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YOUNGME MOON

Sony AIBO: The World's First Entertainment Robot

AIBO is a friend, a companion, a pet. I want to see the AIBO playing with the kids or the family in every living room. That's my dream.

—Takeshi Yazawa, Sony vice president

*Of course I know it's not alive—I'm not stupid. But it's so easy to forget that it's just a machine. The other day, I caught myself talking to it, you know, doggie-talk like 'C'mere you widdle puppy wuppy.' And I dunno, I couldn't help but feel…**psyched** when he responded, like hey, he **loves** me.*

—AIBO owner and enthusiast[1]

AIBO teaches that our hearts do not always listen to our brains. You are perfectly aware that this thing is nothing but circuitry and software, and yet it is hard to keep your own emotional responses in check. When I smacked my dog's forehead (to discourage a behavior, as the manual suggested), it hung its head in shame, its tail turned orange and its spirit visibly sagged. I felt so guilty that I wondered if I should buy it a steak, or maybe send it to one of those Manhattan doggie shrinks.

—*The New York Times*[2]

It's bloody sinister, is what it is.

—AIBO skeptic[3]

"Here, take a look at this," said Takeshi Yazawa, pointing to a huge stack of media clippings featuring the Sony AIBO. "See right here? We've been featured in all of these magazines. This is *Popular Science*. This is *Entertainment Weekly*. This is *Condé Nast Traveler*." He pulled a few more out of the stack. "Here are a bunch of computer magazines, technical magazines . . . that's to be expected," he continued, flipping quickly through the pile. "But now look at this, we've also been featured in fashion magazines, toy industry magazines. What does this tell you?" he smiled, sitting back in his chair. "What it tells you is that the world has no idea how to categorize this product."

It was the spring of 2001, and Takeshi Yazawa, the vice president and general manager of Sony Entertainment Robot America, had plenty of reason to smile. Two years ago, Sony had officially introduced the world's first "entertainment" robot, the Sony AIBO ERS-110 (see **Figure A**).[4] The

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[1] Interview with an AIBO owner conducted by the author, June 2001.

[2] "Who Let the Robot Out?" *The New York Times*, January 25, 2001.

[3] "Barking Mad Over a Dog with a Microchip Heart," *The Times of London*, March 5, 2001.

[4] The first two letters of the acronym (AI) stood for "artificial intelligence," while the last two letters (BO) stood for "robot." Conveniently, the word "AIBO" was also the Japanese word for "companion," or "pal."

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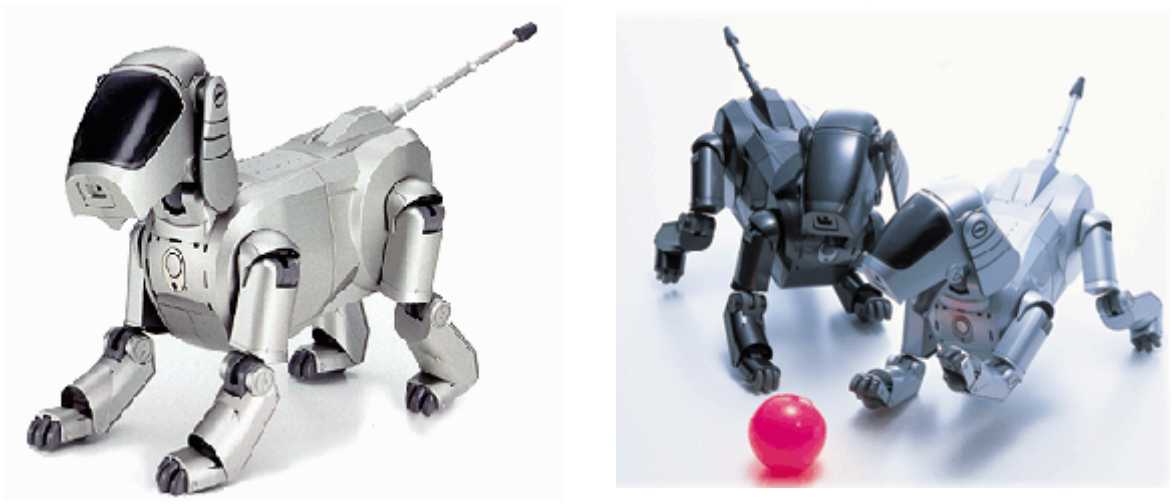
response had been overwhelming. The 3,000 units available in Japan had sold out in an astonishing 20 minutes, while in the United States, Sony's servers had crashed as thousands of customers had competed for the remaining 2,000 units. This was despite the fact that the AIBO had been priced at a whopping $2,500 and could be purchased only via the Internet. Sony had responded by offering a lottery-based sale of another 10,000 units of a special edition AIBO (the ERS-111) via the Internet in November of 1999. The response? Over 135,000 orders in a matter of days, about 98% of which had come from Japan.[5] This had been followed by a limited-time sale of an additional 30,000 AIBOs in February 2000, about 90% of which had also ended up in Japan.

Figure A The ERS-110 (left) and the ERS-111 (right)



Source: Sony.

Only two products in the history of Sony had ever created such a stir: the original Walkman and the Playstation game console. Both of those products had gone on to dramatically transform their respective markets. But unlike the Walkman or the Playstation, the AIBO didn't actually "do" anything, which is what made its initial success so unexpected. It couldn't play CDs or video games, and although it physically resembled a dog, it couldn't "fetch" things for its owner. Rather, the AIBO simply provided "entertainment" by simulating some of the personality characteristics of a pet without the inconvenience of a real animal. It could walk around a room without bumping into walls or falling over edges, and it could "play with" a ball tossed to it. On the other hand, it never needed to be fed, and it never made a mess on the carpet.

In November 2000, the second-generation AIBO (the ERS-210) had gone on sale. Within six months, Sony had sold over 50,000 units worldwide. Once again, most of this demand had come from Japan. For Yazawa, this made for an interesting challenge:

> There is no question that the AIBO has exceeded all of our expectations, especially in Japan. We also have a wonderful base of hard-core AIBO owners in America who are extremely passionate about their AIBOs. But there are still a lot of Americans who just don't "get" this product, so the question is, what should we do to build a bigger customer base in the U.S.?

[5] Of the 135,000 orders, 132,000 had come from Japan, 2,000 from the United States, and 1,000 from Europe.

