workshop.

A few years later, in 2004, a visitor to the studio might have noticed a rudimentary, oversized touch-responsive screen lying on a table. "It was very crude, involving projectors," Ive said. The studio hadn't invented the essential technology—nor, indeed, had Apple engineers—but the designers helped guide it to market, over years. Ive was now involved "in the fundamentals of the products—how to build them efficiently, the technology, how to cool them," as Bob Mansfield put it. Ive told me that he initially pressed for a tablet, then agreed with Jobs that a phone should come first: a tablet would have presented consumers with a new category of machine, and a new way of communicating with a machine, all at once. By the time the iPhone was launched, in 2007, Ive had become "the hub of the wheel," Mansfield said.

Typically, Robert Brunner explained, design had been "a vertical stripe in the chain of events" in a product's delivery; at Apple, it became "a long horizontal stripe, where design is part of every conversation." This cleared a path for other designers. In 2007, Brunner formed his own consultancy, Ammunition, and began working with Beats, a new headphone company founded by Jimmy Iovine and Dr. Dre. Brunner's firm was integrated into the Beats process to a degree that was made possible, he said, by Apple's example. Ive, Brunner said, had "single-handedly elevated our craft to a level that it's never been at before."

Ive's studio assumed power from manufacturers as well as from engineers. Jeff Williams, the senior vice-president, recalled an early iMac revision. "We announced it, and it was beautiful," he said. "But we couldn't figure out how to produce them." Ive and Dan Riccio, now Apple's senior vice-president of hardware engineering, spent eight weeks at LG Electronics, the computer's South Korean manufacturer. "The folks at LG were doing a lot of the designing for us," Riccio said. "Today, we do it a hundred per cent in-house."

Apple's designers still visit factories, but a final prototype part from Cupertino is not the start of a conversation; it's the part. Ive gave me a tour of the area in the studio behind the glass, where, beyond the milling machines, there's also a color lab. He said, "Years ago, you thought you'd fulfilled your responsibility, as a designer, if you could accurately define the form"—in drawings or a model. Now, Ive said, "our deliverable just begins with form." The data that Apple now sends to a manufacturer include a tool's tracking path, speed, and appropriate level of lubricant. Ive noted that the studio's prototyping expertise creates the theoretical risk of beautiful dumb

ideas. “There are some people who can draw something that’s fundamentally ugly, but draw it—hint at detailing—in such a way that it’s seductive.” Three-dimensional models could be equally misleading. “What we try to do is see beyond our ability to implement, beyond our ability to detail.”

One afternoon, Ive and Bart André removed the bottom panel of a MacBook laptop, revealing black and silver components arranged, with unnecessary orderliness, on a matte black circuit board. Ive looked down happily. “This is such an extraordinarily beautiful thing,” he said. André noted that, in a competitor’s computer, the board would be green. He sounded embarrassed on behalf of that other machine. On the same table was a plastic model of an existing Apple headphone—an EarPod—the size of a golf driver.

The company’s process, which is enabled by almost limitless funds, and by sometimes merciless pressure on suppliers and manufacturers, also provides a layer of commercial armor plating: an Apple object is “manufactured in a way that makes it harder to copy,” Paola Antonelli said. “That’s the genius. It’s not only the formal effect.” When, in 2007, Robert Brunner first saw a MacBook’s “unibody” housing—made, unprecedentedly, out of a milled block of aluminum—it was a “mind-blowing epiphany,” he said. Apple “had decided that this was the experience they wanted, so they went out and bought ten thousand C.N.C. milling machines.” (Apple didn’t confirm that figure, but Brunner was not being hyperbolic.) Soon after the iPhone débuted, Brunner said, Ammunition was approached by “a very large Korean company” to create a touchscreen competitor: “They wanted us to do it in six weeks.” He laughed. “We were, like, ‘You don’t realize, this was years. This was years of a lot of very good people.’ ”

One day, I joined a few Apple designers in the studio kitchen, and asked them how they had registered the world’s embrace of their products. They seemed reluctant even to acknowledge it; they made the studio sound happily isolated, like a spa or a Scandinavian prison. “It’s not like the weight of the world’s on our shoulders,” Richard Howarth, the British designer, said. “Jony set it up so that it’s a little—it’s freer than you might imagine.”

Evans Hankey, a design-team member, added, “Most of the pressure comes, I think, from us.” She said that an existing product is often set alongside a model of a potential successor, to see if “the one that we’ve been enjoying for a couple of years or so—if it just feels really old and kind of stodgy, and the new one feels just amazing.” (The designers are not on the same clock as their customers, so that moment may arrive when the stodgy item is first arriving in stores.) Once a new model feels “inevitable,” Hankey said, “we know we have a lot to do, but at least the foundation is

solid."

Hankey's words were a reminder of the difficulty in obeying Dieter Rams's commandment about long-lasting design. In 1973, a Sony ad announced, "This could be the tape deck you'll leave your great-grandson." That line, similar to the theme of Patek Philippe ads, may have been wishful, but it was not yet an absurd way to talk about consumer electronics. Today, Apple's designers, like their competitors, make machines that are almost disposable: the screens crack; the processors become outmoded. I asked if this caused discomfort, and there was a pause. Whang, the d.j., mentioned a friend who still uses a first-generation iPhone. "It's super banged up, but it's absolutely fine," he said, as if the device were a war photographer's scuffed Leica. "So the stuff absolutely lasts."

Earlier, Ive had said that he wouldn't trade reach for permanence. The studio's perpetual advancements improved "the quality of life for millions and millions and millions of people." To decelerate—"to say, 'There you are, it's done' "—would make his professional life simpler. But that, Ive said, would be "really selfish of me."

IV. A Tap on the Wrest

I asked Jeff Williams, the senior vice-president, if the Apple Watch seemed more purely Ive's than previous company products. After a silence of twenty-five seconds, during which Apple made fifty thousand dollars in profit, he said, "Yes."

In 2007, the year of the iPhone launch, the Ives bought an eleven-bedroom seventeenth-century house, with a lake, in rural Somerset, in the West of England. Ive had been at Apple for fifteen years; his children were nearing school age. When Ive and his wife were photographed among the tanned and lacquered guests at San Francisco fund-raisers, they looked palely handsome and a little puzzled, as if misdirected from the set of a Jane Austen adaptation. At the time, Michael Ive hoped that the Somerset house presaged a permanent return. He told me that he had learned not to ask three questions: "When are you coming back to England?"; "What are you working on?"; "Planning any more kids?"

According to Clive Grinyer, Ive had by then considered returning to the U.K., entering a "magnificent early retirement" in which he worked on "luxury items with Marc." As Grinyer recalls his conversations with Ive, Apple's success, and Jobs's worsening health, revised such plans. Apple sold six million phones in the first year. By 2012, the company was selling more than a hundred million a year. In the same period—during which Apple launched the iPad and the MacBook Air—the company's valuation quadrupled. "The iPhone just seemed to change the entire world,"

Grinyer said. “I think he is burdened by it. He’s got no choice, the poor guy. He really has to see it out, and I know it wasn’t his plan. Which is not to say he’s not enjoying it.” By the spring of 2011, the Somerset house was back on the market. (Ive’s former guesthouse—limestone flooring, double Neff oven—is available for short-term rentals.)

Ive told me that he never planned to move: he and his wife bought the house for family vacations, and sold it when it was underused. But he also connected the sale to what he called inaccurate reporting, in the London Times, in early 2011, claiming that Apple’s board had thwarted his hope of a relocation; he did not want to be shadowed by gossip. In 2012, Ive was knighted in Buckingham Palace; by then, he and his wife had become U.S. citizens, although they did not relinquish their British passports.

Jobs was given a diagnosis of pancreatic cancer in 2003. Isaacson reported that, in 2009, when Jobs was hospitalized for a liver transplant, and barely able to speak, he critiqued the design of an oxygen mask. Jobs came back to work, and later hosted the launch of the iPad. But in 2011 he took a leave of absence from which he never fully returned. Ive was a frequent visitor to the Jobs home, and was there, on an afternoon in October, when Jobs died.

At Jobs’s memorial, which was held on the lawn at Infinite Loop, Ive said, “Steve used to say to me—and he used to say this a lot—‘Hey, Jony, here’s a dopey idea.’ And sometimes they were: really dopey. Sometimes they were truly dreadful. But sometimes they took the air from the room, and they left us both completely silent. Bold, crazy, magnificent ideas. Or quiet, simple ones which, in their subtlety, their detail, they were utterly profound.” Ive said to me, “I couldn’t be more mindful of him. How could I not, given our personal relationship, and given that I’m still designing in the same place, at the same table, where I spent the last fifteen years with him sat next to me?”

The Apple Watch—the first Apple device with a design history older than its founder, or its designer—was conceived “close to Steve’s death,” Ive said. It’s hard to build a time line of this or any other Apple creation: the company treats the past, as well as the future, as its intellectual property. But, in 2011, there may have been a greater appetite than usual for investigations of new products. One could imagine that executives were eager to act, in anticipation of grief, market upheaval, and skeptical press. (The Onion: “Apple Unveils Panicked Man with No Ideas.”) Cook said, “We were looking at multiple categories of products, and thinking about which ones to do.” The company began developing the iPad Mini. Before the end of the year, prototype ancestors of the iPhone 6 were lined up in the studio, with screen sizes at “ev-

ery point-one of an inch, from four all the way through to well over six." (Earlier, the studio had designed a larger iPhone based on the architecture of the iPhone 4, but, as Ive recalled, it was "clunky" and "uncompelling.")

I had wondered if the watch project, and Ive's software role, could be seen as a way for Apple to thank and secure Ive: handcuffs in yellow gold and rose gold. "I never thought of that, to be honest," Cook said. "I think Jony really loves Apple—loves being here and loves the products." He added, "The driving force was that our products would be much better." If Jobs and Ive had a father-son dynamic, Ive and Cook seem like respectful cousins. Cook said that Ive was "extremely supportive" both before and after he publicly announced, last fall, that he was gay: "When you do something like that, there's a group of people that throws stones." He went on, "It's been great having people who remind you of all the good in it."

Ive collected watches, and he had often discussed watch design with colleagues and with Newson, who in the nineties had founded his own watch company, Ikepod. "The job of the designer is to try to imagine what the world is going to be like in five or ten years," Newson told me. "You're thinking, What are people going to need?" In 2011, largely thanks to advances in the miniaturization of technology, the answer seemed to be a wearable notification device paired to a phone—making it yet simpler to exchange messages of love, or tardiness. That summer, Google made an eight-pound prototype of a computer worn on the face. To Ive, then unaware of Google's plans, "the obvious and right place" for such a thing was the wrist. When he later saw Google Glass, Ive said, it was evident to him that the face "was the wrong place." Cook said, "We always thought that glasses were not a smart move, from a point of view that people would not really want to wear them. They were intrusive, instead of pushing technology to the background, as we've always believed." He went on, "We always thought it would flop, and, you know, so far it has." He looked at the Apple Watch on his wrist. "This isn't obnoxious. This isn't building a barrier between you and me." He continued, "If I get a notification here, it will tap my wrist"—with silent vibrations. "I can casually look and see what's going on." We were in a conference room at One Infinite Loop, a few doors from Jobs's old office, and I noticed that, at this moment in the history of personal technology, Cook still uses notifications in the form of a young woman appearing silently from nowhere to hold a sheet of paper in his line of sight.

In the fall of 2011, Ive said, a watch conversation became a formal watch project, albeit one that was "still tentative and very fragile." He made the moment sound both unremarkable ("We explore a lot of things, and we're resigned to the fact that most of them don't continue") and portentous ("It's not very often that we start something that's an entirely new platform"). When Ive, in discussing this work with me, re-

ferred to such topics as the evolution of sewn pockets, it was easy to detect his pleasure in being answerable to history. Ive may or may not have longed for Somerset, but, after two decades in design's New World, he'd given himself a task with some Old World constraints. He invited historians and astronomers to give lectures in the studio.

At first, the designers put little on paper. After years of collaboration, "we just get it," Ive said. "We know exactly what somebody means." They first discussed the watch's over-all architecture, rather than its shape. Ive's position was that people were "O.K., or O.K. to a degree," with carrying a phone that is identical to hundreds of millions of others, but they would not accept this in something that's worn. The question, then, was "How do we create a huge range of products and still have a clear and singular opinion?"

If variety was a perceived necessity, it was also an opportunity. "We could make aluminum, and stainless steel, and gold, and different alloys of gold," Ive said. (Hinting at future plans, Ive added, "We've not stopped.") The product range could extend into mass-market luxury, allowing both Ive and Newson to escape the contrasting restrictions of their exalted careers. Newson became an acknowledged Apple contributor only last year, but he worked on the watch from the start; his name will appear on patents. Newson had designed airplane interiors, and the Safilo reading glasses that Ive often hooks over the collar of his T-shirts; but he had seldom made mass-market goods. He had sometimes been envious of what was possible at Apple. In 2007, in order to pursue the costly idea of milling one-off pieces of marble furniture, he had partnered with the Gagosian gallery, crossing the border into fine art. "I needed to find an outlet for my creativity," Newson explained. "I couldn't find a client who would do those kinds of things." To work with Ive, at the other end of the manufacturing scale, would give him a similar license. A designer at Apple "can think about doing things in a way that you otherwise would have dismissed as being impractical or frivolous, or just not economical," Newson said.

According to Clive Grinyer, "Jon's always wanted to do luxury." By this point, Grinyer said, Ive had already fulfilled one duty of industrial design: to design a perfect stapler, for everyone, in a world of lousy staplers. (Most designers driven by that philosophy "didn't really rule the world," Grinyer said. "They just ruled staplers.") A few years ago, Grinyer had considered working with Vertu, the British-based cell-phone manufacturer, whose bejewelled but technologically ordinary products sell for tens of thousands of dollars. Vertu's survival challenged the assumption that inevitable obsolescence removes modern consumer electronics from consideration as luxury goods. Ive was "very interested" in Vertu, Grinyer recalled.

