UNITED STATES COPYRIGHT OFFICE

Long Comment Regarding a Proposed Exemption Under 17 U.S.C. § 1201

Comments of the Electronic Frontier Foundation on Proposed Class 12: Computer Programs—Repair

Item A. Commenter Information

Electronic Frontier Foundation
Cara Gagliano[1]
Kit Walsh
815 Eddy St.
San Francisco, CA 94109
(415) 436-9333
cara@eff.org

Intellectual Property and Information Policy Clinic
Georgetown Law
Amanda Levendowski
Nina Srejovic
500 First St. NW
Washington D.C. 20001
amanda.levendowski@georgetown.edu

The Electronic Frontier Foundation (EFF) is a member-supported, nonprofit public interest organization devoted to maintaining the traditional balance that copyright law strikes between the interests of rightsholders and the interests of the public. Founded in 1990, EFF represents tens of thousands of dues-paying members, including consumers, hobbyists, artists, writers, computer programmers, entrepreneurs, students, teachers, and researchers, who are united in their reliance on a balanced copyright system that ensures adequate incentives for creative work while promoting innovation, discouraging censorship, and enabling broad and equal access to information in the digital age.

Item B. Proposed Class Addressed

EFF submits this Comment in support of Proposed Class 12: Computer Programs—Repair. An exemption should be granted for software and compilations of data, where circumvention is for the purpose of repair, diagnosis, or noninfringing modification of any software-enabled device. A physical device qualifies as a "software-enabled device" if its operation is controlled in whole or in part by software. "Modification" as used here means to alter some aspect of a device's functionality.

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[1] Primary contact. The Electronic Frontier Foundation and Intellectual Property and Information Policy Clinic are deeply grateful to Georgetown Law J.D. Candidates Michael Rubayo and Natasha Tverdynin for their work researching and drafting this comment.

Item C. Overview

As with vehicles, home systems, and appliances, the users of other electronic devices are stifled in making innovative, useful, and expressive uses of those devices as a harmful side effect of Section 1201(a)(1)'s ban on circumvention. Copyright law has destructively inserted itself into Americans' ability to understand the technology around them, keep it in good repair, and make sure that it lives up to its potential to improve people's lives. We ask that the Copyright Office and the Librarian advance the values of copyright law through an exemption that would remove the specter of 1201(a)(1) liability from those exercising their traditional rights to repair, diagnose, and modify devices in noninfringing ways.

The adverse effects of the ban on circumvention are not limited to any narrow category of devices, but impact a wide range of people seeking to make noninfringing uses of works within the proposed class. The evidence presented represents a wide range of software-enabled devices, from those with consumables like litter boxes and printers to robotic companions, e-readers, radios, programming devices, and more. The wide range of devices impacted is evidence that an exemption taking a scattershot approach with narrow conceptions of what devices are covered will miss the forest for the trees and will fail to adequately alleviate the adverse effects on users of the works in the proposed class.

Item D. Technological Protection Measures and Methods of Circumvention

TPMs on the works in the proposed class include:

- Encryption, which scrambles the underlying content using an algorithm and encryption key, and cannot be decrypted without knowing both the algorithm and key used to encrypt;
- Password protection, which locks the underlying content, requiring a series of computer inputs for unlocking the content;
- Read protection hardware, which includes bits and settings on computer memory that ordinarily prevent a user from reading information from (i.e. accessing) the memory.

Encryption is circumvented through decryption[2] once one has discovered or otherwise obtained the decryption key.[3] Password protection can be overcome through acquisition of a password from a third party[4] or brute-forcing different input combinations to discover the

[2] 17 U.S.C § 1201(a)(3)(A).

[3] scanlime, *Feiyu Gimbal Serial Hack*, YOUTUBE https://www.youtube.com/watch?v=zLIaJBqcjNI&list=PLhbhmdpDp9xEeO6E-ihfqqt8nycOP4S8r&index=3&ab_channel=scanlime (The relevant section of the video starts at 21:00); Taylor Killian, *Retrieving ST-Link/V2 Firmware from Update Utility*, (Jan. 6, 2013), http://www.taylorkillian.com/2013/01/retrieving-st-linkv2-firmware-from.html.

[4] *See* Soumil Heble, *Jailbreaking My Kindle Paperwhite 3*, DECRYPTONICS (Jul. 12, 2020), https://decryptronics.github.io/electronics/2020/07/12/jailbreaking-my-kindle-paperwhite-3.html.

password.[5] Read protection hardware can be circumvented by altering the relevant protection bits using electronic means or through radiation with UV light.[6]

Exemplary TPMs and Circumventions

1. Digital Cameras: Encrypted Firmware and Update Protocols

Photographers frustrated by the limitations of digital cameras have found creative ways to bypass access controls and load custom firmware onto their devices to aid their craft. For instance, in the Canon EOS SD Mark II and other Canon EOS DSLR cameras, a project that has enabled new functionality is called Magic Lantern.[7] Magic Lantern has added new video capture capability, audio filtering, overlays, exposure settings, motion detection, user scripting ability, improved dynamic range to capture shadowed details and fast-moving subjects, and a host of other features not included in the stock firmware.[8] For Nikon and Panasonic cameras, corresponding projects are Nikon Hacker and PTool, and both similarly offer enhancements such as improved video capture and options for different lighting conditions.[9]

In order to achieve this customization, in Nikon and Panasonic cameras the firmware must be decrypted for analysis.[10] Then custom firmware can be reflashed to the device.[11] With Canon cameras, someone must analyze an encrypted firmware update to discern the encryption key and then encrypt their own update using the same key.[12] The update can then be pushed to the camera, directing it to access the stock firmware as needed to analyze its functionality and enable the use of custom software.[13] Once the analysis is complete, only a small portion of the

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[5] Brute Force Attack: Definition and Examples, Kaspersky: Home Security: Resource Center, https://www.kaspersky.com/resource-center/definitions/brute-force-attack.

[6] Andrew "bunnie" Huang, *Hacking the PIC 18F1320*, BUNNIE:STUDIOS, https://www.bunniestudios.com/blog/?page_id=40.

[7] "Magic Lantern," www.magiclantern.fm (last visited Dec. 10, 2020).

[8] *Id.*; "magiclantern," PetaPixel, https://petapixel.com/tag/magiclantern/ (last visited Dec. 10, 2020); "New Magic Lantern Improvement Adds 3 Stops of Dynamic Range to 5DIII and 7D," https://petapixel.com/2013/07/16/new-magic-lantern-improvement-adds-3-stops-of-dynamic-range-to-5diii-and-7d/ (last visited Dec. 10, 2020).

[9] "Nikon Hacker Showcase," https://nikonhacker.com/viewforum.php?f=9 (last visited Dec. 10, 2020); "PTool FAQ," Personal View FAQs Wiki, https://www.personal-view.com/faqs/ptool/ptool-faq (last visited Dec. 10, 2020).

[10] "Encryption," https://nikonhacker.com/wiki/Encryption (last visited Dec. 10, 2020); "Cameras status FAQ," Personal View FAQs Wiki, http://www.personal-view.com/faqs/ptool/cameras-status-faq (last visited Dec. 10, 2020).

[11] *Id.*

[12] "Firmware file," Magic Lantern Firmware Wiki, https://magiclantern.fandom.com/wiki/Firmware_file (last visited Dec. 10, 2020).

[13] *Id.*

code, identified from the whole as part of that analysis, needs to be copied into RAM and modified in order to enable the use of custom software.[14]

2. The CatGenie "Smart" Litterbox: Locked Firmware

The CatGenie litterbox is an automatic litterbox that cleans itself and disposes of a cat's waste without any human interaction.[15] The litterbox comes programmed with only two cleaning options: to clean automatically one to four times a day or to clean automatically after every visit by a cat.[16] The litterbox runs on firmware coded in ANSI C. The firmware features a PIC microcontroller, which is unreadable to an external source. The PIC microcontroller contains a "Code Protection Bit" that, when on, prevents the read operation from occurring after the PIC has been programmed.[17] However, there are manual methods to bypass the access restriction, including shining UV light onto the correct portion of the PIC microcontroller to erase the relevant bit and turn off code protection.[18] By performing such a circumvention, owners would then be able to copy the original firmware (including a checksum value needed to successfully use custom firmware) off the PIC microcontroller of the CatGenie and create their own custom modification.