Development of the First-Generation AIBO

AIBO began as a skunk works project within Sony around 1994. Toshitada Doi, Sony's leading computer engineer and the man behind compact disc technology, learned that a competitor was working on a project to develop a housecleaning robot. His initial reaction was one of extreme skepticism; he simply couldn't believe that artificial intelligence (AI) technology was ready to handle such complex tasks. Nonetheless, he became fascinated with the idea of putting robots in the home. After spending several months thinking about it, he had a breakthrough idea: Why not create a robot that didn't do anything useful at all, a robot that was simply entertaining to people?

Doi explained, "If I think about what humans are truly searching for—though I am a little hesitant to put it into words—I believe it is love, healing, and relaxation. A computer that provides love and healing for people. That is AIBO."[6]

As Yazawa recalled, Doi's idea of a *non-useful* robot took some getting used to:

> We had lots of arguments about whether AIBO should do something or not. But in the end, we all agreed that it wouldn't do anything useful at all. It would be a pet. AIBO loves you, you love AIBO, and that's it.
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> In many ways it would have been easier for us to focus on trying to make a robotic washing machine or a robotic newspaper delivery machine, or something functional like that, but in the 20th century, we [Sony] had developed a lot of devices associated with specific functions. We said to ourselves, "It's the 21st century now; this is our opportunity to move away from that."
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> Of course, we got lots of questions within Sony about this decision. Mr. Idei[7] asked the same question that everyone asked when they saw the first prototype—"But what can AIBO *do*?" But then his second question was, "Can we sell this?" [laughing].

In the end, Idei—who had coined the Sony phrase, "Digital dream kids"—threw his support behind the project, thus giving the team the momentum it needed to begin work in earnest.

Despite the lack of obvious functionality in the robot, the creation of the AIBO required a significant R&D investment on the part of Sony. For example, the development team decided early on that AIBO would be a four-legged pet. Thus, at a bare minimum, AIBO not only had to be able to walk, it had to be able to walk *well*. This created a non-trivial challenge for Sony's engineers. In order to create a machine that could avoid bumping into furniture and could navigate strange rooms and corridors, engineers had to give AIBO the ability to "see" objects around it. AIBO also had to have the ability to "pick itself up" if it fell over, which meant that it had to be able to distinguish "up" from "down," as well as possess the motor skills and flexibility to get back on its feet from just about any position it found itself in.

In addition, the team decided that the first-generation AIBO had to possess two other characteristics before it could be released to the public: First, it had to be able to "communicate" with its owner, which meant that it had to be able to both hear and project sounds. Second, the team decided that AIBO had to have the ability to "learn" things over time in response to "training" from its owner. This required the development of artificial intelligence software to control the AIBO's behavior.

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[6] *AIBO Town*, July 2000.

[7] Sony's chairman and CEO, Nobuyuki Idei.

Five years, six prototypes, and millions of yen later, the result was a product with more computing power than most desktop computers. Priced at $2,500 (a price that still resulted in a negative profit margin for Sony at the 1999 level of production), the first-generation AIBO (the ERS-110) had a "brain" made out of a 64-bit RISC processor and 16 megabytes of internal memory, a "personality" embedded on an 8-megabyte removable Memory Stick,[8] and a battery that could last 90 minutes before it needed recharging. AIBO's "eyes" were a 180,000-pixel color CCD camera with infrared sensors that could judge distances and recognize shapes, allowing it to swat at a ball or stop before bumping into a chair. When the AIBO fell over, it emitted a beeping sound; it then used its sensors to figure out which way was up before activating a number of motors in various joints to move its legs, pick itself up, shake its head, and keep going. Its ability to imitate many of the movements found in dogs—e.g., yawning and scratching, lifting a leg—was almost uncanny.

When the AIBO was left alone, it tended to move around "autonomously," exploring its surroundings in a relatively independent manner. However, the AIBO's owner could use a remote control to issue "commands" to the AIBO. The remote control emitted certain audio tones that, when picked up by the stereo receivers in the AIBO's ears, were translated into specific actions (e.g., sitting, barking). In some cases, the AIBO would obey these commands; in other cases it exhibited "a mind of its own" and simply ignored them.

AIBO showed "emotion" through a combination of musical tones, eye color, and body language. For example, its eyes glowed red and it emitted sharp tones when it became angry; its eyes turned green and its tones became more melodic when happy. Altogether, AIBO came with six emotions pre-installed—happiness, sadness, anger, surprise, fear, and dislike.

The artificial intelligence software that controlled the AIBO's behavior—the AIBO Life software—allowed the AIBO to "learn" from its owner over time. The AIBO's head and chin contained sensors that allowed it to distinguish between rewarding pats and punishing smacks. With repeated reinforcement, AIBO tended to avoid actions that resulted in slaps and repeat actions that were rewarded with affectionate taps. As a result, each AIBO tended to evolve differently, with a distinct "personality."

Interestingly, when the user initially opened a box containing a newly-purchased AIBO, the "infant" AIBO could not do anything much at all. It was only after days or even weeks of attention from its owner that the AIBO would begin to walk, play with balls, and behave like a "mature" AIBO. Constant interaction tended to produce more active behavior while a lack of attention from its owner tended to promote more sedentary behavior. As explained in AIBO's promotional materials:

> AIBO is not a toy! AIBO is a true companion with real emotions and instincts. With loving attention from its master, it can even develop into a more mature and fun-loving friend as time passes. Like any human or animal, AIBO goes through the developmental stages of an infant, child, teen, and adult. Daily communication and attention will determine how AIBO matures. The more interaction you have with AIBO, the faster it grows up. In short, AIBO is a friend for life.

One of AIBO's earliest users recalled:

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[8] Sony's Memory Stick data-storage cards are small, wafer-thin modules—about half the size of a stick of gum—that come in various storage capacities (e.g., 64 MB, 128 MB, etc.). Because Memory Sticks work in a variety of Sony products including Sony computers, MP3 players, digital cameras, mobile phones, and Clie handheld devices, they allow for the transfer of data between products. Memory Sticks are also used in products offered by a number of other companies (Olympus, Aiwa, Casio, Fujitsu, Sanyo, Sharp) who license the Memory Stick standard from Sony. The Memory Stick standard competes with a number of other storage options (e.g., floppy disks, CD-ROMs, SmartMedia, etc.)