Bob Mansfield, then closely involved in the watch project, said that Ive's role was to be "himself and Steve" combined. Yet Ive still had to make a case to Apple, and Mansfield recalled "a lot of resistance." It wasn't clear how the company would display such things in stores; there were also concerns about creating a divide between wealthy and less wealthy customers. (As Mansfield said, "Apple wants to build products for everybody.") But Ive won the argument, and in 2013 the company announced the high-level appointments of Angela Ahrendts, the former C.E.O. of Burberry, and Paul Deneve, the former C.E.O. of the Yves Saint Laurent Group. Patrick Pruniaux, from tag Heuer, a part of the L.V.M.H. luxury conglomerate, was hired last year. Apple has announced that the cheapest watch will cost three hundred and forty-nine dollars. In parts of the world already filled with smartphones, that price may give the Apple Watch the graduation-gift appeal that, according to Brunner, Beats consciously sought with its headphone pricing. But Ive's solid-gold models, innocently named Apple Watch Edition, are expected to cost many thousands of dollars. John Gruber, an influential Apple blogger, has written that the prices may be "shockingly high . . . from the perspective of the tech industry," but perhaps "disruptively low from the perspective of the traditional watch and jewelry world." Sebastian Vivas, the director of a watch museum maintained by Audemars Piguet, the Swiss manufacturer, recently described his industry as unperturbed by Apple's plans: "We're not afraid; we're just a little bit smiling." It would be a greater threat, he told me, if men widely accepted that they could wear gemstones without a time-keeping pretext.

Ive's decision to offer choice was a challenge to Apple's recurring theme of design inevitability. In one of our conversations, Ive was scathing about a rival's product, after asking me not to name it: "Their value proposition was 'Make it whatever you want. You can choose whatever color you want.' And I believe that's abdicating your responsibility as a designer." Cook told me, "Jony has better taste than anyone I ever met in my life," and Ive might not demur. Over lunch in an Apple cafeteria, Ive said that he wouldn't think of challenging the technical decisions of "the best silicon-chip designers in the world," who were sitting around us. But industrial designers, he said, are rarely offered the same deference—in part, because most people regularly make taste-based decisions, about shoes and lamps.

The studio adopted a modular system for the watch: a body in various materials, and a choice of interchangeable straps. Six weeks into the project, the studio built its first model.

"It's awkward when you're dealing with models," Ive said. "Often you're reacting, by definition, to newness, or difference." The new has to be given time to annoy, or disappoint. A few years ago, Ive and his colleagues assessed each prototype size of the

future iPhone 6 by carrying them around for days. “The first one we really felt good about was a 5.7,” he recalled. “And then, sleeping on it, and coming back to it, it was just ‘Ah, that’s way too big.’ And then 5.6 still seems too big.” (As Cook described that process, “Jony didn’t pull out of his butt the 4.7 and the 5.5.”)

For the watch, it was a year before Ive settled on straps that clicked into slots. Ive later tested watchbands by wearing them outside the studio with other watches. The shape of the body, meanwhile, barely changed: a rectangle with rounded corners. “When a huge part of the function is lists”—of names, or appointments—“a circle doesn’t make any sense,” Ive said. Its final form resembles one of Newson’s watches, and the Cartier Santos, from 1904.

Ive places the new watch in a history of milestone Apple products that were made possible by novel input devices: Mac and mouse; iPod and click wheel; iPhone and multitouch. A ridged knob on the watch’s right side—the Digital Crown—took its form, and its name, from traditional watchmaking. The watch was always expected to include a new technology that had long been in development at Apple: a touchscreen that sensed how hard a finger was pressing it. (A press and a tap could then have different meanings, like a click and a double-click.) But the Digital Crown, a device for zooming that compensated for the difficulty of pinching or spreading fingers on a tiny screen, was ordered up by the studio. In a reverse of “skinning,” Ive asked Apple’s engineers to make it. In time, the crown’s role grew to include scrolling through lists. Ive was delighted with its versatility, but the sight of one of his colleagues scrolling with a rigid finger—a Doughboy poke—made me wonder if a more natural watch-winding gesture will cause large thumbs to flop, accidentally, onto the touchscreen.

One afternoon in the studio, Ive sketched the Apple Watch as seen from the side, with the crown asymmetrical on two axes: nearer the top of the watch than the bottom, and nearer the face than the back. (There is also a more flush secondary button.) As an afterthought, he quickly drew the front of an iPod: a rectangle within a rectangle, and a circle within a circle. He pointed at the watch drawing. “It’s not for us to say if things are iconic,” he said, and then described it as a “very, very iconic view.” Ive explained that, had he centered the Digital Crown, the watch would be a quite different product. “It’s just literal. And you could say, ‘Why is that an issue?’ Well, if it’s literally referencing what’s happened in the past, the information about what it does is then wrong.” The crown rotates, which is reassuring, but it doesn’t wind the watch or adjust hands. The goal, Ive said, was to create “the strangely familiar.”

Apple was feeling its way toward a product for fitness monitoring, card-free pay-

ments, and flirtatious doodled messaging and wrist-tapping during long commutes. (The company may have used the word "intimate" one or two times too many at the product's launch.) In 2012, Ive gathered small groups from across the company for a series of discussions at the St. Regis Hotel in San Francisco. Jeff Williams said, "Jony had this great way of facilitating ideas, and being incredibly patient—long moments of silence." He remembered a conversation about the amount of information one can absorb in a glance. In another, it was observed that, although some modern cars can automatically alert a service center about a technical problem, a child's looming illness creates no such alert.

When Ive took control of Human Interface, in 2012, his immediate task was reforming the iOS. Jobs had liked digital facsimiles of analog designs; reportedly, the stitched leather in Apple's desktop calendar quoted the interior of his Gulfstream. Ive's view was that such effects were appropriate for the iPhone's launch, when "we were very nervous—we were concerned how people would make a transition from touching physical buttons that moved, that made a noise . . . to glass that didn't move." But, he went on, "It's terribly important that you constantly question the assumptions you've made." (The bulbous iMac, a design with a similar desire to put people at ease, was replaced after three and a half years, and looked dated before then.) Ive was also itching to smooth the corners of iPhone app icons. "They drove me crazy," he said. "All I could see were these unresolved tangency breaks."

Had Ive previously asked to intervene? "There's a step prior to that, which is to say, 'I don't think this is right, but I'm really busy doing my stuff,' " he replied. He'd had that conversation with Jobs. "He knew, absolutely, my views," Ive recalled. "I'm not going to second-guess what he would have done if—had he been well." I asked Cook if, after he became C.E.O., Ive had pressed for a software role. "We clearly spent a lot of time talking about it," Cook said. "And I think it became clear to him that he could add a lot." Ive's career sometimes suggests the movements of a man who, engrossed in a furrowed, deferential conversation, somehow backs onto a throne.

His discussions with Cook were prompted by thoughts of iOS7, but it would have been as clear to him as it was to Alan Dye, a creative director at Apple, that the company's industrial designers were at risk of losing some of their control over its products. As an iPad "becomes a piece of glass," Dye said recently, the experience of the software becomes as important as the hardware, "or more important." The watch would include some grand industrial-design gestures—gold hardened in a novel process of compression; a buckle secured with forty-odd magnets—but across much of Apple's product range such opportunities were becoming rarer.

Dye, a graphic designer who had worked at Kate Spade in New York, and then in

Apple's marketing and communications department, became the head of a new Human Interface team that, before it grew too large, was embedded in the studio. Apple, in fact, already had a Human Interface team, working on the other side of the campus, without the same access to Ive and sober Dutch ringtones. In a development that reflects some part of Apple's evolution since Jobs's death, there were moments of tension between the original team and the new sophisticates, and then there was one merged team, under Ive.

I spoke to Dye at a table by the lawn at Infinite Loop. He had brought a sketchbook, and he opened it to a page where he'd drawn simple outlines: shuttlecock, light bulb, thundercloud, tree. He had been imagining possible elements in a vocabulary of doodled messages for the Apple Watch. "This is silly stuff," Dye said, describing the exercise of seeding a future language.

Last spring, Jimmy Iovine, the C.E.O. of Beats, asked to meet with Robert Brunner. As Brunner recalled, "He walks in, he says, 'I sold the company!' " Iovine couldn't then name the buyer; Brunner's best guess was Samsung. When he learned that it was Apple, which had paid more than three billion dollars, he e-mailed Ive: "Well, we need to have dinner." Brunner recalled that Ive, in his reply, referred to the "odd symmetry" of the moment.

When I spoke to Cook, he lauded Beats' music-streaming service and its personnel before praising its hardware. "Would Jony have designed some of the products?" he said. "Obviously, you can look at them and say no." He went on, "But you're not buying it for what it is—you're buying it for what it can be." Brunner is proud of the Beats brand, but it took him time to adjust to a design rhythm set as if for a sneaker company: "Originally, I hated it—'Let's do a version in the L.A. Lakers' colors!' " He laughed. " 'Great. Purple and yellow. Fantastic.' " When I asked Cook about such novelties, he laughed: "I want Beats to be true to who they are. I don't want to wave the wand over them in a day and say, 'You are now Apple.' Down the road, we'll see what happens."

Brunner and Ive had dinner in San Francisco a few days before Apple's September announcement; they barely talked about the Beats deal. "I was telling my wife I'll be home by ten o'clock," Brunner said. "We were still drinking past twelve-thirty. I think he was blowing off a little steam." (Stephen Fry said of Ive, "He loves a great hotel and a great wine.") Ive was worn out, and preoccupied by the launch, and, Brunner said, by the thought of "doing something like this without Steve." But they gossiped a little about designers, and Brunner was reminded of his former employee's extreme thoroughness when Ive showed him drawings of "a perfectly radiused marble corner" for a future bathroom in Pacific Heights.

The Apple event ended oddly, with charmless stage banter between Cook and Bono, who spoke coyly of a vast, opaque commercial transaction, involving free music, between their two organizations. Like Mickey Mouse, seen that day on one of the watch faces, U2 has perhaps become more a symbol of entertainment than a source of it. I imagined Ive sighing, "Must I do everything myself?"

As people stood to leave, Harper Alexander handed Ive an Apple Watch: it was the larger of two sizes, in rose gold, with a band of white rubbery plastic. Ive tied it to his wrist loosely, and it suited him. A few minutes later, he walked outside to a large white shed that had been built as a temporary showroom. There seemed to be an exaggerated heaviness—a miming of responsibility—in Ive's rolling gait. Referring to three years of work on the watch, he said, "It took a long time and it was very hard." But the ovations had pleased him. The room was full of reporters and fashion-industry guests—including Lily Cole, the model, wearing a gold Rolex Oyster that her friend Olivier Zahm, the studiedly louche editor of the magazine Purple, Instagrammed before the event was over. ("Sorry Apple," someone commented.)

Inside the shed, I tried on a watch, and its stainless-steel chain bracelet, guided by magnets, fell into place with the click of someone stacking nickels. That click, and one or two other immaculate couplings, had been the only sounds, apart from music, heard on a trailer-length "reveal" video that preceded the ten-minute film. The watch was months away from market—it will become available in April—and its display showed only a loop of dummy text and images.

I was walking around with Richard Howarth and Julian Hönig; they stared, slightly dazed, at people handling objects that only they had handled for years. When a product demonstrator gave me his pitch, they interrupted with design footnotes. "The materials in this thing are insane," Howarth said. People, he noted, were saying that the watch's face was made of "sapphire glass": "It's not glass, it's sapphire crystal—completely different structure. And then the stainless steel is super-hardened. And the zirconia ceramic on the back is co-finished with sapphire as well." He added, "This would cost so much money if a different company was making it—Rolex or something. It would be a hundred grand or something."

"We sell it for just fifty thousand," Hönig said, joking.

The next day, I visited Ive in his studio. The table previously covered with a flat cloth was now uncovered: it was a glass-topped Apple Watch display cabinet, accessible to staff from below, via a descending, motorized flap, like the ramp at the rear of a cargo plane. Ive has begun to work with Ahrendts, Apple's senior vice-president

of retail, on a redesign—as yet unannounced—of the Apple Stores. These new spaces will surely become a more natural setting for vitrines filled with gold (and perhaps less welcoming, at least in some corners, to tourists and truants). Apple had not, overnight, become an élite-oriented company—and it would sell seventy-five million iPhones in the final quarter of 2014, many of them in China—but I wondered how rational, and pure of purpose, one can make the design of a V.I.P. area. Ive later told me that he had overheard someone saying, "I'm not going to buy a watch if I can't stand on carpet."

That afternoon, he was eating salmon sashimi, and complaining about seasonal allergies. "I'm going to limp toward the weekend, and take Monday off, I think," he said. He described the previous day as "momentous." His iPhone 6 softly chimed a text alert every minute or two. To those of Ive's generation, the new phones were perhaps large and slippery enough to trigger nostalgia for the small, tough phones of a decade ago. I asked Ive about the slightly protruding camera lens that prevents the iPhone 6 from resting comfortably on its back. Ive referred to that decision—without which the phone would be slightly thicker—as "a really very pragmatic optimization." One had to guess at the drama behind the phrase. "And, yeah . . ." he said.

As we spoke, I removed links from an Apple Watch bracelet, and then put them back, and it seemed possible that the watch's combination of distractions might, for some, be overwhelming. "I know," Ive said. Like an iPhone, an Apple Watch is only "simple and pure"—to quote Ive's film—until it's a threat to sleep, solitude, or the happiness of someone near you in a cinema. Michael Ive, remembering his son's hamster obstacle course, wondered if young people were now "too screen-focussed." On a sidewalk outside the studio, I later saw an employee looking at his Apple Watch while balancing an iPhone 6 on his forearm.

The Apple Watch is designed to remain dark until a wearer raises his or her arm. In the prototypes worn around the Cupertino campus at the end of last year, this feature was still glitchy. For Marc Newson, it took three attempts—an escalation of acting styles, from naturalism to melodrama—before his screen came to life. Under normal circumstances, the screen will then show one of nine watch faces, each customizable. One will show the time alongside a brightly lit flower, butterfly, or jellyfish; these will be in motion, against a black background. This imagery had dominated the launch, and Ive now explained his enthusiasm for it. He picked up his iPhone 6 and pressed the home button. "The whole of the display comes on," he said. "That, to me, feels very, very old." (The iPhone 6 reached stores two weeks later.) He went on to explain that an Apple Watch uses a new display technology whose blacks are blacker than those in an iPhone's L.E.D. display. This makes it easier to mask the point where, beneath a glass surface, a display ends and its frame begins. An Apple

Watch jellyfish swims in deep space, and becomes, Ive said, as much an attribute of the watch as an image. On a current iPhone screen, a jellyfish would be pinned against dark gray, and framed in black, and, Ive said, have "much less magic."