The default settings on the CatGenie litterbox can be inefficient and wasteful. To alleviate this issue, an owner can update the firmware by connecting a microcontroller called PICkit3 to the CatGenie and a computer and installing modified firmware. This modification enables owners of the CatGenie litterbox to have more control over how often the litterbox cleans itself. With updated firmware, owners can program the litterbox to do a full clean following every second, third, or fourth visit by a cat, as well as remove any hard waste during the other uses.[19] The default firmware also requires a specific form of cleaning solution—SaniSolution—to run.[20] The proprietary solution must be placed in the SaniSolution cartridge for the CatGenie to function.[21] With updated

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[14] "HOW ML START (or why it doesn't boot topic) & Restore Camera," Magic Lantern Forum, https://www.magiclantern.fm/forum/index.php?topic=2522.0 (last visited Dec. 10, 2020).

[15] CATGENIE, https://www.catgenie.com/faq (last visited Dec. 11, 2020).

[16] CatGenius, GITHUB, https://github.com/CatGenius/catgenius/wiki (last visited Dec. 11, 2020)

[17] *Give Them No Quarter: Preventing PIC Microcontroller Code from Being Duplicated*, ALTIUM (Dec. 12, 2017), https://resources.altium.com/p/give-them-no-quarter-preventing-pic-microcontroller-code-from-being-duplicated#:~:text=Enable%20Code%20Protection%20Bit%3A%20In,memory%20when%20it%20is%20asserted.&text=This%20is%20an%20effective%20way,re%2Dengineer%20the%20hardware%20itself.

[18] Andrew "bunnie" Huang, *Hacking the PIC 18F1320*, BUNNIE:STUDIOS, https://www.bunniestudios.com/blog/?page_id=40.

[19] CatGenius120, *CatGenius full wash cycle*, YOUTUBE (Mar. 31, 2010), https://www.youtube.com/watch?feature=player_embedded&v=DJySHraGGL8&ab_channel=CatGenius120.

[20] *CatGenie Self Washing Self Flushing Litter Box Review: We Tried It For 3 Weeks*, ALLABOUTCATS https://allaboutcats.com/reviews/best-self-cleaning-litter-box/catgenie-review.

[21] *Id.*

firmware, owners can adjust the default settings to accommodate lower consumption of water and soap or run the CatGenie without soap entirely.[22]

3. Printers: Encrypted Firmware and Compressed Firmware Likely to be Mistaken for Encryption

Due to the cost of replacement ink and toner cartridges, many printer owners seek out deals on third-party refills to save money. This year, however, owners of various HP printer models have reported losing the ability to use third-party cartridges after installing official firmware updates from HP.[23] This is not the first time HP has done this,[24] and Canon and other printer manufacturers are guilty of doing the same.[25] Some bloggers have recommended restoring compatibility by downgrading affected printers to a previous version of the manufacturer's firmware and turning off future security updates.[26] The problem with this solution is that it leaves the user vulnerable to security flaws and unable to benefit from any performance improvements in the latest firmware.[27] Rather than having to make that trade-off, users should have the option of examining the latest

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[22] Christopher Allen (@red13dotnet), SOURCEFORGE, https://sourceforge.net/p/catgenius-red13dotnet/code/HEAD/tree/wiki/CatGeniusUsersManual.wiki (last visited Dec. 10, 2020).

[23] David Gibbons, *HPs Despicable Firmware Update Tricks Continue*, RT MEDIA (July 20, 2020), https://www.rtmworld.com/news/hps-despicable-firmware-update-tricks-continue/; Günter Born, *HP Firmware Update for Ink/Laser Printers Blocks Third-Party Cartridges*, BORN'S TECH AND WINDOWS WORLD (Nov. 8, 2020), https://borncity.com/win/2020/11/08/hp-firmware-update-for-ink-laser-printers-blocks-third-party-cartridges-nov-2020/; Kevin Deldycke, *How-To Revert HP Printer Firmware Ban on 3rd-Party Toner Cartridges* (Nov. 9, 2020), https://kevin.deldycke.com/2020/11/revert-hp-printer-ban-on-third-party-ink-cartridges/.

[24] Günter Born, *HP Firmware Update for Ink/Laser Printers Blocks Third-Party Cartridges*, BORN'S TECH AND WINDOWS WORLD (Nov. 8, 2020), https://borncity.com/win/2020/11/08/hp-firmware-update-for-ink-laser-printers-blocks-third-party-cartridges-nov-2020/; *The Secret Behind Printer Firmware Updates*, 1INK.COM, https://www.1ink.com/blog/the-secret-behind-printer-firmware-updates/.

[25] David Gibbons, *HPs Despicable Firmware Update Tricks Continue*, RT MEDIA (July 20, 2020), https://www.rtmworld.com/news/hps-despicable-firmware-update-tricks-continue/ (noting pending class action against Epson for same conduct); *The Secret Behind Printer Firmware Updates*, 1INK.COM, https://www.1ink.com/blog/the-secret-behind-printer-firmware-updates/ (identifying Canon and Epson as having previously implemented firmware updates blocking usage of unapproved ink cartridges).

[26] *E.g.*, Günter Born, *HP Firmware Update for Ink/Laser Printers Blocks Third-Party Cartridges*, BORN'S TECH AND WINDOWS WORLD (Nov. 8, 2020), https://borncity.com/win/2020/11/08/hp-firmware-update-for-ink-laser-printers-blocks-third-party-cartridges-nov-2020/; Kevin Deldycke, *How-To Revert HP Printer Firmware Ban on 3rd-Party Toner Cartridges* (Nov. 9, 2020), https://kevin.deldycke.com/2020/11/revert-hp-printer-ban-on-third-party-ink-cartridges/.

[27] *See The Secret Behind Printer Firmware Updates*, 1INK.COM, https://www.1ink.com/blog/the-secret-behind-printer-firmware-updates/ (noting that firmware updates can also improve printing speed, patch existing bugs within the system, and allow for smoother operation).

firmware to pinpoint the source of the cartridge limitations and developing a modified version that removes them.

Device owners have been able to analyze firmware functionality by scrutinizing new versions of printer firmware when they are distributed as updates to purchased printers.[28] Some manufacturers, such as Lexmark and Canon, encrypt their updated firmware, which means that a device owner must decrypt it in order to access and modify the firmware.[29] To access and modify HP's copyrighted firmware, the device owner would instead need to contend with multiple layers of compression.[30] HP firmware is compressed once on the binary level and then again on the ASCII compressed output of the binary code.[31] The ability to recognize that the code is just compressed and not encrypted requires specialized knowledge.[32] These multiple levels of compression are likely to be mistaken for encryption, which would appear to a user to be a TPM subject to 1201(a)(1)'s ban on circumvention, deterring and thus adversely affecting their noninfringing use of HP code.[33]

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[28] Moshe Kol, Shlomi Oberman, *Unpacking HP Firmware Updates - Part 1*, (May 13, 2020), https://www.jsof-tech.com/unpacking-hp-firmware-updates-part-1/; Andrey Zagrebin, Moshe Kol & Shlomi Oberman, *Unpacking HP Firmware - Part 2*, (May 19, 2020), https://www.jsof-tech.com/unpacking-hp-firmware-updates-part-2/; Andrey Zagrebin, Moshe Kol & Shlomi Oberman, *Unpacking HP Firmware - Part 3*, (June 5, 2020), https://www.jsof-tech.com/unpacking-hp-firmware-updates-part-3/; Andrey Zagrebin, Moshe Kol & Shlomi Oberman, *Unpacking HP Firmware - Part 4*, (June 15, 2020), https://www.jsof-tech.com/unpacking-hp-firmware-updates-part-4/.