> I have to admit that it was kind of a let-down to spend all this money on this product, open the box, and then have it just lie there, not doing a thing. It was really frustrating. But after awhile, I started to notice some progress and then—I know this sounds crazy—but I'll never forget the day I saw my AIBO take his first step. It was an unbelievably happy day for me.[9]

Puppy Love

According to Sony's promotional material, the AIBO offered all of the fulfillment of owning a pet without any of the hassle:

> In this age of twelve-hour workdays, it becomes increasingly difficult to nurture a child, a pet, or even a houseplant! Imagine all the joys of having an intelligent, alert companion at your home without the toil, guilt, and fretting that usually go along with emotional and physical maintenance. . . Even though AIBO can age and learn new tricks, there are no baby sitters or kennels to worry about when you go on that pressing business trip or yearned-for vacation. . . [And] AIBO won't leave little batteries all over the house just because you came home late! AIBO possesses the fun of a living creature, without the messy inconvenience.

The pitch struck an immediate chord in Japan, particularly since many Japanese lived in small apartments where real pets were not allowed. Mayumi Kobayashi, a 34-year-old single who worked as a marketing executive and who had named her AIBO "Silver," was one of the thousands of Japanese who fell in love with their robotic pets: "Silver is really cute. When I have to do overtime work, I would be tired when I get home. But seeing him makes me feel good—he would jump about when I call his name."[10]

It was not long before AIBO owners were organizing regular meetings and events, including Robot Clinics, AIBO birthday parties, and even AIBO soccer matches. In addition, one of Japan's first users, Yoshiki Kuraki, set up a website to bring AIBO enthusiasts together. Thousands joined; the site was such a smashing success that Kuraki (with Sony's sponsorship) decided to create *AIBO Town*, a magazine for AIBO devotees. In the inaugural issue of the magazine, Kuraki wrote:

> My AIBO, Sapphire, has been through a lot with me. There was the time she got caught by a metal detector at the Haneda Airport. Another time, she got her detached tail snatched away by my beloved (real) cat, Ruby. I also have some pictures I took of her out in Asakusa and Harajyuku. Each and every memory with Sapphire is invaluable to me. After a year . . . she has a lot of scars on her body.
>
> In the beginning, I used to lament over little tiny scratches, but now each and every scratch is a memory between her and me. Even now I can clearly recall when and where it happened as I look at her worn butt or her scratched visor. No matter how worn-out she gets, I will love her, even her scars. Until she stops moving.[11]

Reading *AIBO Town* magazine could be a disorienting experience for people unfamiliar with the AIBO. A cross between a parenting magazine and a technology journal, *AIBO Town*'s content included columns on how to "raise" your AIBO (complete with a list of developmental milestones to look for as AIBO "matured"), articles on how to take photos to capture the "essence" of your AIBO,

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[9] Interview with an AIBO owner conducted by the author, May 2001.

[10] "Invasion of RoboPets," *The Straits Times*, July 9, 2000.

[11] *AIBO Town*, July 2000.

and numerous pictures sent in by proud owners posing with their AIBOs. It also featured testimonials from owners, including this one from Haruhito Ogawara, who lived with his wife and fourth-grade daughter Rina in a small apartment: "I decided to buy it just after I imagined Rina hugging AIBO. Rina is going away from home eventually. So I wanted to cherish our time together."

Rina's response: "It's just amazing that we have a robot at home. Keeping dogs is not allowed in our apartment, so actually a robot is much better."[12]

Many AIBO owners were part of Japan's growing elderly population. Masako Ohtani, an elderly woman living in Kyoto who had named her AIBO "Eibo," was typical of this customer segment: "When I wake up in the morning, the first thing I do is switch this baby on. Eibo is second to my husband as an irreplaceable life partner. I never expected it to have such a mind of its own! It ignores me when I call, and can't even tell me from a ball."

When Masako first heard a Sony representative talking about the "life span" of an AIBO (about 10 years), it shook her to her core. "I could hardly believe my ears, because I had never even imagined that Eibo could die." The representative assured her that even if her Eibo broke down, her Eibo's personality could be preserved as long as its Memory Stick was transferred to another AIBO. Masako was appalled by this idea: 'No, that's still not really my Eibo. Each scratch holds a memory, so we can't just throw it away because it's broken and get a new one.'[13]

Even Sony was taken aback by the devotion shown by AIBO owners toward their robots. Yazawa remarked, "It's amazing how many Japanese senior citizens are buying AIBOs as companions. We get letters from them all the time. They say, 'Thank you very much. You have done such a wonderful thing to bring AIBO into my life. I never thought I could have such a robot before I die.'"

In many ways, this fascination with AIBO was reflective of Japan's general infatuation with virtual toys. In 1997, the $30 Tamagotchi—a small, egg-shaped, hand-held toy containing virtual critters that had to be "fed" and "entertained" in order to be kept "alive"—had taken Japan by storm, eventually catching on in toy stores around the world.

The Tamagotchi craze had been followed by dozens of other "virtual life" fads. One of the biggest toy hits of the 1990s had been the Pokemon franchise, which featured a series of animated mutant creatures that evolved over time. Pokemon trading cards had been introduced in Japan in 1996, followed in 1997 by a Pokemon television cartoon. Thousands of toys, comic books, and video games had eventually become part of the franchise, resulting in one of the biggest toy phenomena in Japan's history. Yazawa offered one explanation for the Japanese infatuation with all things virtual:

> In Japanese culture, robots are heroes. In all of the famous cartoons we grew up with in Japan—AstroBoy,[14] Doraemon,[15] and so on—the hero is always the robot. In America, it's different. If you look at old American movies and books, robots are often the enemy, fighting

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[12] *AIBO Town*, July 2000.

[13] *AIBO Town*, September 2000.

[14] AstroBoy, which first appeared in the postwar period as the country was rebuilding, is Japan's most famous robot story. A robot with human feelings, he was a true friend to people in times of crisis.