Alan Dye later described to me the "pivotal moment" when he and Ive decided "to avoid the edge of the screen as much as possible." This was part of an overarching ambition to blur boundaries between software and hardware. (It's no coincidence, Dye noted, that the "rounded squareness" of the watch's custom typeface mirrors the watch's body.) The studio stopped short of banishing screen edges altogether, Dye said, "when we discovered we loved looking at photos on the watch, and you can't not show the edge of a photo." He laughed. "Don't get me wrong, we tried! I could list a number of terrible ideas." They attempted to blur edges, and squeeze images into circles. There was "a lot of vignetting"—the darkening of a photograph's corners. "In the end, it was maybe putting ourselves first," he said.

After I left Ive that day, he drove to a wine bar in San Francisco, for a celebratory Apple Watch buffet dinner. The evening, he recalled, was "very gentle, reflective, probably because we were so tired." The Apple Watch software will award virtual medals, embossed and enamelled, marking fitness achievements; Ive described their appearance as "slightly nostalgic," with echoes of a mid-century Olympic Games. "When you're judicious with what's literal, it can be powerful," Ive said. At the party, what had been literal became manifest: the guests all left with a metal iteration of a virtual medal, in a black cloth pouch.

In San Francisco, in an L-shaped living room with a large fireplace surrounded by dark wood, Heather Ive turned off some lights to improve the night view. "You can see the wash of light from the lighthouse at Alcatraz," she said. Her husband added, "The new house is way over there. You're almost on top of the water." The work in Pacific Heights, which has included driving piles forty feet into the ground, is scheduled to be finished this year.

His architects there are Foster + Partners, which is led by Norman Foster. Since 2009, the same firm—"Norman's boys," as Ive has sometimes put it—has worked on Apple's new campus. Inevitably, Ive is a co-designer of his house; according to Cook, he is playing the same role with the new headquarters. Apple loves its architects, Cook said, but "you can't outsource your brain." The building should express "the way we look at the world."

In December, a day after a severe coastal storm had sent seabirds darting inland, across Silicon Valley, I met Ive at the site of the future campus, a five-minute drive from Infinite Loop. It was still raining. There was no view of the Santa Cruz Moun-

tains, and no sign of the drone that sometimes buzzes overhead, recording video that is scrutinized online. The site has been cleared of all but one preëxisting office building. This is where thirty Foster architects work; they are sometimes joined by London-based colleagues, and by Ive and his team. In the lobby, there was a wall-size rendering of the campus, into whose central landscaped circle—amphitheatre, fountain, apricot trees—one could drop the Great Pyramid. When the design studio is relocated, it will occupy a top-floor space of thirty thousand square feet, with Industrial Design and Human Interface together, sharing a view of what Apple refers to as the "savanna" between the main building and the fitness center.

"I was very keen to have Norman do the project," Ive said. We walked through a series of rooms filled with prototypes and renderings. Ive has few doubts about his usefulness on architectural projects: in the design disciplines, he said, he finds it "a curious thing that we tend to compartmentalize, based on physical scale." (He later told me that he'd taught Foster's architects something about the geometry of corners. A recurring campus detail will be floors that turn up a little where they intersect with walls.)

We stood by a scale model. Ive said that, in an earlier iteration, the campus was "trilobal." I imagined a three-petalled flower, or the symbol for radioactivity. The single loop seemed to reflect the imperial part of the studio's spirit of imperial solicitousness. Under Cook, Apple has experimented with a softer, less neurotic image, and has, among other things, strived to improve its performance as a proxy employer of overseas factory workers. It's determined to make the case, as Cook put it, that the company's leaders shouldn't be thought of as "greedy bastards looking for more money." A private walled garden, costing an estimated five billion dollars, may not catch this mood.

Later that day, I asked Ive about an Apple design that shares the new campus's formal simplicity: the circular "hockey puck" mouse that was included with the first iMacs. Many found it hard to control, and it is widely considered a design failure. Ive didn't accept that description. He referred to different schools of thought about arms, wrists, and mice. "Everything we make I could describe as being partially wrong, because it's not perfect," he said, and he described the wave of public complaint that accompanies every release. He went on, "We get to do it again. That's one of the things Steve and I used to talk about: 'Isn't this fantastic? Everything we aren't happy about, with this, we can try and fix.' "

The loop can't be fixed, as Ive acknowledged, with a laugh. But, as far as possible, Ive has turned it into an industrial-design product. From the point of view of his discipline, an office building is a handmade prototype that fails to go into produc-

tion. And Ive sees no intrinsic virtue in making things by hand: "You can have careless, unqualified craftspeople." So, if a vast unvarying loop could be thought of as a Jobs hangover, it's also an opportunity for mass production. When Ive enthuses about the building, it's on these grounds. "You have a kit of elements and you just make lots of them," he said, happily. Ive's studio largely designed the building's "void slabs": forty-four hundred precast-concrete units that will have a floor on one side, a ceiling on the other, and a cooling system between them. They are being manufactured in an Apple-built factory in Woodland, California. "We're assembling rather than building," Ive said.

Ive only then made the case that a ring was "a remarkably pragmatic way of connecting the right groups." A taller building, he said, would make such connections more complex. The counterargument is fairly strong: the two full-circumference corridors are each about a mile long.

Before we went outside, Ive showed me the work he'd done on staircases, and on the signage for employee security-card readers; we examined brightly colored polycarbonate panels that will help people establish where, beneath the loop, they have parked. Pinned to a wall were alternate versions of a visitor reception center, separate from the loop. Seen from above, both were modified rectangles. One, marked "Pill," had half-circles at either end. The other ended in a more familiar Apple way, and was labelled "iPhone." "We should be done, but we're still redoing and redoing," Ive said. He had recently introduced the iPhone option, partly for fear that a visitor approaching the Pill by its rounded ends might mistake it for an echo of the main building. He had also insisted—"a big fight"—on simplifying the control panels of the Mitsubishi elevators.

We toured the site in a Jeep, in the rain. "Gosh, that's come on so much," Ive said. The building's ring was a trench, lined with concrete, deep enough for two levels of underground parking. When we got out, Ive declined to wear the construction hat provided; we walked across mud and peered over the edge. His noises of appreciation—"Oh!"—sounded almost regretful.

He was a few days from starting a three-week vacation, the longest of his career. The past year had been "the most difficult" he'd experienced since joining Apple, he said later that day, explaining that the weariness I'd sometimes seen wasn't typical. Since our previous meeting, he'd had pneumonia. "I just burnt myself into not being very well," he said. He had discouraged the thought that Newson's appointment portended his own eventual departure, although when I spoke to Powell Jobs she wondered if "there might be a way where there's a slightly different structure that's a little more sustainable and sustaining." Comparing the careers of her husband

and Ive, she noted that “very few people ever get to do such things,” but added, “I do think there’s a toll.”

We drove around the building’s perimeter. “This is something that Steve cared about passionately,” Ive said. “There is a bittersweetness here, because this is obviously about the future, but every time I come here it makes me think of the past as well—and just the sadness. I just wish he could have seen it.” We went to have lunch with Newson, in a twenty-thousand-square-foot room built as a miniature test run of the future campus cafeteria.

Ten Years of Google Maps, from Slashdot to Ground Truth

Liz Gannes, Re/code Feb 08, 2015

Ten years ago today, Google Maps launched to the world.

When it was born, it was a paper atlas in living form, with no pages to turn. Instead of online mapping leader MapQuest's printable list of directions, navigation routes were overlaid on top of the map itself. And Google Maps loaded map tiles in a Web browser without any special software so you could explore the world without refreshing, a technical feat that had never been seen before.

In 2005, nobody really knew what would come of online maps, or how they would become such a crucial aspect of daily lives in the Internet-connected world.

How Google would partner with Apple to bring online maps to their true home, smartphones, but the alliance would fall apart.

How Google Maps would have more than a billion users and become Google's second-largest property after its search engine.

Nobody had any idea, least of all Google.

And this was only a decade ago.

On the occasion of this 10th anniversary, Re/code spoke with the people who were there at the beginning, and brought back their stories of how something that now seems so fundamental came to be.

Slashdotted

Google Maps wasn't supposed to be unveiled until the next day, and even then it was going to be in beta — but an avid Google watcher on the Internet guessed the URL correctly and posted it to the popular discussion board Slashdot.

The Slashdot comments were glowing: "You can actually drag the map with your mouse to move the part that's being displayed. Way cool!" "This may be the most impressive Web application I have ever seen."

But Slashdotters had one — very justified — complaint: The map was really only drawn in for the U.S., with Canada and Mexico sketched above and below. Everything else was … ocean.

That sea of blue stood in for the brazen ridiculousness of Google's ambition to map the world, which would only broaden as the company added satellite imagery and

street-side photos. And then, it would largely divorced itself from incumbent data providers by cutting direct deals with countries, states and even cities around the world.

Practically Useless

From the beginning, Google Maps pushed forward the notion of "place" on the Internet. You may quibble with how Google delineates some geopolitically contentious area, or dislike one of its interface redesigns — but modern maps are the way they are because of the scale of Google's investment and ambition.

That said, Google wasn't first-to-market with an online map. In fact, the company came late to mapping, after noticing that its competitors were getting ahead.

Bret Taylor was the product manager of a Google product called "Search by Location," which was launched as part of an experimental umbrella called Google Labs in September 2003. It was perhaps Google's first effort related to mapping.

Basically, you could put in a keyword, as well as an address or ZIP code, and Google

would find Web pages that matched both.

“It was a practically useless project,” says Taylor.

The grand example for Search by Location was you were supposed to be able to search for coffee shops near Palo Alto. But Taylor remembers that Sun Microsystems put its address at the bottom of every page of its website, and it named its products after coffee (most famously, Java). So that broke the entire example.

“It had zero users per day,” says Taylor, who is now CEO of productivity startup Quip, after a stint as CTO of Facebook.

That original product was made much more accurate by licensing Yellow Pages information, but it wasn’t the dramatic leap forward that people at Google — particularly now-CEO Larry Page — were hoping to make.

So Google sought inspiration and talent from outside. Just before it went public, it made three relatively small acquisitions in 2004: Keyhole, Where2 and Zipdash. The three deals were led by Page and Megan Smith, who is now CTO of the United States (disclosure: Smith is married to but separated from Re/code co-CEO Kara Swisher).

Do me! Do me!

Keyhole was by far the biggest of the three deals, though the price was never disclosed. At the time, the three-year-old company had 30 employees and was selling an enterprise satellite map Windows application for $69.95. The key technology was a way to stitch satellite images together into a big composite map of the world, and then divide it into millions of tiles, so you could start with a higher-up view and then dive down to a specific location on earth.

There’s a funny story about the Keyhole acquisition that Smith and others recall, from a Monday meeting of then-CEO Eric Schmidt’s key management team.

Here’s how Chris Sacca — who at the time worked on Smith’s team, acquiring companies, and is now a prominent technology investor — describes it:

“I’ll never forget, we were in a meeting discussing the acquisition of Picasa, and this young guy Adrian Graham, who sort of looks like Morrissey, was going through the slides and pitching how we integrate Picasa, and [Google co-founder] Sergey [Brin] was totally distracted. And this was in building 42, in a conference room that had a

stairclimber in it, because Sergey wanted to use his time better in meetings.

"He'd shown his laptop to a couple people, and people said, 'Oh shit, do me, do me.' And this guy doing the presentation was really starting to sweat, and Sergey eventually gets up and unplugs the projector, says 'This thing's cool and we should buy it,' and he plugs his laptop into the projector and shows us Keyhole. And, literally, these executives are shouting out their addresses because they want to zoom in on their houses from space."

Smith said she remembers Brin hijacking the meeting. But, for her, the point of the deal was expressed by then-SVP of engineering Wayne Rosing. Smith, who later helped form the Google X experimental product division, recalls Rosing saying, "If our mission is to make all the world's information useful and accessible — then this is the real world."

But then there was the matter of convincing Keyhole to be bought. The company was weighing the Google acquisition versus multiple sizable venture capital funding offers to stay independent.

Former Keyhole CEO John Hanke recalls being attracted to a broader vision of making maps freely accessible so they could be used for all sorts of purposes. That would be a big deal for scientists who usually paid thousands of dollars for high-resolution satellite photos — archeologists, rainforest conservationists and the like.

Also, this was April 2003. The U.S. was invading Baghdad right at the time the acquisition was being discussed.

"What if you could surf and go to Baghdad and think about humans in a much more local way? You could see how small the world was," Smith remembers saying. "The VCs were saying, 'Come build this huge company.' And we were saying, it matters for all these different reasons — including peace."