[29] Lexmark International, *Security Features of Lexmark Multi-Function and Single Function Printers*, (Nov. 2013), at 6, *Security Features of Lexmark Multi-Function and Single Function Printers*, Lexmark International, 2013, p. 6; Michael Jordon, *Hacking Canon Pixma Printers – Doomed Encryption*, (Jun. 12, 2014), https://www.contextis.com/resources/blog/hacking-canon-pixma-printers-doomed-encryption/.

[30] Moshe Kol, Shlomi Oberman, *Unpacking HP Firmware Updates - Part 1*, (May 13, 2020), https://www.jsof-tech.com/unpacking-hp-firmware-updates-part-1/; Andrey Zagrebin, Moshe Kol & Shlomi Oberman, *Unpacking HP Firmware - Part 2*, (May 19, 2020), https://www.jsof-tech.com/unpacking-hp-firmware-updates-part-2/; Andrey Zagrebin, Moshe Kol & Shlomi Oberman, *Unpacking HP Firmware - Part 3*, (June 5, 2020), https://www.jsof-tech.com/unpacking-hp-firmware-updates-part-3/; Andrey Zagrebin, Moshe Kol & Shlomi Oberman, *Unpacking HP Firmware - Part 4*, (June 15, 2020), https://www.jsof-tech.com/unpacking-hp-firmware-updates-part-4/.

[31] *Id.*

[32] *Id.*

[33] Moshe Kol, Shlomi Oberman, *Unpacking HP Firmware Updates - Part 1*, (May 13, 2020), https://www.jsof-tech.com/unpacking-hp-firmware-updates-part-1/ (stating that one of the compression methods used is a proprietary scheme HP developed).

4. ST-Link/V2 Programmer/Debugger: Encrypted Firmware

The ST-Link/V2 is an in-circuit programmer and debugger for different microcontrollers.[34] The ST-Link allows owners to communicate using their computers with any STM8 and STM32 microcontrollers embedded in their devices.[35] Because the ST-Link code contains a limited amount of functionality and features, device owner Taylor Killian attempted to update the ST-Link with his own preferred custom firmware enabling additional features.[36] The code controlling the updating process for the ST-Link is written in Java, while the actual assembly code controlling the ST-Link is protected by a TPM in the form of AES-128 encryption.[37]

To access the underlying copyrighted code that controls the ST-Link and update his device with his own preferred custom firmware, Mr. Killian had to circumvent the TPM by using a USB hook to extract information from the system and perform an analysis to identify the decryption key apply it to the firmware.[38] Other owners have followed these steps and have commented on Mr. Killian's blogpost detailing this circumvention thanking him for sharing the steps.[39] Circumventing the TPM is the only way for owners to update their ST-Link with their own preferred custom firmware, which enables additional features and allows the owners to utilize the ST-Link's ability to debug and program microcontrollers to their own personal requirements.

5. Feiyu Camera Gimbal: Encrypted Firmware

The Feiyu camera gimbal is a mechanical video camera stabilizer optimized for action shots.[40] Artist Micah Elizabeth Scott has modified the Feiyu to create the Tuco Flyer, which she uses to create motion pictures featuring her cat, Tuco.[41] The Tuco Flyer system includes a camera with tracking capabilities, a 4-axis pulley mechanism to move the camera, and a computerized gimbal that enables the mounted camera to smoothly record video while the camera itself is

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[34] *ST-Link/V2 in-circuit debugger/programmer for STM8 and STM32*, ST, https://www.st.com/en/development-tools/st-link-v2.html (last visited Dec. 11, 2020).

[35] *See id.*

[36] Taylor Killian, *Retrieving ST-Link/V2 Firmware from Update Utility*, (Jan. 6, 2013), http://www.taylorkillian.com/2013/01/retrieving-st-linkv2-firmware-from.html.

[37] Lujji, *Reverse-Engineering the ST-Link Firmware*, (Oct. 13, 2016), https://lujji.github.io/blog/reverse-engineering-stlink-firmware/; Lujji, *Reverse-Engineering the ST-Link Firmware – Part 2*, (Oct. 17, 2016), https://lujji.github.io/blog/reverse-engineering-stlink-firmware-part2/.

[38] Taylor Killian, *Retrieving ST-Link/V2 Firmware from Update Utility*, (Jan. 6, 2013), http://www.taylorkillian.com/2013/01/retrieving-st-linkv2-firmware-from.html.

[39] *Id.*

[40] FEIYU-TECH, https://www.feiyu-tech.com/wg2x/.

[41] Micah Elizabeth Scott, *scanlime032 – Early Flyer View*, https://scanlime.org/tag/tuco-flyer/ (relevant section of the video starts at 1:01).

moving.[42] The Feiyu camera gimbal works over three axes to allow for stability in the camera.[43] In her own words, Ms. Scott's work, including the motion pictures featuring Tuco, combines art, electronics, and reverse and forward engineering.[44]

To create the system integral to her art, Ms. Scott needed to modify the firmware for the Feiyu camera gimbal to control the camera and read out its tracking data using a standard serial port.[45] However, access to the firmware was blocked by a TPM, namely encryption.[46] Fortunately for Ms. Scott, after she shared the firmware's random access memory (RAM) on one of her livestreams, a viewer successfully identified the advanced encryption standard (AES) keys.[47] Only then could Ms. Scott decrypt the firmware blocks, reverse engineer the firmware, and modify the camera gimbal to enable her to produce her art.[48] Ms. Scott's sharing of this process on YouTube has been watched over 6,600 times, conveying widespread interest in the community to replicate the circumvention.[49]

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[42] FEIYU-TECH, https://www.feiyu-tech.com/wg2x/.

[43] *Id.*

[44]Micah Elizabeth Scott, *scanlime032 – Early Flyer View*, https://scanlime.org/tag/tuco-flyer/ (relevant section of the video starts at 1:01).

[45] scanlime, *Winch Bot – scanlime:026*, https://www.youtube.com/watch?v=s3O0jKvxUIM&ab_channel=scanlime Micah Elizabeth Scott, *scanlime032 – Early Flyer View*, https://scanlime.org/tag/tuco-flyer/ (relevant section of the video starts at 1:01).

[46] scanlime, *Feiyu Gimbal Serial Hack – scanlime:021*, https://www.youtube.com/watch?v=zLIaJBqcjNI&list=PLhbhmdpDp9xEeO6E-ihfqqt8nycOP4S8r&index=3&ab_channel=scanlime (relevant section of the video starts at 20:48).

[47] scanlime, *Feiyu Gimbal Serial Hack – scanlime:021*, https://www.youtube.com/watch?v=zLIaJBqcjNI&list=PLhbhmdpDp9xEeO6E-ihfqqt8nycOP4S8r&index=3&ab_channel=scanlime (relevant section of the video starts at 21:00).

[48] scanlime, *Feiyu Gimbal Serial Hack – scanlime:021*, https://www.youtube.com/watch?v=zLIaJBqcjNI&list=PLhbhmdpDp9xEeO6E-ihfqqt8nycOP4S8r&index=3&ab_channel=scanlime (relevant section of the video starts at 22:24).

[49] scanlime, *Feiyu Gimbal Serial Hack – scanlime:021*, https://www.youtube.com/watch?v=zLIaJBqcjNI&list=PLhbhmdpDp9xEeO6E-ihfqqt8nycOP4S8r&index=3&ab_channel=scanlime.