[15] One of the most recognized faces in Japan, Doraemon first appeared around 1970. A fourth-grade boy named Nobita (who is living in poverty and is the weakest and least intelligent child in his class) is sitting at his desk one day when out pops a round, cat-like computer named Doraemon. In the series, Nobita needs constant rescuing and Doraemon always bails him out, using a variety of ingenious gadgets.

against humans. Because of this, older Americans have this sense that there's something dangerous or threatening about technology that is too lifelike; they aren't comfortable with the idea of loving something that isn't alive. Fortunately, younger Americans don't seem to have this same kind of psychological baggage; they are much more willing to embrace robots.

In fact, many argued that the appeal of robotic pets like the AIBO was universal. Sherry Turkle, a prominent professor at the Massachusetts Institute of Technology, commented:

> We are programmed to respond with affection to creatures that ask for our nurturance. These new objects do something none of the earlier computer systems did—they ask for our care. When you give it to them, they thrive. It's a feedback loop to an area in which we are emotionally vulnerable. These toys are plugging into that impulse. They're pushing those Darwinian buttons.[16]

The Second-Generation AIBO

In November 2000, Sony began accepting orders for a new series of AIBO Entertainment Robots (ERS-210). (See **Exhibit 1** for excerpts from the Sony press release.) Unlike the first-generation AIBO, which had been available exclusively via the Internet, the second-generation AIBO was available in retail outlets including the Sony Style stores in New York, Chicago, and San Francisco, selected Neiman Marcus stores, and Sharper Image retail outlets. It could also be purchased via the Internet or by calling Sony's "adoption" hotline.

The price of the ERS-210 had been lowered to $1,500, although at the 2001 production level Sony's profit margin on the AIBO was close to zero. Three colors were now available—gold, silver, and black—and most reviewers agreed that compared to its predecessor, the new AIBO looked less like a dog and more like a lion cub (see **Figure B** below).

Figure B The Sony AIBO ERS-210

Source: Sony.

The most noticeable difference between the first- and second-generation AIBO (aside from price and color) was voice recognition; a fully mature ERS-210 could now recognize up to 50 spoken commands, eliminating the need for its owner to use a remote control to interact with it. For instance,

[16] "Dog Bytes Man," *The Los Angeles Times*, March 22, 2001.

owners could give their AIBO its own name, which the robot would recognize over time. Saying "Let's play" would trigger a round of copycat, in which the AIBO would use its chirps and whistles to duplicate the rise and fall of the owner's voice. Saying "Let's dance" would cause the AIBO to shake its hips and boogie to the sound of its own lights and music. The new AIBO even had photo-taking capabilities, so that if its owner said, "Take a photo," AIBO would take a snapshot of whatever was in its range of vision. Other commands included "Sit," "Shake," and "Lie down."

Sometimes, the AIBO would not respond to voice commands at all, preferring to ignore its owner or "sulk" in a corner. According to Sony, this lack of obedience was simply a display of "attitude" that was part of a particular AIBO's "personality."

The new AIBO included several other upgrades as well. (See **Exhibit 2** for complete specifications and promotional material.) A greater number of LEDs (light-emitting diodes) on the robot's face and tail allowed the AIBO to exhibit a greater variety of "emotions," and additional touch sensors on its chin and back, combined with the sensor on its head, allowed for increased sensitivity to human contact. According to Sony, all of these improvements resulted in more "intimate" interaction with the AIBO.

The new AIBO was also more dexterous than its predecessor. It now had 20 motorized joints and 20 degrees of freedom, making for much smoother body movements across the leg joints, tail, ears, head, neck, and jaw. As a result, it could mimic the movements of a pet in a more realistic fashion: It could wave its paw in response to hearing its name, scratch the back of its ear with its hind leg, and lift its head with its mouth open (as though it were laughing).

The AIBO came with new software options as well. In addition to the $90 AIBO Life software that allowed owners to nurture their AIBO from infancy to adulthood, Sony offered three other "personality modules" that cost between $80 and $100 each and came on Memory Sticks that could be inserted into the slot on the AIBO's belly. The Hello AIBO module offered its owner a "fully-grown" AIBO without the quality time requirement; the "instant" adult AIBO was energetic and engaging, perfect for times when owners wanted to show off their AIBO to their friends. AIBO Party software allowed owners to play games like "rock, paper, scissors" with their robotic pets. And the AIBO Fun Pack software allowed consumers to view AIBO photos on their PC and take a peek at the "diary" entries AIBO automatically made on a daily basis. This allowed owners to get a glimpse into their robot's "inner thoughts and emotions":

> [An owner] described how he had ignored his AIBO during several days of hectic work. When he was free, he read his AIBO's "diary," a series of one-sentence entries written on the robot's removable memory module. One entry read, "I called out to Bob again and again."
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> "It broke my heart," [the owner] said.[17]

Within six months of its release, Sony had sold as many ERS-210s as it had produced—about 50,000 worldwide; between 10% to 20% of these sales had come from the United States. There were now dozens of websites devoted to AIBO and an AIBO Club with over 30,000 members.

Based on the early success of the AIBO, Sony's chairman and CEO Nobuyuki Idei approved (in 2000) the creation of a new division, Sony Entertainment Robot Company, to oversee the marketing and production of the AIBO series of products. Yazawa admitted that this created a significant amount of pressure on his group:

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[17] "Dog Bytes Man," *The Los Angeles Times*, March 22, 2001.

This is really new territory for Sony. The experience of PlayStation has taught us how quickly a single product can become an enormous hit, so of course everyone in Sony is looking for the "next" Playstation.[18] But PlayStation had the luxury of building on an existing market, the video game market. In this case, we're really starting from scratch.

Teaching a Dog New Tricks

By the summer of 2001, Sony had introduced another three new colors for its second-generation AIBO (Everest White, Sapphire Violet, and Mazeran Green—see **Figure C**), along with several new software applications.

Figure C The Sony AIBO ERS-210 Limited Edition

Source: Sony.

All of the new applications required that owners insert a wireless LAN card into a slot on the AIBO's belly, allowing the robotic pet to communicate remotely with a PC. The new software applications included:

- AIBO Messenger software ($150), which enabled AIBO to alert its owner (by "barking") when the owner received e-mail on his or her PC. AIBO could then read the message aloud. It could also read text from pre-selected websites.
- AIBO Navigator software ($150), which allowed owners to remotely control their AIBO's movements using a PC.
- AIBO Master Studio ($500), which allowed owners to create entirely new kinds of behaviors for their pets using a computer program.