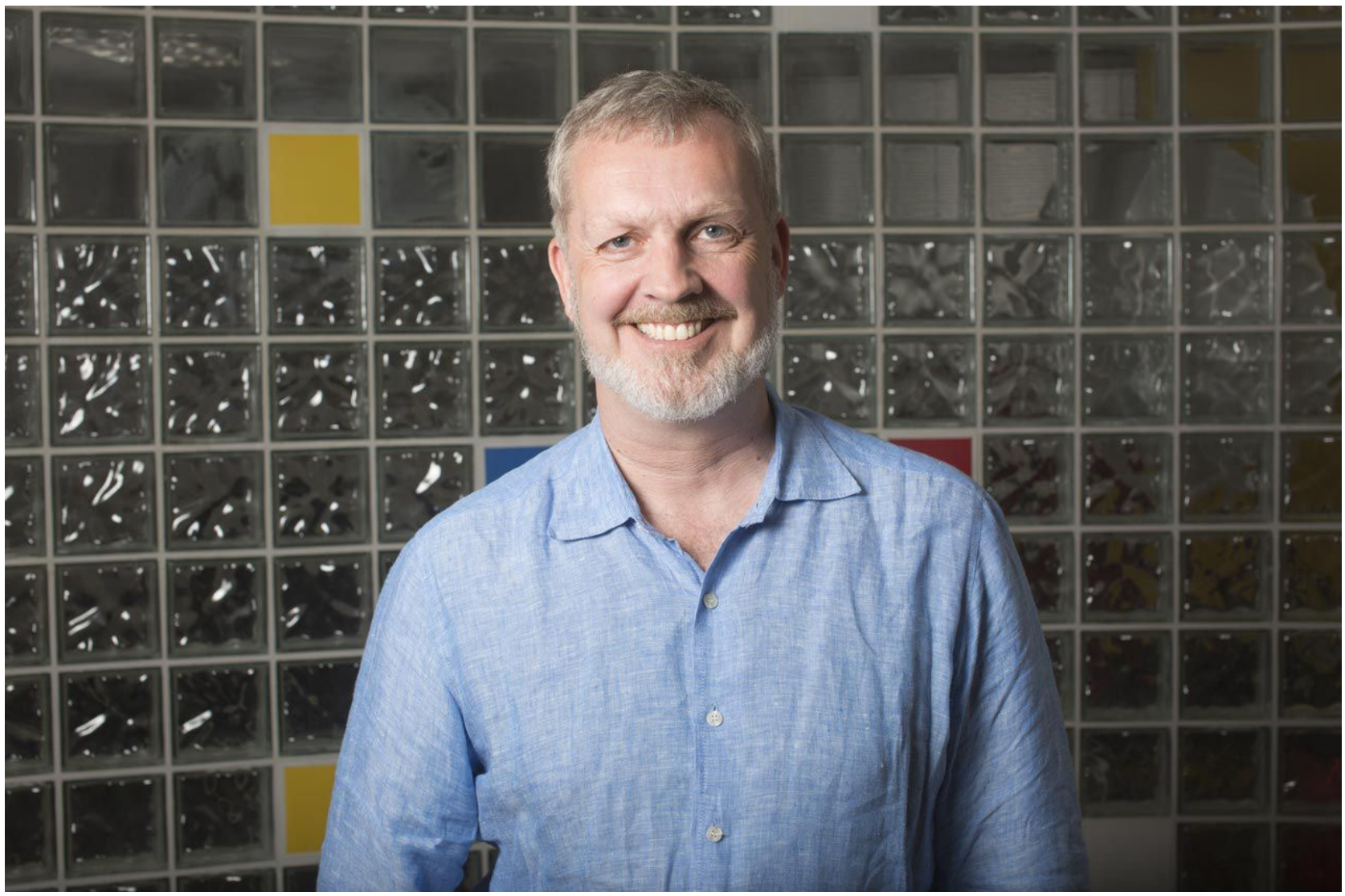
The Google board unanimously approved making an offer, and Keyhole took the deal.

Near-death Experience

Where2 Technologies, the tiny startup that would be most responsible for creating Google Maps, almost died before being acquired. At the time, the online map standard was MapQuest, which was basically a way to display a list of directions with tiny squares about each turn. Jens and Lars Rasmussen, the two Danish brothers

who started Where2, had an idea about making the actual map the center of the display, and letting people scan around and zoom in and out. But nobody was buying it.

“I remember early on, a lot of our detractors — and there were many — telling us,



‘This is not a good area to get into,’” Lars Rasmussen recalls. “They would talk to us about how a person only needed maps, at best, a few times a week.”

Today, of course, many people would literally be lost without using online maps multiple times per day.

Storied venture capital firm Sequoia Capital dropped funding discussions with Where2 when Yahoo Maps launched an update that added Yellow Page entries on a map.

“They pulled out overnight completely from the deal, which felt like quite a blow, as you can imagine,” remembers Lars Rasmussen. “All the other VCs who were circled around us heard about this and also pulled out, so no one would even talk to us anymore.”

This was post-dot-com bust. Lars and his brother were totally broke. Due to visa issues, they were building Where2 in Australia with two engineers named Noel Gordon and Stephen Ma. Without funding, the startup was going under.

“I’m not saying that Sequoia made a wrong decision here,” Lars Rasmussen recalls. “Their view was that our window was going to close before we were done with our development, and so they pulled out.”

But maybe there was another option. Google didn’t have a mapping product at the time, so Sequoia helped hook up the Where2 team with Google co-founder Larry Page.

“Three days later, we were talking to Larry Page,” Lars Rasmussen says.

The little team in Australia had made a desktop app, but Page thought the future was on the Web. So, in the three weeks between meetings with him, the four engineers essentially created the modern idea of a Web application — where data was fetched in the background rather than having to be refreshed to get new data.

(A team inside Google was actually doing something very similar for the first version of Gmail at the same time, but unknown to each other, they created a pretty fundamental Web technology that was later called AJAX.)

“Being in a very heightened state of motivation — as I’m completely broke and without any other options — we scrambled and we took three weeks, worked day and night, and actually built a website specifically to impress Larry and his crew over at Google,” recalls Lars Rasmussen, who now works at Facebook. “It even had the Google logo on it. And we marked up a local search where we used lava lamps as our markers, because Google liked lava lamps.”

The Third Musketeer

Way back in 2004, a little-three person startup called Zipdash — actually not even a startup, they hadn’t formally incorporated — was working on a mobile traffic application.

They were very, very early on this — too early. Zipdash was only for Nextel phones. Founder Mark Crady coughed up thousands of dollars of his own money to license traffic data from taxi fleets in the San Francisco Bay Area. From that sample, he was able to estimate traffic delays in real time, and once people started using the app, Zipdash incorporated their user activity to improve the estimates.

It was actually a lot like Waze, the peer-to-peer traffic map app Google acquired in 2013 for a billion dollars. Zipdash founder Mark Crady says that’s still a bit of a sore

spot — he sold Zipdash for only two million dollars. But he did get to join Google before the IPO, which wasn't too shabby, financially.

Crady tells a funny story from his first meeting with Megan Smith. "At one point, Megan asked us how many users we have. I said, '200 or 300.' She said, 'Thousand?' We were definitely not Google-size at the time."

Zipdash landed at Google, and Crady and his tiny team got to work on building what would become the mobile version of Google Maps.

By the way, those humble beginnings didn't foretell the future. Between Where2's Google Maps on the Web, Keyhole's Google Earth on the desktop, little Zipdash's Google Maps for mobile would become the biggest product of all. Today it has more than one billion users. Crady left Google in 2009, and is now working on a local event listing project.

Life at Google

At Google, the Keyhole, Where2 and Zipdash teams were basically plopped down in Mountain View and told to make a Google version of what they'd built on their own. They were able to recruit people internally, but they had to win them over on their own. The Danish Rasmussen brothers used the enticing schtick of handing out delicious danishes.

And then they got to work. The Where2 crew shoved some Windows computers in a closet to crank out map tiles. Jens Rasmussen, who is acknowledged as the idea guy in the duo, came up with the idea of the Google Maps pin, rather than Yahoo Maps' red star. The appeal of it was that the tiny point of a pin could show a place on a map without overlapping with it and obscuring it. (The kiss-ass lava lamps were left on the cutting room floor.)

Jens is very detail-oriented, even 10 years on. He says he tried to approximate the sense of a 3-D map with pins and drop shadows. But if you look closely, the original shadows on the pins crossed over each other and got darker. Kind of like in the middle of a shaded Venn diagram, where the overlapping section is darker than the other portions.

In real life, Jens says with a smile, "You can't block out the same light twice." He is keeping quiet about his current projects.

Meanwhile over in the Keyhole cluster, John Hanke recalls working on an elaborate

staggered plan for acquiring more high-resolution satellite imagery, because it was expensive. He wanted to start with the cities first. He prepared a big presentation of the cost structure for Larry Page, Sergey Brin and Eric Schmidt.

At the end of it, Brin said to Hanke: "Why don't we just do all of it?"

Hanke says he was flabbergasted, but that's exactly what they did. It cost many millions of dollars, and Google set up a special high-bandwidth interconnect to get data from the supplier in Colorado.

But for a while, that scale of ambition wasn't matched by the scale of interest in Google's mapping products.

Going Big

Initially, both Google Maps and Google Maps Mobile had disappointing traffic. For all the success they've had today, people didn't seem to notice them at first.

When Google Maps was Slashdotted before the team intended to launch it, it got huge traffic. On that first day, it got just over 10 million map views, according to Bret Taylor, who by then had joined the Where2 team, and was Google Maps' first product manager.

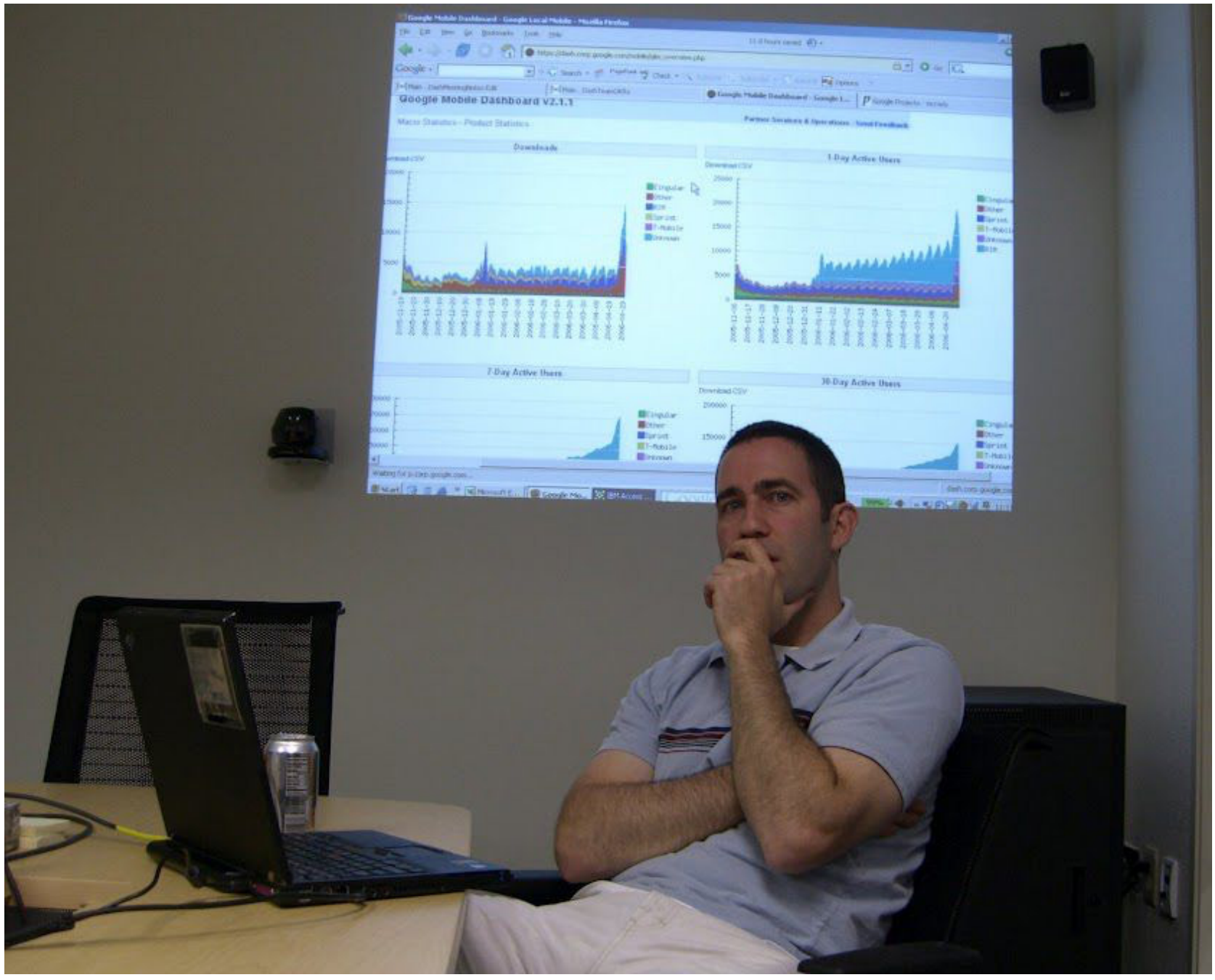
It took months — nearly a year — for the site to equal that launch-day traffic. The Google Maps team thought they had a better product than the competition, and many people agreed with them, but that didn't mean they showed up and used the thing.

Two things led to the product taking off on its eventual ever-upward traffic trajectory: Google Maps added satellite data from Keyhole, and that trick of looking up your own home from space brought in a big new crowd. And Taylor led an effort over the next Christmas break to completely rewrite everything to make it faster. It also didn't hurt that Google Maps released developer tools early on, so people outside the company started building on top of it and evangelizing it.

From then on, the growth didn't stop. By the end of 2006, less than two years after launch, Google Maps was the largest maps provider in the world. Soon it was Google's second-most trafficked site, after Google.com.

Something similar happened for Google Maps for Mobile. The first version was only available for a few phones, and it didn't include the traffic data that had initial-

ly set Zipdash ahead. It didn't get a lot of downloads, and even people who downloaded it didn't use it much. The app only really took off for real when they added BlackBerry support, Crady recalls.