6. Kindle Paperwhite E-Reader: Password-Protected Firmware

The Kindle Paperwhite is an electronic reader, or e-reader, made by Amazon.[50] The company maintains an extensive digital bookstore from which Kindle-compatible ebooks can be purchased.[51] As purchased, the Kindle is limited to the features installed by Amazon, including stock screensavers, fonts, and applications.[52] To enforce these limitations, the firmware for Kindle Paperwhites features a TPM in the form of password protecting the software files on the Kindle.[53] Owners must bypass the password protection to install custom screensavers, fonts, and applications on their Kindle Paperwhite.[54]

The only method to access the Kindle firmware, a copyrighted work, is by circumventing the TPM.[55] The circumvention is possible by opening up the physical Kindle shell, soldering several wires to the Kindle's circuit board, and using a USB to Serial converter while connected to a Linux PC.[56] When those steps have been taken, an owner is prepared to do the actual circumvention of the TPM, which requires the owner to factory reset their Kindle, "forget" all wireless connections to their Kindle, and place the Kindle in Airplane Mode.[57] The owner must then restart the Kindle in diagnostics mode, which allows the owner to utilize their connected PC to alter the Kindle's firmware.[58] Then, by using log-in information discovered by other owners to access the root account, the owner can change the firmware settings to not require a password for the main root account, circumventing the TPM in place.[59] After the requirement for a password has been removed, owners have full access to the software of the device and can modify it.[60] Kindle Paperwhite owners modify their devices by installing a range of noninfringing features, including

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[50] Yifan Lu, *Kindle 3.1 Jailbreak*, RANDOM STUFF I'M MAKING AND THINKING (Feb. 21, 2011), https://yifan.lu/2011/02/21/kindle-3-1-jailbreak/.

[51] *Id.*

[52] *Id.*

[53] Soumil Heble, *Jailbreaking My Kindle Paperwhite 3*, DECRYPTONICS (Jul. 12, 2020), https://decryptronics.github.io/electronics/2020/07/12/jailbreaking-my-kindle-paperwhite-3.html.

[54] *Id.*

[55] *Id.*

[56] *Id.* There are additional steps not discussed in-depth here. *Id.*

[57] *Id.*

[58] *Id.*

[59] *Id.* The username is "root", and the password was determined to be the output of a specific hash algorithm on the Kindle's serial number. *Id.*

[60] *Id.*

custom screensavers, fonts, and applications like calculators and weather screens,[61] as well as improving viewing for comics.[62]

7. Aibo Robotic Companion: Encrypted Firmware

The Aibo is a dog-shaped robotic companion made by Sony.[63] Aibo robotic companions were first introduced to the market in 1999 and discontinued in 2006, then reintroduced in 2008.[64] Early generation of Aibos[65] come pre-programmed to perform a limited range of tasks and tricks[66] and develop their own unique personalities over time.[67] According to Aibo's chief designer, Koji Kageyama, "Most owners treat their Aibo affectionately, as they would a real pet."[68] MIT researcher Kate Darling has observed that "[t]here are some great use cases" for robotic companions like the Aibo, such as replicating the health effects of owning a dog or cat.[69] To approximate the experience of watching a pet learn and develop, additional software programs

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[61] RyanYammyYam, "What Are The Advantages of 'Jailbreaking' a Kindle Paperwhite?," REDDIT (July 7, 2014), https://www.reddit.com/r/kindle/comments/2a1re4/what_are_the_advantages_of_jailbreaking_a_kindle/.

[62] Iris Yan, "Kindle Jailbreak Apps and Hacks," EPUBOR (Apr. 15, 2020), https://www.epubor.com/kindle-jailbreak-appsand-hacks.html.

[63] David Pogue, "Looking at Aibo, the Robot Dog," *N.Y. Times* (Jan. 25, 2001), https://www.nytimes.com/2001/01/25/technology/looking-at-aibo-the-robot-dog.html. The second-generation Aibo, which is the focus of this Comment, cost $1,500 and now sells for much more in secondary markets. *See* TK.

[64] Kaya Yurieff, "Sony's Robot Dog Has Learned Some New Tricks," *CNN Business* (Jan. 10, 2018), https://money.cnn.com/2018/01/10/technology/sony-aibo-robot-dog-ces-2018/index.html.

[65] The Aibos introduced in 2008, the ERS-1000, are compatible with Sony's API, where owners and coders can develop new tasks and tricks, a departure from the proprietary memory sticks used with second-generation Aibos. *See* Sony, "Aibo Developer Site," (last accessed Dec. 11, 2020), https://developer.aibo.com/us/home. The ERS-1000 API does have limitations, similar to those of the ERS-210, that would be mitigated by circumvention. *See* Evan Ackerman, "How to Program Sony's Robot Dog Aibo," *IEEE Spectrum* (Feb. 11, 2020), https://spectrum.ieee.org/automaton/robotics/robotics-software/how-to-program-sony-aibo.

[66] David Labrador, "Teaching Robot Dogs New Tricks," *Scientific American* (Jan. 21, 2002), https://www.scientificamerican.com/article/teaching-robot-dogs-new-t/.

[67] Randi Klett & Erico Guizzo, " Sony's Aibo Robot Dog is Coming to America," IEEE Spectrum (Aug. 23, 2008), https://spectrum.ieee.org/automaton/robotics/home-robots/sony-aibo-robot-dog-is-coming-to-america?utm_source=robots.ieee.org.

[68] David Labrador, "Teaching Robot Dogs New Tricks," *Scientific American* (Jan. 21, 2002).

[69] Kate Baggaley, "New Companion Robots Can't Do Much But Make Us Love Them," NBC News (June 23, 2019), https://www.nbcnews.com/mach/science/new-companion-robots-can-t-do-much-make-us-love-ncna1015986. Note that Darling voices privacy concerns over robotic companions, and circumvention is necessary to evaluate and mitigate such concerns. *Id*.

equipped with new tasks and tricks can be purchased from Sony.[70] The software is stored on proprietary memory sticks, previously sold by Sony.[71]

At least one owner has modified their Aibo beyond what was encoded by Sony. Known by the online handle AiboPet, that owner successfully circumvented the technological protection measure—encryption—insulating Aibo's copyrighted firmware.[72] AiboPet reverse engineered that firmware and produced modified firmware packages that empowered owners to teach their Aibos new tasks and tricks, such as dancing and sharing the video used for Aibo's vision.[73] Although AiboPet circumvented Sony's encryption, he never publicly disclosed his method of decryption.[74] Rather, AiboPet created a website—AiboHack—to release firmware packages that could be easily copied onto a Sony memory stick and input into an owner's Aibo.[75] Owners still needed one of Sony's proprietary memory sticks for each task or trick the owner wanted to give their Aibo.[76] The updated firmware provided by AiboPet encouraged owners to buy more Sony memory sticks to expand their Aibo's capabilities.[77] Using AiboPet's modified firmware packages, coupled with a memory stick purchased from Sony, any Aibo owner could effectively circumvent the encryption on their Aibo and access the underlying copyrighted firmware.[78]

In 2012, after the second-generation Aibo had been discontinued, Sony sent a cease and desist letter to AiboPet alleging a violation of the Digital Millennium Copyright Act and demanding removal of all software from the AiboHack website, which he did promptly.[79] While

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[70] *See* Eric A. Taub, "Silicon Pets, But the Pride Is Real," *N.Y. Times* (May 2, 2002), https://www.nytimes.com/2002/05/02/technology/silicon-pets-but-the-pride-is-real.html.

[71] *Id.* The proprietary memory sticks sold for $150 each initially. David Labrador, "Teaching Robot Dogs New Tricks," Scientific American (Jan. 21, 2002).

[72] Christopher Soghoian, *Caveat Venditor: Technologically Protected Subsidized Goods and the Customers Who Hack Them*, 6 NW. J. TECH & INTELL. PROP. 46, 56 (2007), https://scholarlycommons.law.northwestern.edu/njtip/vol6/iss1/3/. The memory sticks are no longer available from Sony but can be found on resale websites like eBay. *See* eBay, "SONY Programmable Memory Stick AIBO 16 Mb PMS Card," https://www.ebay.com/itm/SONY-Programmable-Memory-Stick-AIBO-16Mb-PMS-Card-/273894349652 (last accessed Dec. 11, 2020) (screenshot attached as Exhibit A).