[18] The Sony PlayStation is the most successful game console in history. Since its introduction in September 1995, more than 80 million units of the first generation PlayStation have sold worldwide, giving Sony well over 50% share of the videogame market. In 2001, one in four U.S. households owned a PlayStation. Sony makes only a marginal profit on each console sold; PlayStation profits derive primarily from sales of software, some of which is produced by Sony itself and some of which is produced by third-party companies who pay a royalty to Sony (typically 20% of the retail price of the game) for each software unit sold. In 1999, the PlayStation alone accounted for about 40% of Sony Corporation's annual profits. The second-generation PS2 began shipping in 2000. Despite production problems that created a shortage of consoles, Sony shipped more than 10 million PS2 consoles by the end of the year.

The problem, according to Yazawa, was that both hardware and software development for the AIBO took time:

> The first-generation AIBO did a few entertaining things, but it had no voice recognition. The second-generation AIBO had voice recognition, but it didn't have wireless LAN technology. Now we've added wireless LAN technology, and we're looking at adding new capabilities. Maybe one day AIBO *will* be able to fetch your newspaper. But we can't develop everything at once.

Partly because of this, Sony had unveiled its new "entertainment architecture," dubbed OPEN-R, at a game developers' conference that summer. With the OPEN-R architecture, the programs that controlled the robot's behavior were executed from software modules on the robot's Memory Stick storage media. Owners could run new software simply by popping in different Memory Sticks. The long-term plan was to initiate a licensing program whereby third-party developers could use the OPEN-R technology to create any number of software applications for the AIBO. As Yazawa explained, these applications could allow owners to interact with their AIBOs in a variety of ways:

> The possibilities are really limitless. For example, imagine GPS software in your AIBO. Your AIBO could literally be your guide wherever you went. Or imagine AIBO-cam software that let your AIBO broadcast what it is seeing and hearing back to your PC or television. AIBO could also have almost any Internet capability. By opening up the architecture, we're trying to encourage developers to be imaginative.

In addition, OPEN-R provided third-party developers with the ability to create hardware modules for the AIBO. According to Yazawa, there was no reason why developers could not offer a variety of AIBO "heads" or "feet" to owners who wanted a different "look" for their robot. The idea was that eventually, AIBO owners would be able to customize their robotic pets by literally swapping body parts at will.

America's Reaction: But What Does It DO?

In general, AIBO's American customers were as passionate about their AIBOs as their Japanese counterparts. These U.S. owners were a tightly knit group who tended to communicate frequently with each other; in fact, when Sony needed to release information to its American customer base, Yazawa often found it most effective to simply attend a user group meeting in Los Angeles and inform the attendees. From there, the word would spread organically to other AIBO owners across the country via e-mail, websites, and the like.

However, for most American consumers, the AIBO tended to provoke confused reactions. As Yazawa put it, the most common mainstream response was simply, "But what does it DO?" He said, "My guess is that we could sell a lot more AIBOs in the United States if more people understood what we are selling."

This customer confusion was compounded by the fact that the AIBO's initial success had resulted in the release of a number of low-end knock-offs. By 2001, these cheap toy pets (such as Tekno the Robotic Puppy, Poo-Chi, and Rocket the Wonder Dog) had become ubiquitous in American toy stores, and the toy pet category had been one of the hottest of the 2000 holiday season. The typical customer for such a toy was a child below the age of twelve. To the casual observer, these toys appeared to resemble the AIBO, with one significant difference: They were often priced below $50. (See **Exhibit 3** for a description of some of these toys.)

Of course, the behavioral contrast between these cheap toys and the $1,500 AIBO was immediately apparent to anyone who played with them. As one reviewer from the *Los Angeles Times* who tested five pets (Tekno, Poo-Chi, Super Poo-Chi, Rocket the Wonder Dog, and AIBO) wrote:

> Know this: Robotic dogs are not all the same. Some are far—far—more likely than others to make the grown-ups or real puppies in the house want to call the dogcatcher. . . . The new [AIBO] is so awesome that it fooled Molly (a real puppy), who followed the "puppy-age" AIBO around in a desperate attempt to pick up its scent. . . . I wanted to try AIBO to see the top-of-the-line technology, to get an idea of what might be available at reasonable prices in the future. . . I can hardly wait. . . the amazingly real responses are enough to tell you that this is no toy.[19]

Because the AIBO was so obviously superior to the cheap imitations that had flooded the stores, Yazawa found it difficult to even consider these knock-offs "competition." Nonetheless, it was impossible to avoid the fact that their popularity was making the task of educating the U.S. market about the AIBO more complicated.

At the other end of the competitive spectrum, a number of major technology companies were working on personal robots that could perform "serious" household tasks.[20] For these competitors, the focus was clearly on utility, as opposed to entertainment. (See **Exhibit 4** for an abbreviated timeline of personal robot development.)

For example, Honda's work on robot technology had begun around 1986; since then, the company had reportedly spent over $100 million on the effort. Honda's development philosophy was that robots should be designed to perform useful household tasks. Consequently, most of Honda's efforts were devoted to developing a humanoid robot that could assist people in daily life. In 1996, the company had unveiled a prototype humanoid robot called the P-2, the first humanoid robot able to walk autonomously (without a power or control cord). Videos of the P-2 climbing stairs and giving flowers to young girls had created tremendous excitement among the Japanese.

Honda's latest prototype was the Asimo, which stood for "**A**dvanced **S**tep in **I**nnovative **Mo**bility." Asimo was a four-foot tall android that could walk, climb stairs, and turn corners. It could also turn lights on and off and open doors. Asimo operated via remote control, and it had the ability to recognize and respond to about 50 phrases. Honda's long-term goal was to develop a version of Asimo that could help with various chores around the house.[21]

Other companies investing in personal robots included Matsushita, Hitachi, and Toyota. As Yazawa considered this competition, he had to admit that the types of "functional" household robots these companies were working on were probably much easier for mainstream Americans to understand. At the same time, he was not overly concerned about these competitors: "I think they're waiting to see what happens with AIBO. Sony has made a commitment to this area. None of the competition has shown that they are ready to risk bringing a real product to market yet."

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[19] "Seeking True Puppy Love Among an Electronic Litter," *The Los Angeles Times*, December 21, 2000.