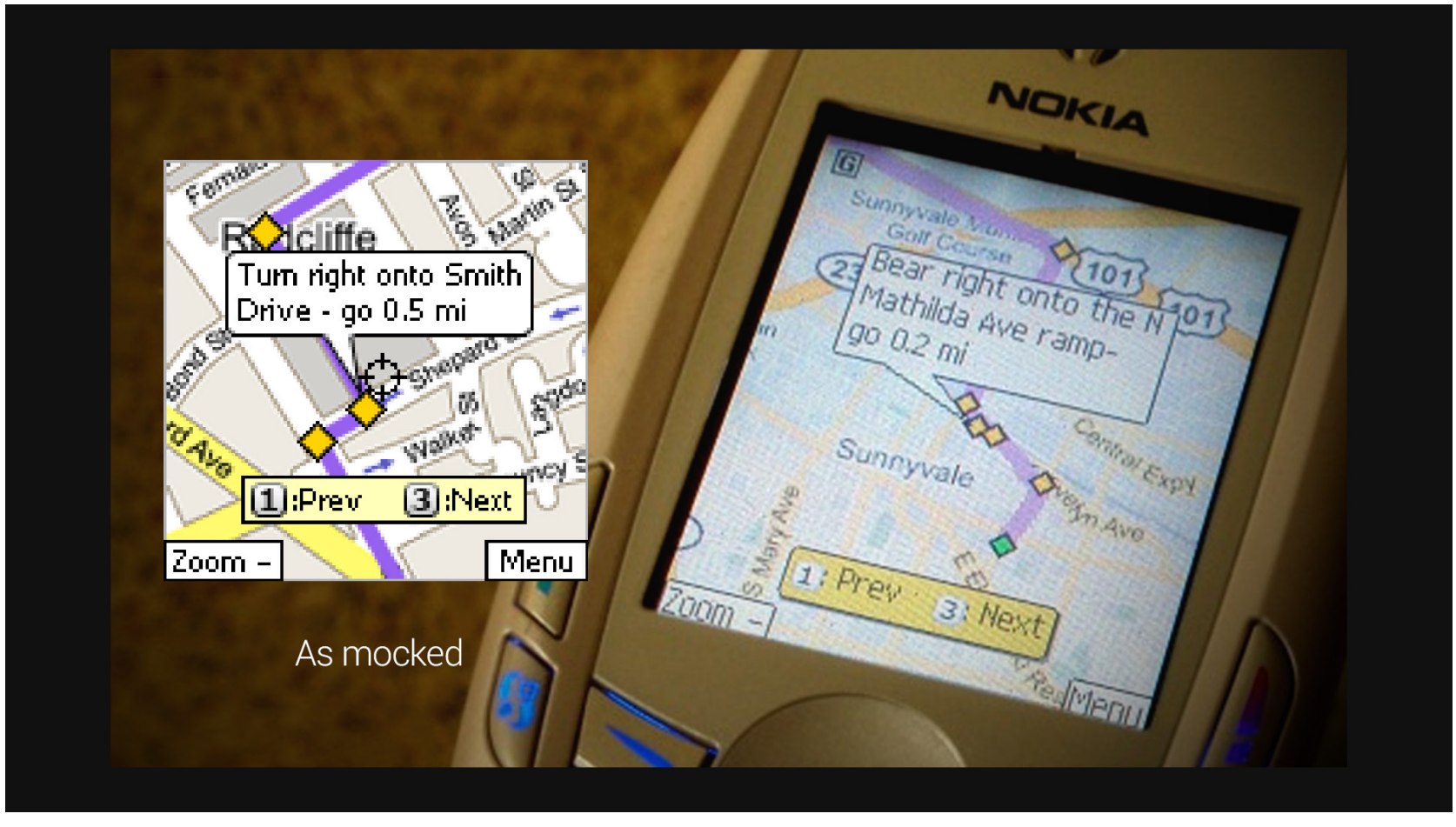
But even then, some people — including then-CEO Eric Schmidt — didn't quite see the full potential, Crady says. Internally at Google, more powerful figures like Nikesh Arora got more resources for efforts to create a mobile marketplace for payments and transactions like ringtones. That no longer exists, obviously.

In January 2006, Yahoo launched a product called Yahoo Go that brought a lot of its products together: Search, news, mail, weather, traffic. Crady recalls Schmidt asking the mobile team to come up with a killer app to respond.

"From the early days, there was all this talk about, 'You need to find the killer app.' And here we were making all these cool features, and as far as we were concerned, this was the killer app," Crady says. "We were working on the killer app."

The Apple Deal

Today, it's absolutely obvious that maps is the killer app for mobile. The fact that your phone knows where it's located means you can drive yourself somewhere new, find a nearby coffee shop, route around traffic, and hail an Uber.



And it's not just Google Maps. For most of the last decade, there have been comparable products from Baidu, Microsoft and Yahoo, and more recently Apple. But mobile apps didn't really exist 10 years ago.

It was a huge coup for Google Maps to be installed as the default on the iPhone, but the Apple-Google hookup was a troubled relationship from way earlier than you might think — way, way before Apple launched its own iPhone mapping app in 2012.

Before it debuted the iPhone in 2007, Apple let Google in on the secret. Apple wanted the phone to come preloaded with a mobile mapping application, so it needed Google's help. But it didn't trust Google to design the user interface, only to contribute data and smarts. So, under strictest code of secrecy, maps for the iPhone were built in collaboration between a group from Apple and the former Zipdash team.

The two cultures didn't have a lot in common from the start, Mark Crady remembers, but then Apple became uncomfortable with Google's work on Android.

Apple started making all sorts of demands, Crady says, including blocking Google from using double-tap to zoom on maps. "It really irked me," he says. And Apple wouldn't share iPhone user activity with Google, meaning that Google had to make

its traffic estimates without including a huge swath of users.

The list of sticking points got longer. The original deal made Google the exclusive maps provider for the iPhone. When Apple decided to allow third-party apps, that had to be renegotiated. Google asked again for user activity, but Apple wouldn't give it up.

In hindsight, Mark says, the Google-Apple mapping relationship showed that even Steve Jobs, for all his storied foresight, had no idea how big maps or apps were going to be.

(Then again — given the relationship had been so frayed for so long — Google should maybe have had a Plan B ready to go when Apple made its own Apple Maps app and pulled the plug on installing Google Maps on iPhones by default in 2012. Instead, Google was caught on its heels for a good three months.)

The View from the Street

For its next big mapping act, launched in May 2007, Google again brought in outside talent. It recruited a research team from Stanford that had made a 3-D scan of Michelangelo's David, and acquired Stanford professor Sebastian Thrun's startup, called VuTool, which was working on imaging using a fleet of cars and off-the-shelf cameras. The outsiders were combined with an internal team that volunteered their experimental "20 percent time" to the project, which would end up being one of Google Maps' most distinctive features: Street View.

Luc Vincent, a Google engineering director who has been at the company for more than a decade, was working on Google Books at the time and Street View when he could. Vincent recalls that in the early days, the team set up shop buying used Chevy Astrovans for something like $5,000 each.

The Street View crew filled the vans with equipment and drove around Mountain View and Palo Alto taking pictures. They drove very slowly to minimize blur. To make things worse, Vincent says, the vans had lasers mounted on them that were very visibly branded from the company that made them, which was named SICK.

It wasn't creepy. Not at all.

Kidding aside, by this point Google Maps was attracting all sorts of privacy controversies. Years later, it would be discovered that a Google engineer had rigged Street View to suck up people's Wi-Fi transmissions as it was driving by and send them

back to Google servers. Google was internationally cited and fined over the incident.

Even in the earliest days, people were freaked out by satellite imagery that showed their own home. Now there were street-level pictures. Ultimately, Google agreed to blur license plates and faces. And Street View currently doesn't capture images in places like Germany, over longstanding privacy concerns including the Wi-Fi incident.

But that doesn't mean Street View has been tamped down as a project. It's now available in 65 of Google Maps' 200-some countries. And these days, photos taken by Street View cars actually help create and validate the underlying data behind Google Maps. Using machine-learning techniques, Google can now fairly accurately look at pictures of buildings and signs and extract street numbers and driving rules.

Ground Truth

The last episode of the Google Maps origin story was a tightly held secret for many years.

In a pair of multibillion-dollar deals in 2007, TomTom bought Tele Atlas and Nokia bought Navteq. The two largest map providers were suddenly in new, and not necessarily friendly, hands. Google realized it needed to do a better job of controlling its own destiny.

A skunkworks team at Google started exploring what types of data it would need to build its own maps, who owned the data and perhaps most importantly, who would sell it. In many cases, Google needed to go to down to the city level to get the details it wanted. They called it Ground Truth.

Along the way, says Megan Quinn — who led the data acquisition project, and later the product itself — the team realized that Ground Truth would not only free it from archaic licensing agreements built for CD-ROMs and in-car navigation systems, but would also allow Google to do new things, like create biking and walking directions, that the incumbents weren't doing.

So Google decided to go for it. "It was very deliberate," Quinn says now. "The challenge of deciding you're going to map the world is that you can't ever stop. The world is ever-changing. And in some ways, this was a real departure for the company, because this is not something you're going to test and toss."

A team of 20 people across the world worked full-time on acquiring map data. Sebastian Thrun led an effort to build a sort of holodeck of tools and services to integrate all the datasets. A large operations group in India helped pull everything together.

When the first push was done, for American map data, Quinn sent out an email to every Google employee. She asked them to test the maps in their hometowns, their college towns, anywhere they had lived. For every bug they found, she would bake and send a chocolate-chip cookie.

"I just spent a whole weekend making cookies," recalls Quinn, now a partner at Kleiner Perkins. "I home-made 7,000 chocolate-chip cookies."

While the homegrown maps may not have been bug-free at the end of the effort, Quinn recalls the incident as "a rallying moment for the company."

Epilogue

The early history of Google Maps ends there. Most of the seminal Google Maps

team members have moved on, but to a person they recall working on Maps as the most fulfilling and successful project of their careers. They still take it personally when they hear of bugs in the product or complaints about misguided redesigns.

At Google, Luc Vincent remains focused on imagery, but now he's working on things like the two satellites Google now owns through its $500 million Skybox acquisition of June 2014.

Keyhole people have outlasted just about everybody else from this era. Co-founders Hanke and Brian McClendon are still key Google executives working on Geo products, and co-founder Chikai Ohazama is an entrepreneur-in-residence at Google Ventures. Late last year the mapping team got a new chief honcho, longtime Google executive Jen Fitzpatrick, amid a larger management reorganization.

Today, Geo is one of Google's main product divisions. Ground Truth remains an ongoing project, and Google developed tools to keep its maps updated through direct user contributions. The division continues to be acquisitive, buying Zagat and Waze and Skybox in recent years. Street View has mapped the Grand Canyon and the canals of Venice. And Google's maps have laid the groundwork for its most ambitious project yet — self-driving cars.

Steve Jobs, the Lost Interview

Robert Cringely (Mark Stephens), 1995

16 years ago, when I was making my television series “Triumph of the nerds,” I interviewed Steve Jobs. That was in 1995. 10 years earlier, Steve had left Apple following a bruising struggle with John Sculley, The C.E.O. he’d brought into the company. At the time of our interview Steve was running NEXT -- The niche computer company he founded after leaving Apple. Little did we know that within 18 months he would sell next to Apple and six months later he’d be running the place.

The way things work in television, we used only a part of that interview in the series. And for years we thought the interview was lost forever because the master tape went missing while being shipped from london to the U.S. in the 1990s. Then just a few days ago, series director Paul Sen found a VHS copy of that interview in his garage. There are very few TV interviews with Steve Jobs and almost no good ones. They rarely show the charisma, candor and vision that this interview does. And so, to honor an amazing man, Here is that interview in its entirety. Most of this has never been seen before. -- Robert Cringely

INTERVIEWER

So how did you get involved with personal computers?

STEVE JOBS

I ran into my first computer when I was about 10 or 11. And it’s hard to remember back then, but -- I’m an old fossil now. I’m an old fossil, so when I was 10 or 11 was about 30 years ago and no one had ever seen a computer. To the extent that they’d seen them, they’d seen them in movies And they were these big boxes with whirring -- for some reason they fixated on the tape drives As being the icon of what the computer was Or flashing lights somehow. And so nobody had ever seen one. They were very mysterious, very powerful things that did something in the background. And so to see one and actually get to use one Was a real privilege back then.

And I got into NASA, the AMES Research Center down here, And I got to use a timesharing terminal. So I didn’t actually see the computer, but I saw a timesharing terminal. And in those days -- again, it’s hard to remember how primitive it was -- There was no such thing as a computer with a graphics video display. It was literally a printer. It was a teletype printer with a keyboard on it. And so you would keyboard

these commands in and then you would wait for a while. And then the thing would go “ta-dah-dah-dah-dah,” and it would tell you something out. But even with that, It was still remarkable, especially for a 10-year-old, That you could write a program In B.A.S.I.C., let’s say, or Fortran and actually this machine Would sort of take your idea and it would -- it would sort of execute your idea and give you back some results. And if they were the results that you predicted, your program really worked, it was an incredibly thrilling experience.

So I became very captivated by a computer. And a computer to me was still a little mysterious, ‘Cause it was at the other end of this wire and I’d never really seen the actual computer itself. And then I got tours of computers after that and saw the insides. And then I was part of this group at hewlett-packard. When I was 12, I called up Bill Hewlett who lived in Hewlett-Packard at the time. And again, this dates me, but there was no such thing as an unlisted telephone number then, so I could just look in the book and looked his name up. And he answered the phone and I said, “Hi. My name’s Steve Jobs. You don’t know me, but I’m 12 years old and I’m building a frequency counter and I’d like some spare parts.”

So he talked to me for about 20 minutes. I’ll never forget it as long as I live. And he gave me the parts, but he also gave me a job working at Hewlett-Packard that summer. And I was 12 years old. And that really made a remarkable influence on me. Hewlett-Packard was really the only company I’d ever seen in my life at that age, And it formed my view of what a company was and how well they treated their employees, you know? At that time -- I mean, they didn’t know about cholesterol back then, but at that time they used to bring a big cartful of donuts and coffee out at 10:00 every morning. Everybody would take a coffee-and-donut break. And just little things like that -- It was clear that the company was -- the company recognized that its true value was its employees.

So anyway, things led to things with Hewlett-Packard and I started going up to their Palo Alto research labs every Tuesday night with a small group of people to meet some of their researchers and stuff. And I saw the first desktop computer ever made, which was the Hewlett-Packard 9100. It was about as big as a suitcase, but it actually had a small cathode-ray tube display in it. And it was completely self-contained. There was no wire going off behind the curtain somewhere. And I fell in love with it. And you could program it in B.A.S.I.C. and A.P.L. And I would just for hours, you know -- get a ride up to Hewlett-Packard and just hang around that machine and write programs for it. And so that was the early days.