[73] *Id. See also* AiboPet, http://aibohack.com/111/yart11x.htm, *AiboHack* (last accessed Dec. 11, 2020).

[74] Christopher Soghoian, *Caveat Venditor: Technologically Protected Subsidized Goods and the Customers Who Hack Them*, 6 NW. J. TECH & INTELL. PROP. 46, 56 (2007).

[75] AiboPet, http://aibohack.com/111/yart11x.htm, *AiboHack* (last accessed Dec. 11, 2020).

[76] Christopher Soghoian, *Caveat Venditor: Technologically Protected Subsidized Goods and the Customers Who Hack Them*, 6 NW. J. TECH & INTELL. PROP. 46, 56 (2007).

[77] David Labrador, "Teaching Robot Dogs New Tricks," *Scientific American* (Jan. 21, 2002).

[78] *Id.*

[79] Christopher Soghoian, *Caveat Venditor: Technologically Protected Subsidized Goods and the Customers Who Hack Them*, 6 NW. J. TECH & INTELL. PROP. 46, 56 (2007).

the two parties ultimately reached an agreement—AiboHack could continue hosting most of the modified programs so long as Sony could adopt and sell any of the ideas and code, royalty-free—other owners were outraged, even cancelling orders for Sony's memory sticks.[80] The AiboHack website has not yet published any modifications for the newest generation Aibo, ERS-1000.[81] But Sony has taken a different approach to owners who wish to modify new Aibos. Instead of relying on proprietary memory sticks, Sony has created its own API where owners and coders can create limited tasks and tricks to teach their Aibos.[82] It appears that further customization through modification would still require making changes to the Aibo's firmware. Limitations of the modern Aibo include the inability to teach Aibo to visually recognize new objects, the inability to have Aibo take a picture with its built-in camera, the inability to add custom sounds or motions for the Aibo to use, and the inability to direct the Aibo to go to specific places.[83]

The limited default programs for the Aibo reflect that it would be impossible for Sony to create the innovative range of functionality and features envisioned by device owners and modders.[84] It is natural, human, and noninfringing to seek this kind of personal connection with a pet, even a robotic one.

8. Tytera MD380 Radio: Encrypted Firmware

The Tytera MD380 Radio is a portable digital mobile radio that is compatible with Motorola's Digital Radio communications network.[85] In its current configuration, the Tytera MD380 communicates using Digital Mobile Radio, a digital radio standard, through either a public talk group or a private contact.[86] By default, it is only possible to monitor one talk group at a time—to be aware of multiple separate discussions, the owner must constantly change the radio settings.[87] The firmware contains a TPM in the form of a Readout Device Protection (RDP) feature

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[80] David Labrador, "Teaching Robot Dogs New Tricks," *Scientific American* (Jan. 21, 2002).

[81] AiboPet, http://aibohack.com/111/yart11x.htm, *AiboHack* (last accessed Dec. 11, 2020).

[82] Sony continues to profit from next-generation Aibos beyond selling the robotic dog itself, including the new cloud subscription required for its newest generation of Aibos. *See* Anshel Sag, "Sony Aibo: The Dog and Personal Assistant of the Future," *Forbes* (May 1, 2019), https://www.forbes.com/sites/moorinsights/2019/05/01/sony-aibo-the-dog-and-personal-assistant-of-the-future/?sh=1441076b7fff.

[83] Evan Ackerman, *How to Program Sony's Robot Dog Aibo*, IEEE SPECTRUM (Feb 11, 2020 02:00 PM), https://spectrum.ieee.org/automaton/robotics/robotics-software/how-to-program-sony-aibo.

[84] One customization offered by AiboPet, for example, makes the Aibo behave more like a cat. AiboPet, http://aibohack.com/2or3/obeycat.htm, *AiboHack* (last accessed Dec. 11, 2020); David Labrador, "Teaching Robot Dogs New Tricks," *Scientific American* (Jan. 21, 2002).

[85] Tytera, http://tyterausa.com/tytera-md380 (last visited Dec. 11, 2020).

[86] phasenoise, *Jailbreak firmware now available for cheap digital walkie-talkie allowing DMR scanning*, LIVEJOURNAL (Jan. 29, 2016, 9:30 AM), https://phasenoise.livejournal.com/1142.html.

[87] *Id*.

on the central processing unit (CPU) that prevents access to the underlying code.[88] The only method to access the copyrighted firmware on a MD380 radio is by circumventing this TPM. Further, all updates to the MD380 are encrypted and cannot be analyzed or modified prior to installation except through circumvention.[89]

The Tytera MD380's limited capability to only monitor one public channel at a time and only reach private contacts individually is inefficient. To improve the function of the radio that one owns, a Tytera MD380 owner must circumvent the TPM installed by Tytera. Owners can circumvent the TPM in the Tytera MD380 by changing the line of code controlling the RDP to allow access to the entire code.[90] Only with access to the entire code can owners of the Tytera MD380 Radio create firmware modifications, which enable the radio to monitor multiple channels concurrently.[91]

Item E. Adverse Effects on Noninfringing Uses

1. The Ban on Circumvention Limits Repair, Diagnosis, and Modification of Software-Enabled Devices as a Class

The requested exemption is needed to alleviate the adverse effects of the circumvention ban on three categories of activities that are common to all software-enabled devices:

- Repair of defects, damage, wear, or other issues affecting the physical device or software.
- Diagnosis of faulty, unintended, or undesired behavior, including behavior such as privacy intrusions or planned obsolescence that are intended by the manufacturer but objectionable to the consumer.
- Modification to add new features, load the software of one's choice, disable undesired functionality, or customize the operation of the device to one's preferences.

In the last rulemaking cycle, the Copyright Office declined to evaluate software-enabled devices as a unified class, questioning whether all such devices share enough relevant commonalities. They do. EFF is not aware of any category of software-enabled device where TPMs have not been used. Nor is there any category of device that will never require repair or diagnosis, or that would not present opportunities for useful, noninfringing modifications. On the contrary, the evidence presented reflects that the use of TPMs in connection with software-enabled

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[88] Travis Goodspeed, *Reverse Engineering the Tytera MD380*, International Journal of PoC || GTFO, 76-85 (Jan. 16, 2016) https://www.sultanik.com/pocorgtfo/pocorgtfo10.pdf .

[89] Travis Goodspeed, *Reversing MD380 Firmware with IDA Pro*, https://github.com/travisgoodspeed/md380tools/wiki/IDAPro.

[90] Travis Goodspeed, *Reverse Engineering the Tytera MD380*, International Journal of PoC || GTFO, 76-85 (Jan. 16, 2016).

[91] phasenoise, *Jailbreak firmware now available for cheap digital walkie-talkie allowing DMR scanning*, LIVEJOURNAL (Jan. 29, 2016, 9:30 AM).

devices is widespread, with commonalities in the types and effects of those TPMs that cut across product categories. When the same types of TPMs have been applied to products as disparate as litterboxes, e-readers, and handheld radios, the Copyright Office has ample basis to consider software-enabled devices as a class.

2. The Uses of Copyrighted Works that the Requested Exemption Would Enable Are Noninfringing

The Register's previous conclusion that "[t]raditional copyright doctrines such as the idea/expression dichotomy, merger, scènes-à-faire, and fair use provide a combined and reasonable defense for many tinkering and repair activities" likewise holds true across the spectrum of software-enabled devices and the range of activities covered by the proposed exemption.[92] With respect to repair and diagnosis, the Register has already concluded as a general proposition that repair or diagnosis of a software-enabled device is likely to be a fair use.[93] Fair use also encompasses accessing software that controls the operation of a device for the purpose of modifying that device, as modification is defined and described above.