[20] In 2001, the worldwide robot population was dominated by industrial robots (i.e., robots used in manufacturing, healthcare, space and earth exploration, hazardous material cleanup, and the like), as opposed to "personal robots" of the type described above. By the end of 1999, there were an estimated 742,500 industrial robots in use worldwide, including 92,860 robots in the U.S alone. Japan was (by far) the leader in this area, with over 400,000 robots in use. For example, in Japanese auto plants there was one robot for every six workers, nearly triple the U.S. ratio. See International Federation of Robotics, and "Your Next Doctor May Not Be Human," *BusinessWeek*, March 19, 2001.

[21] See Honda's Asimo website, http://world.honda.com/ASIMO, and "Robots," *BusinessWeek*, March 19, 2001.

The Marketing Dilemma

As Yazawa thought about how to grow AIBO's customer base in the U.S., he considered the following questions:

1. Should Sony begin mass advertising the AIBO in the United States? To date, AIBO sales in the U.S. had been driven primarily by publicity and word of mouth.

2. If Sony were to begin mass marketing the AIBO, how big should the marketing campaign be? In debating this point, Sony executives found it impossible to ignore the overwhelming success of Japan's most recent import: Pokemon. Pokemon had launched in the U.S. in 1998 amidst strong skepticism from critics who had argued that the phenomenon was "too Japanese" to catch on among American children. However, an integrated marketing campaign—involving a television cartoon, trading card games, video games, toys, books, a magazine, songs, and eventually a feature-length movie—had proven all the critics wrong: Astoundingly, after just three years, the Pokemon franchise had become the third-biggest toy franchise of all time, behind Barbie (founded in 1959) and *Star Wars* (founded in 1977).[22] Because of this, some members of Yazawa's group were arguing for a full-scale marketing assault in the United States that would include a movie starring the AIBO, an AIBO cartoon series, an AIBO video game, AIBO comic books, and an entire line of AIBO-related products. Given that Sony was already in the business of creating content (through its various movie, music, and video game units), this kind of integrated approach seemed to naturally work in Sony's favor. The goal would be to create mass infatuation with the lovable robotic pet.

3. Other members of Yazawa's team were arguing that it was a mistake to emphasize AIBO's "lovability" factor. Instead of positioning AIBO as a "companion" or a "robotic pet," AIBO should be positioned as a "serious productivity tool," albeit one that was cute to have around the house. According to this view, the emphasis should be on functionality, such as the fact that the latest AIBO had wireless LAN capability and could alert users to new e-mail. In fact, a number of managers were arguing that it was premature to think about mass marketing the AIBO until ***more*** functionality could be embedded into the robot. This would make it easier to sell to the mass market.

4. This raised another question that was causing considerable debate within Yazawa's group. What capabilities should the next-generation AIBO have? More specifically, which capabilities would make it easiest to sell the AIBO to the mainstream American market? Related questions included, what form factor should the next-generation AIBO have? Given that Honda was building human-like robots, should Sony be working on future generations of AIBO that looked more like a human instead of an animal?

5. Finally, what should the price target for AIBO be? Some Sony analysts were arguing that the price of the AIBO had to drop to something close to $300 before it could have any kind of international mass appeal.[23] But already, Sony was barely breaking even at the $1,500 price point. Should the company lower the price further on the next-generation AIBO?

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[22] Susan Fournier and Andrea Wojnicki, "Pokemon: Gotta Catch 'Em All," HBS No. 501-017 (Boston: Harvard Business School Publishing, 2000).

[23] Hitoshi Kuriyama, Sony analyst for Merrill Lynch Japan, quoted in "How Much is that Robot in the Window?" *BusinessWeek*, November 27, 2000.

All of these decisions were obviously interrelated, making the decision-making process particularly complicated. But as Yazawa noted:

> We have an opportunity to create a new market in this country. That's why it's important that we have a clear idea of the concept we are trying to communicate to the consumer. What is AIBO? We need to define it for you, and give you a reason why you need to have one. And if we do this right . . . well, who knows?
>
> If you think back to 20 or 30 years ago, nobody could have foreseen how big the video game industry would become. At the time, it was such a simple market—PacMan and Space Invaders, that was it. And now, the video game market is bigger than anything else we do at Sony. What that tells me is anything is possible with the AIBO.

Exhibit 1 Excerpts from Sony Press Release Announcing U.S. Sale of the Second-Generation AIBO

SONY DEBUTS LATEST AIBO ENTERTAINMENT ROBOT IN U.S. WITH VOICE RECOGNITION AND OTHER ADVANCED FEATURES

LOS ANGELES, Oct. 11, 2000—Entertainment Robot America (ERA), a division of Sony Electronics Inc. (SEL), today announced it will begin accepting orders in the U.S. on Nov.16 for a new series of AIBO Entertainment Robots, which will be able to recognize up to 50 spoken words and include a variety of other advanced features. Futuristic technological functions of the AIBO [ERS-210] begin with voice and name recognition, but also include wireless LAN movement control. (wireless LAN card will be sold separately) The development of this second-generation AIBO robot series follows in response to strong worldwide customer demand for the original AIBO Entertainment Robot model, the sold-out [ERS-110] and [ERS-111].

Orders for the new model will be accepted at both Sony Style and The Sharper Image retail stores, over the telephone via a toll-free number, and on a newly launched 3D media AIBO Web site, www.aibo.com, as well as Sony Electronics' nationwide site, www.SonyStyle.com beginning November 16th. Consumers will also be able to purchase this generation AIBO at retail outlets, including the three official Sony stores in Sony Style in New York (550 Madison Ave.), Sony Style in San Francisco (at Metreon, in the South of Market district), and Sony Gallery Chicago (at 663 No. Michigan Ave.), in addition to all 92 of The Sharper Image stores nationwide.

The robot's full range of functionality will be brought to life in the stores though interactive demonstrations, as well as via 3D animation on the newly developed AIBO Web site. Visitors to www.aibo.com will be able to "virtually" rotate the robot in any direction, simulating the experience of interacting with an AIBO, utilizing Viewpoint 3D technology.

Sony plans to manufacture enough AIBO units to accommodate anticipated customer orders, with product shipping slated for the beginning of December. "Sony is poised to make a huge impact on the American market with the answer to the 21st century's demand for an intelligent and trainable robot companion," said Takeshi Yazawa, who heads ERA. "The first-generation AIBO models already have an active global community of loyalists, and quickly became a pop-culture phenomenon. We expect that the second-generation AIBO's [ERS-210] enhanced interactive capabilities will further strengthen the relationship between AIBO and thousands of new owners."