And I met Steve Wozniak around that time too -- maybe a little earlier, when I was about 14-15 years old. And we immediately hit it off. He was the first person i’d met

that knew more about electronics than I did, and so I was -- I liked him a lot. And he was maybe five years older than I. He'd gone off to college and gotten kicked out for pulling pranks and was living with his parents and going to De Anza -- the local junior college. So we became best friends and started doing projects together, And we read about the story in "Esquire" magazine about this guy named "Captain Crunch" who could supposedly make free telephone calls. - you've heard about this, I'm sure. And we were captivated. How could anybody do this? And we thought it must be a hoax.
And we started looking through the libraries, looking for the secret tones that would allow you to do this. And it turned out we were at Stanford Linear Accelerator Center one night and way in the bowels of their technical library, way down at the last bookshelf in the corner bottom rack, we found an ATT&T Technical Journal that laid out the whole thing. And that's another moment I'll never forget. When we saw this journal, we thought, - "my God, it's all real." - (laughs) And so we set out to build a device to make these tones And the way it worked was -- you know when you make a long-distance call, you used to hear "too-doo-doo-doo-doo" right in the background? They were tones that sounded like the touchtone you could make on your phone, but they were a different frequency, so you couldn't make them. It turned out that that was the signal from one telephone computer to another, controlling the computers in the network. And AT&T made a fatal flaw when they designed the original digital telephone network was they put the signaling from computer to computer in the same band as your voice, which meant that if you could make those same signals, you could put it right in through the handset, and literally the entire AT&T international phone network would think you were an AT&T computer.

So after three weeks we finally built a box like this that worked. And I remember the first call we made was down to L.A. -- one of Woz's relatives down in Pasadena. We dialed the wrong number, but we woke some guy up in the middle of the night. And we were yelling at him like, "don't you understand? We made this call for free." and this person didn't appreciate that. But it was miraculous. And we built these little boxes to do "blue boxing," as it was called. And we put a little note in the bottom of them. Our logo was "He's got the whole world in his hands." (laughs) And they worked. We built the best blue box in the world. It was all digital, no adjustments. And so you could go up to a pay phone and you could take a trunk over to white plains and then take a satellite over to Europe and then go to Turkey, take a cable back to Atlanta. You know, and you could go around the world. You could go around the world five or six times, 'Cause we learned all the codes for how to get on the satellites and stuff. And then you could call the pay phone next door. And so you could shout in the phone and after about a minute, It would come out the other phone. It was miraculous.

And you might ask, “well, what’s so interesting about that?” What’s so interesting is that we were young. And what we learned was that we could build something ourselves that could control billions of dollars’ worth of infrastructure in the world. That was what we learned, was that us two -- you know, we didn’t know much -- we could build a little thing that could control a giant thing. And that was an incredible lesson. I don’t think there would have ever been an Apple computer had there not been blue box.

INTERVIEWER

Woz said you called the Pope.

STEVE JOBS

Yeah, we did call the Pope. He pretended to be Henry Kissinger. We got the number of the Vatican and we called the Pope. And they started waking people up in the hierarchy, you know -- I don’t know, cardinals and this and that. And they actually sent someone to wake up the Pope when finally we just burst out laughing and they realized that we weren’t Henry Kissinger. Yeah, and so we never got to talk to the Pope, but it was very funny, so...

INTERVIEWER

So the jump from blue boxes to personal computers -- what sparked that?

STEVE JOBS

Necessity, in the sense that there was timesharing computers available. And there was a timesharing company in Mountain View that we could get free time on, so but we needed a terminal and we couldn’t afford one. So we designed and built one. And that was the first thing we ever did. We built this terminal. And so what an “Apple I” was really an extension of this terminal, Putting a microprocessor on the back end. That’s what it was really kind of two separate projects put together. So first we built the terminal and then we built the Apple I. And we really built it for ourselves because we couldn’t afford to buy anything. And we’d scavenge parts here and there and stuff. And we’d build these all by hand. I mean, they’d take, you know, 40 to 80 hours to build one. And then they’d always be breaking, ‘Cause there’s all these tiny little wires. And so it turned out a lot of our friends wanted to build them too. And although they could scavenge most of the parts as well, they didn’t have the sort of skills to build them that we had acquired by training ourselves through building them. And so we ended up helping them build most of their computers. And it was

really taking up all of our time.
And we thought, you know, if we could make what's called a printed circuit board, which is a piece of fiberglass with copper on both sides that's etched to form the wires, so that you could build a computer -- you could build an Apple I in a few hours instead of 40 hours. If we only had one of those, we could sell them to all our friends for, you know, as much as it cost us to make them and make our money back. And everybody would be happy. And we'd save-- you know, we'd get a life again.

So we did that. I sold my Volkswagen bus and Steve sold his calculator and we got enough money to pay a friend of ours to make the artwork to make a printed circuit board. And we made some printed circuit boards and we sold some to our friends. And I was trying to sell the rest of them so that we could get our microbus and calculator back. And I walked into the first computer store in the world, which was "the byte shop" of Mountain View, I think, on El Camino. It metamorphosized into an adult bookstore a few years later. But at this point it was the byte shop. And the person that ran it -- I think his name was Paul Terrell -- He said, "you know, I'll take 50 of those." I said, "this is great." He said, "but I want them fully assembled." We'd never thought of this before. So we then kicked this around and we thought, "why not? Why not try this?" And so I spent the next several days on the phone Talking with electronics parts distributors. We didn't know what we were doing. And we said, "look, here's the parts we need. We need--" We figured we'd buy 100 sets of parts, build 50, sell them to the byte shop for twice what it cost us to build them, therefore paying for the whole 100. and then we'd have 50 left and we could make our profits by selling those.

So we convinced these distributors to give us the parts on net 30 days credit. We had no idea what that meant. "net 30? Sure, sign here." And so we had 30 days to pay them. And so we bought the parts, we built the products, and we sold 50 of them to the byte shop in Palo Alto and got paid in 29 days and then went and paid off the parts people in 30 days. And so we were in business. But we had the classic marxian profit-realization crisis in that our profit wasn't in a liquid currency, our profit was in 50 computers sitting in the corner. So then all of a sudden we had to think, "wow, how are we going to realize our profit?" And so we started thinking about distribution. Are there any other computer stores? And we started calling the other computer stores tThat we'd heard of across the country and we just kind of eased into business that way.

INTERVIEWER

The third key figure in the creation of Apple was former Intel executive Mike Mark-

kula. I asked Steve how he came aboard.

STEVE JOBS

We were designing the Apple II. And we really had some much higher ambitions for the Apple II. Woz's ambitions were -- he wanted to add color graphics. My ambition was that -- it was very clear to me that while there were a bunch of hardware hobbyists that could assemble their own computers or at least take our board and add the transformers for the power supply and the case and the keyboard and go get -- you know, etc -- go get the rest of the stuff -- for every one of those there were a thousand people that couldn't do that, but wanted to mess around with programming -- software hobbyists -- just like I had been when I was, you know, 10, discovering that computer. And so my dream for the Apple II was to sell the first real packaged computer -- packaged personal computer, where you didn't have to be a hardware hobbyist at all.

And so combining both of those dreams, we actually designed the product. And I found a designer and we designed the packaging and everything. And we wanted to make it out of plastic and we had the whole thing ready to go, but we needed some money for tooling the case and things like that. We needed a few hundred thousand dollars. And this was way beyond our means, so I went looking for some venture capital. And I ran across one venture capitalist named Don Valentine Who came over to the garage. And he later said I looked like a "renegade from the human race." That was his famous quote. (chuckles) And he said he wasn't willing to invest in us, but he recommended a few people that might. And one of them was Mike Markkula. So I called mike on the phone and mike came over. And Mike had retired at about 30 or 31 from Intel. He was a product manager there and gotten a little bit of stock and, you know, made, like, a million bucks on stock options, which at that time was quite a lot of money. And he'd been investing in oil and gas deals and kind of staying home and doing that sort of thing. And he, I think, was kind of antsy to get back into something and Mike and I hit it off very well. And so Mike said, "okay, I'll invest after a few weeks." And I said, "No. No, we don't want your money. We want you." (chuckles)

So we convinced Mike to actually throw in with us as an equal partner. And so mike put in some money and Mike put in himself. And the three of us went off and we took this design that was virtually done with the Apple II and tooled it up and announced it a few months later at the "west coast computer faire."

INTERVIEWER

What was that like?

STEVE JOBS

It was great. We got the best. The west coast computer faire was small at that time, but to us it was very large. And so we had this fantastic booth there. We had a projection television showing the Apple II and showing its graphics -- which today look very crude -- but at that time were by far the most advanced graphics on a personal computer. And I think, you know -- my recollection is we stole the show. And a lot of dealers and distributors started lining up and we were off and running.

INTERVIEWER

How old were you?

STEVE JOBS

21.

INTERVIEWER

You're 21. You're a big success. You know, you've just sort of done it by the seat of your pants. You don't have any particular training in this. How do you learn to run a company?

STEVE JOBS

Throughout the years in business I found something, which was I'd always ask why you do things. And the answers you invariably get are, "oh, that's just the way it's done." Nobody knows why they do what they do. Nobody thinks about things very deeply in business. That's what I found. I'll give you an example. When we were building our apple is in the garage, we knew exactly what they cost. When we got into a factory In the Apple II days, the accounting had this notion of a "standard cost" -- where you'd kind of set a standard cost and at the end of a quarter you'd adjust it with a "variance." and I kept asking, "well, why do we do this?" and the answer was, "well, that's just the way it's done." And after about six months of digging into this
What I realized was, the reason you do it is because you don't really have good enough controls to know how much it costs, so you guess. And then you fix your guess at the end of the quarter. And the reason you don't know how much it costs is because your information systems aren't good enough. But nobody said it that

way. And so later on, when we designed this automated factory for Macintosh, we were able to get rid of a lot of these antiquated concepts and know exactly what something cost to the second. So in business, a lot of things are -- I call it “folklore.” They’re done because they were done yesterday and the day before. And so what that means is if you’re willing to sort of ask a lot of questions and think about things and work really hard,
You can learn business pretty fast. It’s not the hardest thing in the world.

INTERVIEWER

Now when you were first coming in contact with these computers -- inventing them, and before that working on the HP 9100, you know, you talk about writing programs. What sort of programs? What did people actually do with these things?

STEVE JOBS

Well, i’ll give you a simple example. When we were designing our blue box, we wrote a lot of custom programs to help us design it, you know, and to do a lot of the dog work for us in terms of calculating master frequencies with subdivisors to get other frequencies and things like that. We used the computer quite a bit to calculate, you know, how much error we would get in the frequencies and how much could be tolerated.

So we used them in our work, but, much more importantly, it had nothing to do with using them for anything practical. It had to do with using them to be a mirror of your thought process, to actually learn how to think. I think the greatest value of learning how to -- I think everybody in this country should learn how to program a computer, should learn a computer language, because it teaches you how to think. It’s like going to law school. I don’t think anybody should be a lawyer, but I think going to law school would actually be useful, ‘Cause it teaches you how to think in a certain way, in the same way that computer programming teaches you in a slightly different way how to think. And so I view computer science as a liberal art. It should be something that everybody learns, you know, takes a year in their life -- one of the courses they take is, you know, learning how to program.

INTERVIEWER

Yeah, but I learned A.P.L., which, you know, obviously is part of the reason why i’m going through life sideways.

STEVE JOBS

Well, was it -- do you look back and consider it an enriching experience that taught you to think in a different way or not?

INTERVIEWER

No, not that particularly. Other languages perhaps more so but I started with A.P.L.

So, obviously, The Apple II was a terrific success. And the company grew like topsy and eventually went public and you guys got really rich. What's it like to get rich?

STEVE JOBS

It's very interesting. I was worth about -- over a million dollars when I was 23 and over $10 million when I was 24 and over $100 million when I was 25. And it wasn't that important, because I never did it for the money. I think money is a wonderful thing 'Cause it enables you to do things. It enables you to invest in ideas that don't have a short-term payback and things like that. But especially at that point in my life, it was not the most important thing. The most important thing was the company, the people, the products we were making, what we were gonna enable people to do with these products. So I didn't think about it a great deal. You know, I never sold any stock and just really believed that the company would do very well over the long term.

INTERVIEWER

Central to the development of the personal computer was the pioneering work being done at Xerox's Palo Alto Research Center, which Steve first visited in 1979.

STEVE JOBS

I had three or four people who kept bugging me that I ought to get my rear over to Xerox PARC and see what they were doing. And so I finally did. I went over there. And they were very kind. And they showed me what they were working on. And they showed me really three things, but I was so blinded by the first one that I didn't even really see the other two. One of the things they showed me was object-oriented programming. They showed me that, but I didn't even see that. The other one they showed me was really a networked computer system. They had over a hundred Alto computers all networked, using e-mail, etc. I didn't even see that. I was so blinded by the first thing they showed me, which was the graphical user interface. I thought

it was the best thing i'd ever seen in my life. Now remember, it was very flawed -- what we saw was incomplete, they'd done a bunch of things wrong, but we didn't know that at the time. It still, though -- they had -- the germ of the idea was there and they'd done it very well.

And within, you know, 10 minutes, it was obvious to me that all computers would work like this someday. It was obvious. I mean, you could argue about how many years it would take. You could argue about who the winners and losers might be, but you couldn't argue about the inevitability. It was so obvious. You would have felt the same way had you been there. You know, that's--

INTERVIEWER

Those are the exact words that Paul Allen used. It's really interesting.

STEVE JOBS

Yeah, it was obvious.

INTERVIEWER

But there were two visits. You saw it, then you brought some people back with you, and what happened the next time? They made you cool your heels for a while?

STEVE JOBS

No.

INTERVIEWER

No? Well, Adele Goldberg says otherwise. (chuckles)

STEVE JOBS

What do you mean?

INTERVIEWER

Well, she did the demo when the group came back. And she said that she argued against doing it for three hours, and they took you other places and showed you other things while she was arguing.

STEVE JOBS

Oh, you mean they were reluctant to show us the demo?

INTERVIEWER

She was.

STEVE JOBS

Okay. Well, I have no idea. I don't remember that. I thought you meant something else. Yeah. But they did show us. And it's good that they showed us, because the technology crashed and burned at Xerox.