Each fair use factor weighs in favor of this conclusion, irrespective of the type of device or the precise nature of the modification. In brief: First, altering the original work with new expression empowers consumers to customize their devices to meet their personal needs. Analyzing the functional aspects of software code and creating modified software for the purpose of modifying the product's operation is transformative. Moreover, the Register has concluded in previous rulemakings that the first factor may favor fair use where the use facilitates or enhances the intended use of a device by its owner.[94] Allowing a device owner to fine-tune the operation of a device to better suit their needs undoubtedly facilitates and enhances that device's intended use. Second, the relevant software is minimally creative, containing primarily functional components that enable the operation of a product, and use of the copyrightable work focuses on the alteration of largely functional components. Third, where the entirety of the software must be accessed, it is because the entire copyrightable work is necessary to effectively modify the product it controls both because functionality may be found throughout the code and to comply with checksum calculations that limit the use of modified firmware. And fourth, there is no negative effect on the market for the copyrightable work because the software's copyrightable code is not

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[92] Copyright Office, *Software-Enabled Consumer Products* ("Software Report"), 33; *id.* at 31-34 (discussing the above in detail, as well as Section 117, as protecting numerous repair and tinkering activities).

[93] Recommendation of the Acting Register of Copyrights, Section 1201 Rulemaking: Seventh Triennial Proceeding to Determine Exemptions to the Prohibition on Circumvention ("2018 Recommendation"), 202-205 (Oct. 2018), https://cdn.loc.gov/copyright/1201/2018/2018_Section_1201_Acting_Registers_Recommendation.pdf.

[94] *See* Recommendation of the Register of Copyrights, Section 1201 Rulemaking: Sixth Triennial Proceeding to Determine Exemptions to the Prohibition on Circumvention ("2015 Recommendation"), 235 (Oct. 2015), https://cdn.loc.gov/copyright/1201/2015/registers-recommendation.pdf (discussing exemptions for smartphone jailbreaking and vehicle diagnosis and repair).

commercially sold outside of the product it is designed to control. The four fair use factors thus weigh in favor of finding that the use of the copyrightable code in a software-enabled device for the purpose of modifying the device's functionality is a noninfringing use.

The following sections present more detailed fair use analyses for each of the example circumventions identified in Item D. Though individualized, the analysis for each example is identical in all key respects, demonstrating the uniformity of the issues across modifications and device types. This further supports the granting of an exemption that covers modification for all software-enabled devices.[95]

In conducting its fair use analysis, the Register should also consider that manufacturers have not put firmware restrictions in devices in order to protect a market for copies of the firmware. Rather, the restrictions exist to control the ways in which the hardware can be used and to restrict access to information about functionality. As the Register stated in 2010, "while a copyright owner might try to restrict the programs that can be run on a particular operating system, copyright law is not the vehicle for imposition of such restrictions, and other areas of the law, such as antitrust, might apply. It does not and should not infringe any of the exclusive rights of the copyright owner to run an application program on a computer over the objections of the owner of the copyright in the computer's operating system."[96]

The same analysis supports the granting of an exemption allowing device owners to tinker with the firmware that operates their devices. Whether or not manufacturers have adopted business models that benefit from restricting access to knowledge about how devices function, copyright is not a valid tool to enforce that ignorance on the public. Nor is it a valid tool to deprive users of control over their own devices and the ability to repair and customize them.

Further, the Register has noted that Section 117 independently protects a number of repair and modification activities.[97] The passage of Section 117 also demonstrates that the purposes above are favored uses more likely to be fair.

3. The Statutory Factors Support the Requested Exemption

The factors listed in Section 1201(a)(1)(C) also support granting this exemption.

First, availability of copyrighted works will be improved by the proposed exemption. As described above, technical measures currently restrict the availability of device firmware for a variety of lawful uses. There will be no adverse effect on the availability of copyrighted works,

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[95] The Register's 2018 Recommendation acknowledged that modification of "a functional element of a device for a personal, noncommercial use" was likely to qualify as a fair use. 2018 Recommendation at 207. At a minimum, the Copyright Office should grant an exemption for this subset of modification activities.

[96] Recommendation of the Register of Copyrights in RM 2008-8, Rulemaking on Exemptions from Prohibition on Circumvention of Copyright Protection Systems for Access Control Technologies ("2010 Recommendation"), 96-97 (June 11, 2010), www.copyright.gov/1201/2010/initialedregisters-recommendation-june-11-2010.pdf.

[97] Software Report at 35-38.

since code is necessary for the devices to function and is produced for non-copyright-related reasons, and because no market harm cognizable by copyright law will result from the proposed exemption. To the contrary, additional copyrighted works will be made available that rely on the non-copyrightable information made accessible via the proposed exemption. The various videos and writings cited in this comment discussing how to repair and tinker with devices are prime examples. Software patches also depend on access, including patches to fix serious vulnerabilities. Numerous tools designed to analyze and manipulate firmware also depend on the ability to access software and reverse engineer it. The availability of copyrighted works will be promoted by the proposed exemption.

Second, education about engineering and tinkering will benefit from increased knowledge of device firmware to use as real-world examples in teaching and the increased ability of individuals to explore the technology for themselves. In addition, it will be possible to archive and preserve firmware on general-purpose storage media, without expensive and unreliable storage of idiosyncratic device hardware or entire appliances. Furthermore, tinkering is itself educational and is a common path for young people to become interested in studying science and engineering.[98] Copyright law should not prevent or discourage this important activity, but should permit works to be used for the educational purpose of hands-on learning.

Third, the prohibition on circumvention curtails speech in all of the categories identified in the third statutory factor. The legal cloud resulting from the prohibition on circumvention reduces participation in research, scholarship and teaching on device functionality, repair, and modification, as well as critiquing, commenting, and reporting on the functionality of manufacturer software and potential alternatives.

Fourth, the relevant markets will not suffer any harm cognizable under copyright law, as discussed in the fair use analysis.

As for the fifth "factor," which encompasses "such other factors as the Librarian may consider appropriate," it is improper to restrict an exemption to Section 1201 on the basis of factors that form no part of the inquiry into whether the ban on circumvention has or is likely to have adverse effects on noninfringing uses of copyrighted works. Doing so contradicts the statutory language and exacerbates the constitutional flaws of Section 1201.

Section 1201(a)(1)(D) provides that an exemption shall be granted if "noninfringing uses by persons who are users of a copyrighted work are, or are likely to be, adversely affected." Thus, if the standard is met, issuing an exemption is mandatory; it "shall" issue. In making the determination of whether this standard is met, the Librarian is instructed to consider four specific factors that speak to adverse effects and infringement, and "such other factors as the Librarian

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[98] *See, e.g.*, Steve Song, *In Praise of Taking Things Apart*, *available at* https://manypossibilities.net/2008/03/in-praise-of-taking-things-apart/ (quoting an interview with John Seely-Brown in which he said "A huge amount of the learning that a lot of us do, that formed the foundations of all the formal education that we got afterwards, could be called 'tinkering.' Because of changes in electronics and cars, a whole generation couldn't tinker.").

considers appropriate."[99] It would be illogical to consider factors that do not bear on whether the ultimate standard is met.

Interpreting the fifth factor to grant total discretion to the Librarian also undermines the predictability and fairness of the process. Rather than relying on objective standards, a broad interpretation of factor five turns the rulemaking into an exercise in the Librarian's discretion, and invites the consideration of questions lying far beyond the Librarian's expertise and mandate. The First Amendment does not permit a speech-licensing regime with such open-ended decision-making powers.

Further examples and examination of how the statutory factors apply to the proposed exemption are laid out in the following sections. As with the fair use inquiry, these individualized analyses are tailored to the facts of each example, but each raises the same issues and yields the same conclusions regardless of the device involved. This further demonstrates that a broad exemption covering all software-enabled devices is both necessary and proper.