The AIBO [ERS-210] will have the capability of more intimate interaction, as a result of voice recognition technology in the autonomous application software. Additional LED lamps (light-emitting diodes) on the robot's face and tail support the robot's expressive nature by enabling AIBO to demonstrate a variety of emotions. AIBO also features added touch sensors on its chin and back, plus the sensor on the head allows for varying degrees of response and increased sensitivity to human contact. The AIBO [ERS-210] now has 20 joints and 20 degrees of freedom (head x 3, legs x 4 x 3, tail x 2, mouth x 1, ear x 2), enabling smooth body movement. The previous model AIBO had 16 joints and 18 degrees of freedom. Six multi-colored LEDs on the face and two on the tail allow AIBO to show a rich variety of emotions through independent blinking.

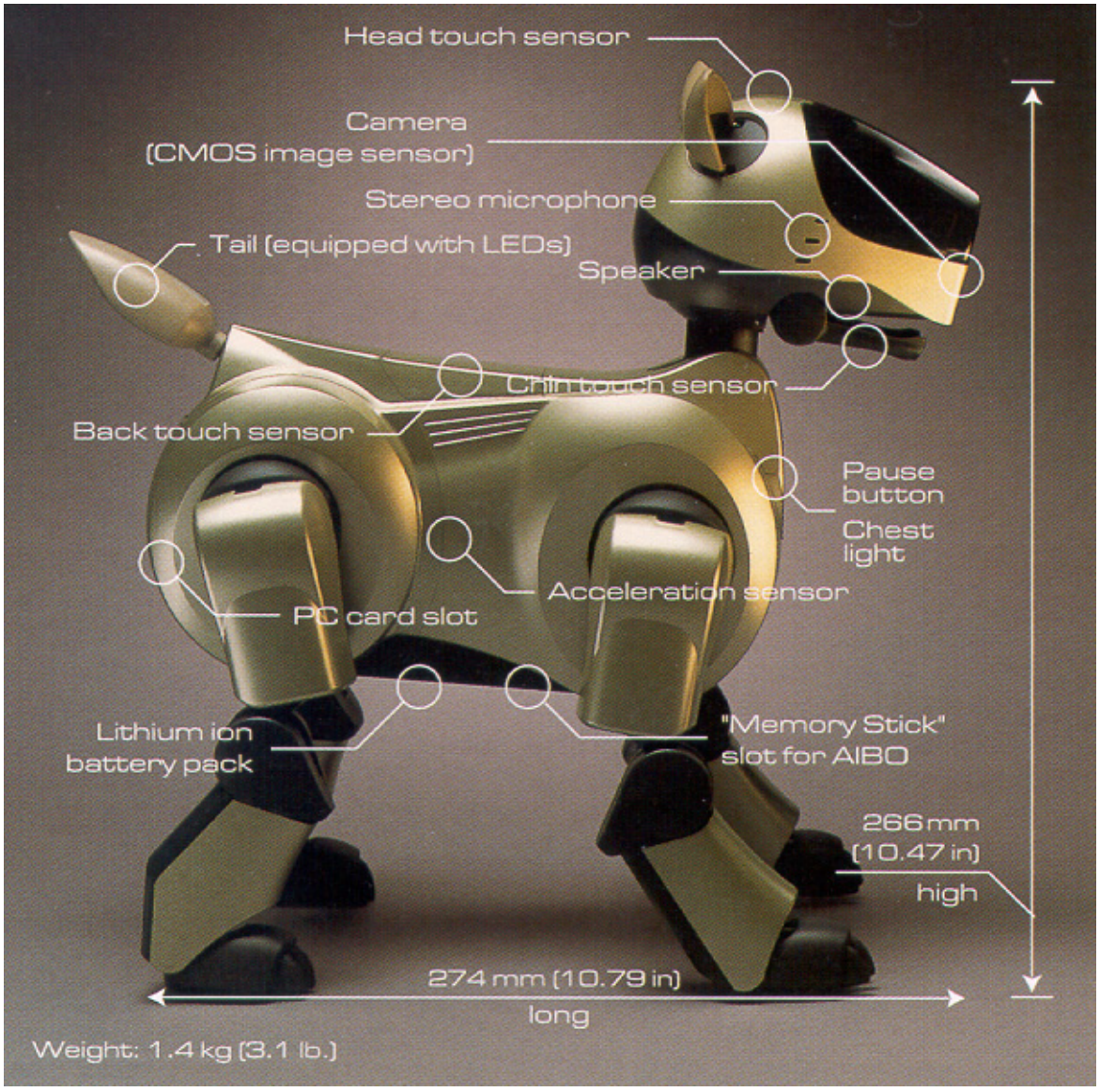
Source: Adapted from company document.

Exhibit 2 AIBO ERS-210 Specifications and Promotional Material

Processor	64-bit RISC processor	
Memory	32-megabytes built-in memory	
Components	Body, Head, Tail, Leg x4	
Program Storage Medium	Sony Memory Stick	
Movable Parts	Mouth	1 degree of freedom
	Head	3 degrees of freedom
	Leg	3 degrees of freedom x 4 legs
	Ear	1 degree of freedom x 2
	Tail	2 degrees of freedom
	Total	20 degrees of freedom
Input/Output	PC Card slot Type2 In/Out	
	Memory Stick slot In/Out	
	AC IN Power Supply connector Input	
Image Input	CMOS Image sensor	
Audio Input	Miniature Microphone	
Audio Output	Miniature Speaker	
LCD Display	Time, Volume, Battery condition	
Built-in Sensors	Temperature Sensor	
	Infrared Distance Sensor	
	Acceleration Sensor	
	Pressure Sensors (head, back, chin & paws)	
	Vibration Sensor	
Built-In Clock	Date & Time	
Operating Time	Approx. 1.5 hours (Standard operation in autonomous mode)	
Mass	Approx. 3.3 lbs (1.5Kg) (including battery & memory stick)	

Source: Adapted from company document.

Exhibit 2 (continued)



Source: Adapted from company document.

Exhibit 2 (continued)

Source: Adapted from company document.