INTERVIEWER

Why?

STEVE JOBS

I actually thought a lot about that. And I learned more about that with John Sculley later on, and I think I understand it now pretty well. What happens is, like with John Sculley -- John came from PepsiCo, and they at most would change their product once every 10 years. I mean, to them, a new product was like a new size bottle, right? So if you were a product person, you couldn't change the course of that company very much. So who influenced the success of PepsiCo? The sales and marketing people. Therefore they were the ones that got promoted, and therefore they were the ones that ran the company.

Well, for PepsiCo, that might have been okay, but it turns out the same thing can happen in technology companies that get monopolies like -- oh, IBM and Xerox. If you were a product person at IBM or Xerox, So you make a better copier or a better computer -- so what? When you have a monopoly market share, the company is not any more successful. So the people that can make the company more successful are sales and marketing people. And they end up running the companies. And the product people get driven out of the decision-making forums. And the companies forget what it means to make great products. Sort of the product sensibility and the product genius that brought them to that monopolistic position gets rotted out by people running these companies who have no conception of a good product versus a bad product. They have no conception of the craftsmanship that's required to take

a good idea and turn it into a good product. And they really have no feeling in their hearts usually about wanting to really help the customers. So that's what happened at Xerox.

The people at Xerox PARC used to call the people that ran Xerox "toner heads." And they just had -- these toner heads would come out to Xerox PARC and they just had no clue about what they were seeing.

INTERVIEWER

And for our audience, toner is what?

STEVE JOBS

Oh, toner is what you put into a copier, you know, the toner that you add to an industrial copier. The black stuff. So basically they were copier heads that just had no clue about a computer or what it could do. And so they just grabbed defeat from the greatest victory in the computer industry. Xerox could have owned the entire computer industry today, could have been, you know, a company 10 times its size, could have been IBM, could have been the IBM of the '90s, could have been the Microsoft of the '90s.

INTERVIEWER

That's all ancient history. It doesn't really matter anymore. You mentioned IBM. When IBM entered the market, was that a daunting thing for you at Apple?

STEVE JOBS

Oh, sure. I mean, here was Apple -- you know, a one-billion-dollar company and here was IBM -- at that time probably about 30-some-odd-billion-dollar company entering the market. Sure, it was. It was very scary. We made a very big mistake, though. IBM's first product was terrible. It was really bad. And we made a mistake of not realizing that a lot of other people had a very strong vested interest in helping IBM make it better. So if it had just been up to IBM, they would have crashed and burned. But IBM did have, I think, a genius in their approach which was to have a lot of other people have a vested interest in their success. And that's what saved them in the end.

INTERVIEWER

So you came back from visiting Xerox PARC with a vision. And how did you implement the vision?

STEVE JOBS

Well, I got our best people together and started to get them working on this. The problem was that we'd hired a bunch of people from Hewlett-Packard. They didn't get this idea. They didn't get it. I remember having dramatic arguments with some of these people who thought the coolest thing in user interface was soft keys at the bottom of a screen, you know. They had no concept of proportionally spaced fonts, no concept of a mouse -- as a matter of fact, I remember arguing with these folks -- people screaming at me that it would take us five years to engineer a mouse and it would cost $300 to build. And I finally got fed up. I just went outside and found David Kelley Design and asked him to design me a mouse. And in 90 days, we had a mouse we could build for 15 bucks that was phenomenally reliable. So I found that in a way, Apple did not have the caliber of people that was necessary to seize this idea in many ways. And there was a core team that did, but there was a larger team that mostly had come from Hewlett-Packard that didn't have a clue.

INTERVIEWER

Well, this becomes this issue of professionalism. There is a dark side and a light side to it, isn't there?

STEVE JOBS

No. You know what it is? No, it's not dark and light. It's that people get confused. Companies get confused. When they start getting bigger, they want to replicate their initial success. And a lot of them think, "well, somehow there is some magic in the process of how that success was created." So they start to try to institutionalize process across the company. And before very long, people get very confused that the process is the content. And that's ultimately the downfall of IBM. IBM has the best process people in the world. They just forgot about the content. And that's what happened a little bit at Apple too. We had a lot of people who were great at management process. They just didn't have a clue as to the content. And in my career, I found That the best people, you know, are the ones that really understand the content. And they're a pain in the butt to manage, But you put up with it because they're so great at the content. And that's what makes great products, it's not process. It's content.

So we had a little bit of that problem at Apple. And that problem eventually resulted in the "Lisa," which had its moments of brilliance. In a way, it was very far ahead of

its time, but there wasn't enough fundamental content understanding. Apple drifted too far away from its roots. To these Hewlett-Packard guys, $10,000 was cheap. To our market, to our distribution channels, $10,000 was impossible. So we produced a product that was a complete mismatch for the culture of our company, for the image of our company, for the distribution channels of our company, for our current customers. None of them could afford a product like that. And it failed.

INTERVIEWER

Now you and John fought for leadership, how did that come about?

STEVE JOBS

Well, I thought "Lisa" was in serious trouble. I thought "Lisa" was going off in this very bad direction, as I've just described. And I could not convince enough people in the senior management of Apple that that was the case. And we ran the place as a team for the most part. So I lost. And at that point in time, you know, I brooded for a few months. But it was not very long after that that it really occurred to me that if we didn't do something here, the Apple II was running out of gas. And we needed to do something with this technology fast or else apple might cease to exist as the company that it was.

And so I formed a small team to do the "Macintosh" and, you know, we were on "a mission from God," you know, to save Apple. No one else thought so, but it turned out we were right. And as we evolved the Mac, it became very clear that this was also a way of reinventing Apple. We reinvented everything. We reinvented manufacturing. I made -- I visited probably 80 automated factories in Japan. And we built the world's first automated computer factory in the world in California here. So we adopted the 68,000 microprocessor that "Lisa" had. We negotiated a price that was a fifth of what "Lisa" was gonna pay for it because we were gonna use it at much higher volume. And we really started to design this product that could be sold for a thousand dollars called the "Macintosh." And we didn't make it. We could have sold it at $2000, although we came out at $2500. And, you know, we spent four years of our life doing that. We built the product. We built the automated factory -- the machine to build the machine. We built a completely new distribution system. We built a completely different marketing approach. I think it worked pretty well.

INTERVIEWER

Now you built this team, motivated it, guided them, dealt with them. You know, we've interviewed just lots and lots of people from your Macintosh team. What it

keeps coming down to is your passion, your vision. How do you order your priorities in there? What's important to you in the development of a product?

STEVE JOBS

One of the things that really hurt Apple was after I left, John Sculley got a very serious disease. And that disease -- I've seen other people get it too -- It's the disease of thinking that a really great idea is 90% of the work and that if you just tell all these other people, you know, "here's this great idea," then of course they can go off and make it happen. And the problem with that is that there is just a tremendous amount of craftsmanship in between a great idea and a great product. And as you evolve that great idea, it changes and grows. It never comes out like it starts, because you learn a lot more as you get into the subtleties of it and you also find there is tremendous trade-offs that you have to make. I mean, there are just certain things You can't make electrons do. There are certain things you can't make plastic do or glass do -- and as you get in -- or factories do or robots do. And as you get into all these things, designing a product is keeping 5000 things in your brain -- these concepts -- and fitting them all together and kind of continuing to push to fit them together in new and different ways to get what you want. And every day you discover something new that is a new problem or a new opportunity to fit these things together a little differently. And it's that process that is the magic.

And so we had a lot of great ideas when we started, but what I've always felt that a team of people doing something they really believe in Is like -- is like when I was a young kid There was a widowed man that lived up the street. And he was in his 80s. He was a little scary-looking. And I got to know him a little bit. I think he might have paid me to mow his lawn or something. And one day he said, "come on into my garage. I want to show you something." And he pulled out this dusty old rock tumbler. It was a motor and a coffee can And a little band between them. And he said, "come on with me." We went out to the back and we got some -- just some rocks, some regular old ugly rocks. And we put them in the can with a little bit of liquid and a little bit of grit powder. And we closed the can up. And he turned this motor on and said, "come back tomorrow." And this can was making, you know, a racket as the stones went around. And I came back the next day. And we took -- we opened the can. And we took out these amazingly beautiful polished rocks. The same common stones that had gone in, through rubbing against each other like this, creating a little bit of friction, creating a little bit of noise, had come out these beautiful polished rocks. And that's always been in my mind, my metaphor for a team working really hard on something they're passionate about -- is that it's through the team, through that group of incredibly talented people bumping up against each other, gaving arguments, having fights sometimes, making some noise, and working together, they

polish each other and they polish the ideas. And what comes out are these really beautiful stones, you know? So it's hard to explain. And it's certainly not the result of one person. I mean, people like symbols, so i'm the symbol of certain things. But it really was a team effort on the Mac.

Now, in my life, I observed something Fairly early on at Apple which -- I didn't know how to explain it then, but I've thought a lot about it since -- most things in life, the dynamic range between "average" and "the best" is at most two-to-one. Like, if you go to new york city and you get an average TaxiCab driver versus the best TaxiCab driver, you know you're probably gonna get to your destination with the best Taxi-Cab maybe 30% faster. You know, in an automobile, what's the difference between average and the best? Maybe, I don't know, 20%? The best CD player and an average CD player?
I don't know. 20%? So two-to-one is a big dynamic range in most of life. In software -- and it used to be the case in hardware too -- the difference between average and the best is 50-to-one, maybe 100-to-one.

Very few things in life are like this, but what I was lucky enough to spend my life in is like this. And so I've built a lot of my success off finding these truly gifted people and not settling for "B" and "C" players, but really going for the "A" players. And I found something. I found that when you get enough "A" players together, when you go through the incredible work to find, you know, five of these "A" players, they really like working with each other
Because they've never had a chance to do that before. And they don't want to work with "B" and "C" players. And so it becomes self-policing. And they only want to hire more "A" players. And so you build up these pockets of "A" players and it propagates. And that's what the mac team was like. They were all "A" players. These were extraordinarily talented people, so...

INTERVIEWER

But they're also people who now say that they don't have the energy anymore to work for you.

STEVE JOBS

I think if you talk to a lot of people on the Mac team, they will tell you it was the hardest they've ever worked in their life. Some of them will tell you it was, you know, the happiest they've ever been in their life. But I think all of them will tell you that it is certainly one of the most intense and cherished experiences. Some of those things are not sustainable for some people.

INTERVIEWER

What does it mean when you tell someone their work is shit?

STEVE JOBS

It usually means their work is shit. Sometimes it means, “I think your work is shit” and I’m wrong. But usually it means their work is not anywhere near good enough.

INTERVIEWER

I had this great quote from Bill Atkinson, who says when you say someone’s work is shit, you really mean, “I don’t quite understand it, would you please explain it to me?” (laughs)

STEVE JOBS

No, that’s not usually what I meant. I, you know -- when you get really good people, they know they’re really good, and you don’t have to baby people’s egos so much. And what really matters is the work. And everybody knows that. That’s all that matters is the work. So people are being counted on to do specific pieces of the puzzle. And the most important thing, I think, you can do for somebody who is really good and who’s really being counted on is to point out to them when their work isn’t good enough, and to do it very clearly and to articulate why and to get them back on track. And you need to do that in a way that does not call into question your confidence in their abilities, but leaves not too much room for interpretation that the work that they have done for this particular thing is not good enough to support the goal of the team. And that’s a hard thing to do. And I’ve always taken a very direct approach.

And I think if you talk to people that have worked with me, the really good people have found it beneficial. Some people have hated it, you know, but I’m also one of these people that I don’t really care about being right, you know. I just care about success. So you’ll find a lot of people that will tell you
That I had a very strong opinion and they presented evidence to the contrary and five minutes later I completely changed my mind, ‘Cause i’m like that. I don’t mind being wrong. And i’ll admit that i’m wrong a lot. It doesn’t really matter to me too much. What matters to me is that we do the right thing.

INTERVIEWER

So how and why did Apple get into desktop publishing, which would become the Mac's killer app?

STEVE JOBS

I don't know if you know this, but we got the first Canon Laser printer engine shipped in the United States at Apple. And we had it hooked up to a Lisa actually imaging pages before anybody, before HP -- long before HP, long before Adobe. But I heard a few times, people would tell me, "hey, there are these guys over in this garage that left Xerox PARC. You ought to go see them." And I finally went and saw them. And I saw what they were doing. And it was better than what we were doing. And they were gonna be a hardware company. They wanted to make printers and the whole thing. And so I talked them into being a software company.

Within two or three weeks, we had canceled our internal project. A bunch of people wanted to kill me over this, but we did it. And I had cut a deal with Adobe to use their software and we bought 19.9% of Adobe at Apple. They needed some financing. We wanted a little bit of control. And we were off to the races. And so we got the engines from Canon. We designed the first Laser printer controller at Apple. And we got the software from Adobe and we introduced the Laserwriter. And no one at the company wanted to do it but a few of us in the Mac group. Everybody thought a $7000 printer was crazy. What they didn't understand was you could share it with AppleTalk. I mean, they understood it intellectually, but they didn't understand it viscerally, because the last really expensive thing we tried to sell was Lisa. So we pushed this thing through. And I had to basically do it over a few dead bodies, but we pushed this thing through and it was the first Laser printer on the market, as you know, and, you know, the rest is history.

When I left Apple, Apple was the largest printer company measured by revenue in the world. It lost that distinction to Hewlett-Packard about three or four years after I left, unfortunately. But when I left, it was the largest printer company in the world.

INTERVIEWER

Did you envision desktop publishing? Was that a no-brainer?

STEVE JOBS

Yes, but we also envisioned, really, the networked office. And so in January of 1985 when we had our annual meeting and introduced our new products, I made proba-

bly the largest marketing blunder of my career by announcing the “Macintosh Office” instead of just “desktop publishing.” And we had desktop publishing as a major component of that, but we announced a bunch of other stuff as well. And I think we should have just focused on desktop publishing at that time.

INTERVIEWER

Tell us about your departure from Apple.