Exemplary Uses

1. Digital Cameras: Encrypted Firmware and Updates

A. The Ban on Circumvention Limits Noninfringing Uses of Digital Camera Firmware

The ban on circumvention adversely affects the ability of digital camera owners to use digital camera firmware code to learn about, customize, and optimize their devices.

The functionality of unmodified digital cameras is limited in various ways that device purchasers wish to change or enhance. Circumvention of the firmware encryption and update encryption allows owners to customize their cameras to their personal requirements. This can include installing new features such as higher-fidelity video capture and dynamic use of the audio and optical sensors to optimize capture for different conditions.[100] Granting an exemption for this circumvention would open up new opportunities for owners of digital cameras to customize their own physical devices and the video and photographic works they create with them, which should not be limited by a TPM that prevents access to the functional elements of a copyrighted work controlling the physical device.

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[99] 17 U.S.C. § 1201(a)(1)(C)(v).

[100] "Magic Lantern," www.magiclantern.fm (last visited Dec. 10, 2020); "magiclantern," PetaPixel, https://petapixel.com/tag/magiclantern/ (last visited Dec. 10, 2020); "New Magic Lantern Improvement Adds 3 Stops of Dynamic Range to 5DIII and 7D," https://petapixel.com/2013/07/16/new-magic-lantern-improvement-adds-3-stops-of-dynamic-range-to-5diii-and-7d/ (last visited Dec. 10, 2020); "Nikon Hacker Showcase," https://nikonhacker.com/viewforum.php?f=9 (last visited Dec. 10, 2020); "PTool FAQ," Personal View FAQs Wiki, https://www.personal-view.com/faqs/ptool/ptool-faq (last visited Dec. 10, 2020).

B. Modifying the Digital Cameras Is Noninfringing

Modifying digital camera firmware for the purpose of modifying the device's functionality does not infringe manufacturers' copyright in software code because it is a fair use, and "fair use of a copyrighted work . . . is not an infringement of copyright."[101]

1. The Purpose and Character of the Use

The first statutory factor focuses on the purpose and character of the use of the copyrighted work. Central to this inquiry is whether the new work "merely supersedes the objects of the original creation" or is transformative—that is, whether the secondary user expands on the expression, meaning, or message of the original work.[102] "[A] transformative use is one that communicates something new and different from the original or expands its utility, thus serving copyright's overall objective of contributing to public knowledge."[103]

Digital camera modders use the firmware and updates to understand its functional aspects and create their own customized firmware that adds new functions and increases the utility of both the original code and the hardware it controls. Courts have found that copying computer code for similar purposes constitutes fair use. In *Sega v. Accolade*, the Ninth Circuit explained that research into the functional aspects of Sega's video game software was a legitimate fair use purpose, even for a competitor seeking to develop competing games.[104] The court emphasized that the functional aspects of Sega's software were not copyrightable and recognized that copying the entire software—including copyrightable elements—was necessary for analysis.[105] Here, just as Accolade copied code from Sega's games to create new games that would interoperate with the Sega Genesis, owners wanting to create modified digital camera firmware require knowledge of functional elements and attributes of the original firmware. For Canon cameras, decrypting a firmware update is a necessary step in accessing the firmware. For other cameras, such as Nikon and Panasonic models, the encrypted firmware is retrieved from the device and decrypted for analysis. Owners who add functionality to their devices create something new, with a different purpose than the original firmware. Moreover, this use fits even more firmly within the fair use framework than Sega's because installing modified firmware on your own device to customize it to your individual needs is a personal, noncommercial use.

The Ninth Circuit reaffirmed the reasoning of *Sega* in *Sony v. Connectix*, where the court held that Connectix's copying of Sony's BIOS firmware, which controls the Sony PlayStation console's ability to read Sony PlayStation games, to create their own console that could read and

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[101] *Id.*

[102] *See Campbell v. Acuff-Rose Music, Inc.*, 510 U.S. 569, 579 (1994) (internal quotation marks omitted); *see also* Pierre N. Leval, *Toward a Fair Use Standard*, 103 Harv. L. Rev. 1105, 1111 (1990).

[103] *See Authors Guild v. Google, Inc.*, 804 F.3d 202, 214 (2d Cir. 2015).

[104] *See Sega Enters. Ltd. v. Accolade, Inc.*, 977 F2d 1510, 1522-23 (9th Cir. 1992) (holding that using copyrighted material to study functional requirements was fair use).

[105] *Id.*

play Sony PlayStation games, was a noninfringing fair use.[106] This is analogous to how the original digital camera firmware is required for the owner to create their own customized firmware, because the owner needs to analyze the original firmware and replace existing code with their modified code to achieve the new, desired control. Under established caselaw, this is a transformative purpose supporting a finding of fair use.

2. The Nature of the Copyrighted Work

The second statutory factor considers the nature of the copyrighted work.[107] If the work is factual or functional in nature, there is more latitude to copy without infringing.[108] As discussed in *Sony*, if the copying of the original firmware was necessary for the modified use, that supports a finding of fair use.[109] The works in question here are works of code that control the functions of digital cameras. This code is primarily functional in nature. Moreover, the creative, protectable elements of the code are merely incidental to the reason for using the work, which is to analyze its functional characteristics.

This is similar to what occurred in *Sony*, where Connectix had to access all of Sony's code to understand the code's functional aspects in order to build an emulator that could play Sony games.[110] To understand how to best customize their digital cameras, owners need to analyze the functional aspects of the code controlling those cameras. Just as the Ninth Circuit found in *Sony*, the only way to access the functional aspects of digital camera code is by copying the entire work.[111] Since functional aspects were "expressly denied copyright protection by Congress," they may be copied without infringing on the copyright to examine the functionality of the original code.[112] Because the firmware is a work that is not solely expressive, but rather contains functional and factual elements, and the owner is accessing the original firmware within the device only for those functional and factual elements, the second fair use factor supports a finding of fair use.[113]

3. The Amount and Substantiality of the Portion Used

The third fair use factor examines the amount of the copyrighted work used in an effort to determine whether the "quantity and value of the materials used are reasonable in relation to the purpose of the copying."[114] The use of an entire work does not preclude an activity from being a

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[106] *See Sony Computer Entm't Inc. v. Connectix Corp.*, 203 F.3d 596, 599, 609 (9th Cir. 2000).

[107] 17 U.S.C. § 107.

[108] *See Sega*, 977 F.2d at 1524.

[109] *See Sony*, 203 F.3d at 603.

[110] *See id.* at 603-05.

[111] *See id.* at 603.

[112] *See id.* at 605 (citing *Sega*, 977 F.2d at 1526).

[113] *See Sega*, 977 F.2d at 1524.

[114] *Campbell*, 510 U.S. at 586-87.

fair use.[115] The amount taken only need be "reasonable" and for a legitimate purpose.[116]

In *Sony* and *Sega*, the Ninth Circuit found that copying a software program in its entirety in order to understand its functional components was necessary to achieving a favored purpose, and was therefore fair.[117] Similarly, in *Kelly v. Arriba Soft*, the court emphasized that copying anything less than an entire work would be insufficient in order to allow users to recognize images in a visual search engine.[118] In *Perfect 10,* the court concluded that Google's use of Perfect 10's images was reasonable in light of its purpose of communicating information to its users.[119] In both cases, the court found this copying to be fair use. And in *Authors Guild, Inc. v. Google*, in which the plaintiffs participated in the scanning and electronic storage of numerous books in their entirety, the court held that the copying was reasonable in light of its purpose.[120]

The reasoning of these cases applies equally here. Functionality may be found throughout a piece of software, and, as discussed previously, to create modified firmware for a digital camera, the owner must first analyze the original firmware. Thus, to create their new, expressive firmware, owners must first copy the original firmware in its entirety. Even though the entire the work is copied, the use is still a fair use because copying the entire work is needed to achieve the ultimate transformative use. The third factor thus weighs in favor of a finding of fair use.