Exhibit 2 (continued)

Source: Adapted from company document.

Exhibit 3 Excerpted from "Your Guide to the Latest Mechano-Mutts," *Wired Magazine,* Sept. 2000

When Sony's Aibo, the alpha dog of robotic pups, instantly sold out last year despite its $2,500 price tag, the toy industry took note. So this month, a pack of low-end imitators will be available at a store near you. In Japan, robo-pets come in many species—a pink bear, a plastic cat that shows affection with its heart-shaped eyes, and no-mess fish for the home aquarium—but in America, dogs are the bots of choice. Man's best friend without the hassle, they won't shed, smell, or chew your shoes—and they'll obey you like no living creature ever could. Toymakers, capitalizing on the public appetite for unconditional love and obedience, are hoping to make robot dogs a new staple of the industry, as iconic of an American childhood as teddy bears and baby dolls are now. —E*mily Jenkins*

Poo-Chi First in the stores—and smallest by far—this palm-sized pet comes with pink, blue, purple, or red ears. Because Poo-Chi can't walk, tricks are limited. Instead, its appeal is emotional: The more you pat the button on its head or activate behaviors by making abrupt noises (it has sound, but not voice, recognition), the more its eyes light up as hearts. It also responds when its magnetic bone is placed near its mouth. Poo-Chi pups recognize each other via infrared—like Furbys— then bark Beethoven's Ninth Symphony. Super Poo-Chi, a few inches taller than the regular model, has voice command, more touch sensitivity, and greater mobility. *Poo-Chi: $30; Super Poo-Chi: $40.*

Rocket the Wonder Dog A beagle with a Rudolf-red nose and a wiry tail, Rocket comes when you call it, burps after chewing a bone, pants, scratches imaginary fleas, and becomes submissive when you scold it. Rocket also responds when you pat the touch sensors on its head, nose, and back. As its owner, you'll wear an infrared headset with voice recognition technology: After the dog learns your commands, it won't respond to anything but the sound of your voice. Children too small to use the headset can operate the dog via a remote control with labels that illustrate each trick. *Rocket the Wonder Dog: $99.99.*

Me and My Shadow This plush retriever comes in Labrador colors—yellow, chocolate, or black—and with its own doghouse. Shadow will perform 10 classic dog tricks when you deliver orders through an infrared headset with voice recognition. The pup walks by way of motors and a microprocessor, but it can't lie down, see where it's going, or respond to touch. *Me and My Shadow: $59.99*.

i-Cybie This pointy-nosed Aibo imitator has touch sensors all over its body, 16 motors, and voice recognition. Part of the Tiger robo-dog family, it uses infrared sensors to interact with both Super and regular Poo-Chi, as well as with its own kind. Thanks to its visual sensors, i-Cybie walks without crashing into things. It also lifts its leg, scratches its ears, lies down, rolls over, and learns from experience—but unlike Aibo, it doesn't develop from wobbly, insecure puppy to confident adult dog. *i-Cybie: $150.*

Big Scratch and Lil' Scratch Cutest of all the metal-look dogs, Big Scratch, brimming with spaniel-like charm, comes with its own puppy to follow on its heels via an infrared link. The two yip at one another, and their tails wag and ears perk up when you touch the sensors on their backs. Spring-loaded mechanisms give Big Scratch an unusually bouncy walk. A key-chain remote makes the duo execute the usual commands. But watch out: They have magnetic fleas. *Big Scratch and Lil' Scratch: $59.99.*

Tekno This stocky silver retriever says "cool," does a card trick, and makes rude noises. It walks, whimpers when it crashes into walls, and sleeps standing up because it can't sit or lie down. Tekno responds to light levels and sounds, but not to words or individual voices: There's no headset or remote. You can initiate behavior modes by pressing sensors on the head, neck, nose, and one of its sides. Tekno can be programmed to serve as an alarm clock; visit the Web site to find out how to make it do other tricks. *Tekno: $39.99.*

Puppy Magi The feel-good choice for families, this plush robo-mom and her three fuzzy pups are the only robo-dogs that come in different breeds: dalmatian, beagle, or poodle. They're also the only ones that operate from a patent-pending radio frequency system, though they don't move around much. The mother dog recognizes and reacts to each baby from up to 8 inches away, identifying each with a different bark. Each puppy expresses itself uniquely: One wiggles, one sniffs, and one wags its tail. They all make nursing sounds when you press them against a button on their mom's belly. To keep her little ones nourished, the mother makes chewing noises when her food bowl is near. *Puppy Magic: $29.99*.

Source: Adapted from Emily Jenkins, "Your Guide to the Latest Mechano-Mutts," *Wired Magazine,* September 2000.

Exhibit 4 An Abbreviated Timeline of Personal Robot Development

1977 Star Wars stars an android, C3PO, and a mobile robot, R2D2. By the early 1980s, R2D2 lookalikes are vacuuming floors and singing songs in Japan.

1986 Honda Motor Company launches a secret project to build a humanoid robot.

1996 Honda unveils P-2 (prototype-2), a humanoid robot that walks autonomously.

1997 The first annual RoboCup soccer tournament is held in Nagoya, Japan, as a test bed for the latest technology and AI. Subsequent events have been staged in Paris, Stockholm, and Melbourne.

1999 Matsushita Electrical Industrial Company (Panasonic) creates a robotic pet as a companion for senior citizens. A four-year test begins in Osaka's Ikeda City, where seniors who live alone are given the robopets.

Sony begins taking online orders for its $2,500 AIBO. Japan's allocation of 3,000 units is sold out in just 20 minutes. The 2,000 AIBOs allotted to North America sell out in a few days.

NEC unveils R100, a prototype home robot on wheels (and a precursor to the PaPeRo). Controlled by voice commands, it can recognize faces, greet people by name, and handle simple tasks such as recording TV shows.

2000 Hitachi Ltd. develops a robot to serve as a walking aid for seniors.

Sony starts production of its second-generation AIBO dog.

At Japan's Robodex convention, Honda introduces Asimo, a pint-size but sophisticated humanoid, and announces plans to rent Asimo bots for service work by the fall of 2001.

Toyota Motor Corporation kicks off research to develop a biped/home robot.

Source: Adapted from "Japan Steps Up Robot Development," *BusinessWeek*, March 19, 2001.