STEVE JOBS

Oh, it was very painful. I’m not even sure I want to talk about it. What can I say? I hired the wrong guy. And he destroyed everything i’d spent 10 years working for -- starting with me, but that wasn’t the saddest part. I would have gladly left Apple if Apple would have turned out like i’d wanted it to. He basically got on a rocket ship that was about to leave the pad. And the rocket ship left the pad, and it kind of went to his head. He got confused and thought that he’d built the rocket ship. And then he kind of sort of changed the trajectory so that it was inevitably gonna crash into the ground.

INTERVIEWER

Well, in the pre-Macintosh days and the early Macintosh days, it was always the Steve and John show. You two were joined at the hip for a while there. And then something happened to split you. What was that -- what was that catalyst?

STEVE JOBS

Well, what happened was that the industry went into a recession in late 1984. Sales started seriously contracting. And John didn’t know what to do. He had not a clue. And there was a leadership vacuum at the top of Apple. There were fairly strong general managers running the divisions -- I was running the Macintosh division. Somebody else was running the Apple II division, etc. There were some problems with some of the divisions. There was a person running the storage division that was completely out to lunch and a bunch of things that needed to be changed.

But all of those problems got put in a pressure cooker because of this contraction in the marketplace. And there was no leadership. And John was in a situation where the board was not happy and where he was probably not long for the company. And one thing I did not ever see about John until that time
Was he had an incredible survival instinct. Somebody once told me, “this guy didn’t

get to be the president of PepsiCo without these kinds of instincts." And it was true. And john decided that a really good person to be the root of all these problems would be me. And so we came to loggerheads. And John had cultivated a very close relationship with the board, and they believed him. So that's what happened.

INTERVIEWER

So there were competing visions for the company.

STEVE JOBS

Oh, clearly. Well, not so much competing visions for the company, Because I don't think john had a vision for the company.

INTERVIEWER

I guess I'm asking, what was your vision that lost out in this instance?

STEVE JOBS

It wasn't an issue of vision. It was an issue of execution in the sense that my belief was that Apple needed much stronger leadership to sort of unite these various factions that we'd created with the divisions, that the Macintosh was the future of Apple, that we needed to rein back expenses dramatically in the Apple II area, that we needed to be spending very heavily in the Macintosh area -- things like that. And John's vision was that he should remain the C.E.O. of the company. And anything that would help him do that would be acceptable, I think that, you know, apple was in a state of paralysis in the early part of 1985, and I wasn't at that time capable, I don't think, of running the company as a whole. You know, I was 30 years old and I don't think I had enough experience to run a two-billion-dollar company. Unfortunately, john didn't either.

So anyway, I was told in no uncertain terms that there was no job for me. It was really-- really tragic.

INTERVIEWER

Siberia.

STEVE JOBS

It would have been far smarter for Apple to sort of, you know, let me work on the next -- I volunteered. I said, “why don’t I start a research division? and, you know, give me a few million bucks a year and i’ll go hire some really great people. We’ll do the next great thing.” And I was told there was no opportunity to do that. And my office was taken away. It was -- I mean, i’ll get real emotional if we keep talking about this. But that’s irrelevant. I’m just one person and the company was a lot more people than me, so that’s not the important part. The important part was the values of Apple, you know, over the next several years were systematically destroyed.

INTERVIEWER

I then asked Steve for his thoughts on the state of Apple. Remember, this was 1995 -- a year before he would go back to Apple. Remember too that when Apple bought next a year after this interview, Steve immediately sold the Apple stock he received as part of the sale.

STEVE JOBS

Apple’s dying today. Apple’s dying a very painful death. It’s on a glide slope to die. And the reason is because -- when I walked out the door at Apple, we had a 10-year lead on everybody else in the industry. Macintosh was 10 years ahead. You know, we watched Microsoft take 10 years to catch up with it.
Well, the reason that they could catch up with it was because Apple stood still. I mean, the Macintosh that’s shipping today is, like, you know, 25% different Than the day I left.

They’ve spent hundreds of millions of dollars a year on R&D -- I mean, you know, a total of probably five billion dollars on R&D. What did they get for it? I don’t know. But what happened was, the understanding of how to move these things forward and how to create these new products somehow evaporated. And I think a lot of the good people stuck around for a while, but there wasn’t an opportunity to get together and do this, ‘Cause there wasn’t any leadership to do that. So what’s happened with Apple now is that they’ve fallen behind in many respects, certainly in market share. And most importantly their differentiation has been eroded by Microsoft.

And so what they have now is they have their installed base, which is not growing and which is shrinking slowly, but will provide a good revenue stream for several years, but it’s a glide slope that’s just gonna go like this. So it’s unfortunate. And I don’t really think it’s reversible at this point in time.

INTERVIEWER

Neither do I. What about Microsoft?

STEVE JOBS

I mean, that's the juggernaut now. And it's a kind of, you know, a Ford LTD going into the future. It's definitely not a Cadillac.

Microsoft's orbit was made possible by a Saturn V booster called IBM. And I know Bill would get upset with me for saying this, but of course it was true.Much to Bill and Microsoft's credit, they used that fantastic opportunity to create more opportunity for themselves. Most people don't remember, but until 1984 with the Mac, Microsoft was not in the applications business. It was dominated by Lotus. And Microsoft took a big gamble to write for the Mac and they came out with applications that were terrible. But they kept at it and they made them better. And eventually they dominated the Macintosh application market, and then used a springboard of Windows to get into the PC market with those same applications. And now they dominate the applications in the PC space too.

So they have two characteristics -- I think they're very strong opportunists -- and I don't mean that in a bad way. And two, they're like the Japanese. They just keep on coming. Now they were able to do that because of the revenue stream from the IBM deal. But nonetheless, they made the most of it. And I give them a lot of credit for that. The only problem with Microsoft is they just have no taste. They have absolutely no taste. And what that means is --
I don't mean that in a small way. I mean that in a big way, In the sense that they don't think of original ideas and they don't bring much culture into their product. And you say, "well, why is that important?" Well, you know, proportionally spaced fonts come from typesetting and beautiful books. That's where one gets the idea. If it weren't for the Mac, they would never have that in their products.

And so I guess I am saddened -- not by Microsoft's success. I have no problem with their success. They've earned their success for the most part. I have a problem with the fact that they just make really third-rate products. Their products have no spirit to them. Their products have no sort of spirit of enlightenment about them. They are very pedestrian. And the sad part is that most customers don't have a lot of that spirit either. But the way that we're gonna ratchet up our species is to take the best and to spread it around to everybody, so that everybody grows up with better things and starts to understand the subtlety of these better things. And Microsoft is just Mcdonald's.

So that's what saddens me, not that Microsoft has won, but that Microsoft's products don't display more insight and more creativity.

INTERVIEWER

So what are you doing about it? Tell us about NEXT.

STEVE JOBS

Well, I'm not doing anything about it. Because next is too small of a company to do anything about that. I'm just watching it. And there is really nothing I can do about it.

INTERVIEWER

Next we talked about NEXT -- the company Steve was running in 1995, which Apple was soon to buy. NEXT software would become the heart of the Mac in the form of OS X.

STEVE JOBS

Well, maybe the best thing, since we don't have much time, is I'll just tell you what NEXT is today in the industry.

There hasn't been clearly the innovation in the computer industry is happening in software right now. There hasn't been a real revolution in how we create software in the last 20 years. As a matter of fact, it's gotten worse. While the Macintosh was a revolution for the end user, To make it easier to use, It was the opposite for the developer. The developer paid the price, and software got much more complicated to write as it became easier to use for the end user.

So software is infiltrating everything we do these days. In businesses, software is one of the most potent competitive weapons. I mean, the most successful business war was "Friends & Family" -- MCI's "Friends & Family" in the last 10 years. And what was that? It was a brilliant idea. And it was custom billing software. AT&T didn't respond for 18 months, yielding billions of dollars' worth of market share to MCI. Not 'cause they were stupid, but because they couldn't get the billing software done. So in ways like that and in smaller ways, software is becoming an incredible force in this world to provide new goods and services to people, whether it's over the internet or what have you. Software is gonna be a major enabler in our society.

We have taken another one of those brilliant original ideas at Xerox PARC that I saw in 1979, but didn't see really clearly then, called "object-oriented technology." and we have perfected it and commercialized it here and become the biggest supplier of it to the market. And this object technology lets you build software 10 times faster. And it's better. And so that's what we do.

And we've got a small to medium-sized business. And we're the largest supplier of objects, but, you know, we're a $50 to $75-million company, got about 300 people. And that's what we do.

INTERVIEWER

At the end of the third show actually is the one moment where we do look into the future, as Channel 4 has asked us to do that. And so what's your vision of, you know, 10 years from now with this technology that you're developing?

STEVE JOBS

Well, you know, I think the Internet and the web -- there are two exciting things happening in software and in computing today. I think one is objects, but the other one is the web. The web is incredibly exciting because it is the fulfillment of a lot of our dreams that the computer would ultimately not be
Primarily a device for computation, but metamorphosize into a device for communication. And with the web, that's finally happening. And secondly, it's exciting 'cause Microsoft doesn't own it and therefore there's a tremendous amount of innovation happening.

So I think that the web is gonna be profound in what it does to our society. As you know, about 15% of the goods and services in the U.S. are sold via catalogues or over the television. All that's gonna go on the web and more. Billions and billions, soon tens of billions of dollars' worth
Of goods and services are gonna be sold on the web. If you could -- a way to think about it is that it is the ultimate direct-to-customer distribution channel. Another way to think about it is the smallest company in the world can look as large as the largest company in the world on the web.
So I think the web -- as we look back 10 years from now, the web is going to be the defining technology, the defining social moment for computing. And I think it's going to be huge. I think it's breathed a whole new generation of life into personal computing. And I think it's gonna be huge.

INTERVIEWER

And you're making software that?

STEVE JOBS

Oh, absolutely, but so is everybody. Just forget about what we're doing. Just as an industry, the web is gonna open a whole new door to this industry.

INTERVIEWER

It's another one of those things That it's obvious once it happens, but five years ago, who would have guessed?

STEVE JOBS

Right. That's right. Isn't this a wonderful place we live in?

INTERVIEWER

I was keen to know about Steve's passion. What drove him?

STEVE JOBS

I read an article when I was very young in "Scientific American" and it measured the efficiency of locomotion for various species on the planet. So for, you know, bears and chimpanzees and raccoons and birds and fish, how many kilocalories per kilometer did they spend to move? And humans were measured too.
And the condor won. It was the most efficient. And mankind, the crown of creation, came in with a rather unimpressive showing about a third of the way down the list. But somebody there had the brilliance To test a human riding a bicycle -- blew away the condor all the way off the charts. And I remember this really had an impact on me. I really remember this -- that humans are tool builders. And we build tools that can dramatically amplify our innate human abilities. And to me -- we actually ran an ad like this very early at Apple that the personal computer was the bicycle of the mind. And I believe that with every bone in my body -- that of all the inventions of humans, the computer is going to rank near, if not at the top as history unfolds and we look back. And it is the most awesome tool that we have ever invented. And I feel incredibly lucky to be at exactly the right place in Silicon Valley at exactly the right time historically where this invention has taken form.

And as you know, when you set a vector off in space, if you can change its direction

a little bit at the beginning, it's dramatic when it gets a few miles out in space. I feel we are still really at the beginning of that vector. And if we can nudge it in the right directions, it will be a much better thing
As it progresses on. And I think we've had a chance to do that a few times. And it brings, I think, all of us associated with it tremendous satisfaction.

INTERVIEWER

But how do you know what's the right direction?

STEVE JOBS

Ultimately it comes down to taste. It comes down to taste. It comes down to trying to expose yourself to the best things that humans have done and then try to bring those things in to what you are doing. I mean, Picasso had a saying. He said, "good artists copy. Great artists steal." And we have always been shameless about stealing great ideas. And I think part of what made the Macintosh great was that the people working on it were musicians and poets and artists and zoologists and historians who also happened to be the best computer scientists in the world.

But if it hadn't been for computer science, these people would have all been, you know, doing amazing things in life in other fields. And they brought with them -- we all brought to this effort a very liberal arts sort of air, a very liberal arts attitude, that we wanted to pull in the best that we saw in these other fields into this field. And I don't think you get that if you're very narrow.

INTERVIEWER

One of the questions I asked everyone in the series was, "are you a hippie or a nerd?"

STEVE JOBS

Oh, if I had to pick one of those two, I'm clearly a hippie.

All the people I worked with were clearly in that category too.

INTERVIEWER

Why? Do you seek out hippies or are they attracted to you?

STEVE JOBS

Well, ask yourself, what is a hippie? I mean, this is an old word. It has a lot of connotations. But to me, 'cause I grew up -- I mean, remember that the '60s happened in the early '70s, right? So we have to remember that. And that's sort of when I came of age, so I saw a lot of this. And a lot of it happened right in our backyard here. So to me, the spark of that was that there was something beyond sort of what you see every day. There's something going on here in life beyond just a job and a family and two cars in the garage and a career. There's something more going on. There's another side of the coin That we don't talk about much. And we experience it when there's gaps, when we kind of just aren't really -- when everything's not ordered and perfect, when there's kind of a gap.

You experience this in-rush of something. And a lot of people have set off throughout history to find out what that was, whether it's thoreau, or whether it's some indian mystics or whoever it might be. And the hippie movement got a little bit of that, they wanted to find out what that was about. And that life wasn't about what they saw their parents doing. And of course the pendulum swung too far the other way and it was crazy, but there was a germ of something there. And it's the same thing that causes people to want to be poets instead of bankers, you know?

And I think that's a wonderful thing. And I think that that same spirit can be put into products. And those products can be manufactured and given to people and they can sense that spirit. I mean, if you talk to people that use the Macintosh, they love it. I mean, you don't hear people loving products very often -- you know, really. But you could feel it in there. There was something really wonderful there.

So, I don't think that most of the really best people that i've worked with have worked with computers for the sake of working with computers. They've worked with computers because they are the medium that is best capable of transmitting some feeling that you have that you want to share with other people.
And, you know, before they invented these things, all these people would have done other things.

But computers were invented, and they did come along. And all these people did get interested in school or before school and said, "hey, this is the medium
That I think I can say something in."