4. Effect on the Market for the Copyrighted Work

The fourth and final statutory factor considers "the effect of the use upon the potential market for or value of the copyrighted work" by looking to see whether the new use would be a competing substitute for the original—i.e., whether purchasers would opt to acquire the copy instead of the original.[121] In this instance, the modified firmware is of no use to any owner who has not already purchased a digital camera that runs on the original firmware. Because the copyrighted work is purchasable only as part of the physical product itself, and the modified firmware is only useful as alternative code controlling the physical product, the potential market for the camera manufacturer's code would not decrease in any form. If anything, having the option to install alternative code available will likely incentivize more potential buyers to purchase these cameras, as they would be able to install modified firmware onto it that expands its utility and better suits their needs. Thus, the fourth factor weighs in favor of a finding of fair use.

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[115] *Sega*, 997 F.2d at 1526.

[116] *Campbell*, 510 U.S. at 586.

[117] *Sega*, 977 F.2d at 1526; *Sony*, 203 F.3d at 605-06.

[118] 336 F. 3d at 820-21; *see also Field v. Google Inc.*, 412 F. Supp. 2d 1106, 1120-121 (D. Nev. 2006) (finding the third factor weighing in favor of neither party because, while Google copied entire pages in its web caching service, the amount used was necessary to the purpose).

[119] 508 F.3d at 1167-68.

[120] *Authors Guild v. Google, Inc.*, 804 F.3d 202, 221-22 (2d Cir. 2015).

[121] 17 U.S.C. § 107.

C. The Statutory Factors Support Granting an Exemption

1. The Proposed Exemption Would Increase the Availability for Use of Copyrighted Works

The preceding discussion demonstrates how the availability of copyrighted works will be improved by the proposed exemption. As described above, technical measures currently restrict the availability of copyrighted digital camera firmware for lawful uses that cannot be achieved except through circumvention.

There will be no adverse effect on the availability of copyrighted works, since code is necessary for the digital cameras to function and is produced for non-copyright-related reasons, and because no market harm cognizable by copyright law will result from the proposed exemption. To the contrary, the requested exemption will likely give rise to the creation of additional copyrighted works, such as new forms of photographic and video expression, new firmware, and the various writings cited in this comment that discuss reasons for, methods of, and results of modifying digital cameras.

2. The Proposed Exemption Would Increase the Availability for Use of Works for Non-Profit Archival, Preservation, and Educational Purposes

The vibrant discussion forums for Magic Lantern, Nikon Hacker, and PTool demonstrate how a community of enthusiasts comes together to share knowledge around technology. Further, it has been shown that the ability to interact with technology generally, such as the copyrighted firmware within digital cameras, is educational and is a common path for young people to become interested in studying science and engineering.[122]

3. Prohibiting Circumvention of the TPM Applied to Digital Camera Firmware Has a Negative Impact on Criticism, Comment, News Reporting, Teaching, Scholarship, and Research

Prohibiting this circumvention and others like it curtails all of the activities identified in the third factor. For example, the ability to capture higher-quality video helps in news reporting, and access to the firmware in digital cameras helps the community comment, teach, and learn.

4. Allowing Circumvention Would Not Harm the Potential Market

For the reasons discussed in the above analysis of the fourth fair use factor, the relevant markets will not suffer any harm cognizable under copyright law.

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[122] *See, e.g.*, Steve Song, *In Praise of Taking Things Apart*, *available at* https://manypossibilities.net/2008/03/in-praise-of-taking-things-apart/ (quoting an interview with John Seely-Brown in which he said "A huge amount of the learning that a lot of us do, that formed the foundations of all the formal education that we got afterwards, could be called 'tinkering.' Because of changes in electronics and cars, a whole generation couldn't tinker.").

5. No Other Factors are Relevant to Consideration of This Exemption

There are no additional factors that should be considered for this exemption. Denying or restricting an exemption to Section 1201 on the basis of factors that form no part of the inquiry into whether the ban on circumvention has or is likely to have adverse effects on noninfringing uses of copyrighted works would go against the statutory language of Section 1201, which states that an exemption "shall" be granted if noninfringing uses by "persons who are users of a copyrighted work are, or are likely to be, adversely affected."[123]

2. The CatGenie "Smart" Litterbox: Locked Firmware

A. The Ban on Circumvention Limits Noninfringing Uses of CatGenie Firmware

The ban on circumvention adversely affects the ability of CatGenie owners to use CatGenie firmware code to learn about, customize, and optimize their CatGenie devices.

The functionality of unmodified CatGenie devices is limited in various ways that device owners wish to change. For example, it offers only a few preset options for how often it will run a cleaning cycle.[124] Further, it requires a proprietary cleaning solution that is contained in cartridges with microchips that must be present for the CatGenie to run and, once the cartridge has been emptied, prevent re-filling the cartridge with an alternative cleaning solution.[125]

These functional elements of the CatGenie's operation cannot be altered without circumventing the Code Protection Bit that controls access to the CatGenie firmware, a copyrighted work. By performing this circumvention, however, owners can optimize the functionality of their CatGenie litterboxes by allowing for the cleaning cycle to run at custom intervals, such as on every third visit by a cat.[126] Also, the CatGenie could be made usable without the SaniSolution cartridge microchip, enabling the owner to either use a different cleaning solution or run the cleaning cycle without a cleaning solution entirely.[127] If this circumvention were permitted by a clear exemption, owners of the CatGenie would be able to customize their product to run more efficiently and limit the potential waste of water and cleaning supplies from unnecessary cleaning cycles occurring from a cat coming in and out of the CatGenie without using it or running on a timer when the product has not been used since the last cycle.

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[123] 17 U.S.C. § 1201(a)(1)(C).

[124] CatGenius, GITHUB, https://github.com/CatGenius/catgenius/wiki

[125] *Id.*

[126] *Id.*

[127] Christopher Allen (@red13dotnet), SOURCEFORGE, https://sourceforge.net/p/catgenius-red13dotnet/code/HEAD/tree/wiki/CatGeniusUsersManual.wiki (last visited Dec. 10, 2020).

B. Modifying the CatGenie Litterbox Is Noninfringing

Reading and modifying the CatGenie firmware for the purpose of modifying the litterbox's functionality does not infringe CatGenie's copyright in its software code because it is a fair use, and "fair use of a copyrighted work . . . is not an infringement of copyright."[128]

1. The Purpose and Character of the Use

The first statutory factor focuses on the purpose and character of the use of the copyrighted work. Central to this inquiry is whether the new work "merely supersedes the objects of the original creation" or is transformative—that is, whether the secondary user expands on the expression, meaning, or message of the original work.[129] "[A] transformative use is one that communicates something new and different from the original or expands its utility, thus serving copyright's overall objective of contributing to public knowledge."[130]

CatGenie modders use the CatGenie firmware to understand its functional aspects and create their own customized firmware that adds new functions and increases the utility of both the original code and the hardware it controls. Courts have found that copying computer code for similar purposes constitutes fair use. In *Sega v. Accolade*, the Ninth Circuit explained that research into the functional aspects of Sega's video game software was a legitimate fair use purpose, even for a competitor seeking to develop competing games.[131] The court emphasized that the functional aspects of Sega's software were not copyrightable and recognized that copying the entire software—including copyrightable elements—was necessary for analysis.[132] Here, just as Accolade copied code from Sega's games to create new games that would interoperate with the Sega Genesis, owners wanting to create modified CatGenie firmware require knowledge of functional elements of the original CatGenie firmware, including the code that controls the cleaning cycle and the SHA 1 checksum value required for the modified firmware to interoperate with the device. Moreover, this use fits even more firmly within the fair use framework than Sega's because installing modified firmware on your own device to customize it to your individual needs is a personal, noncommercial use.

The Ninth Circuit reaffirmed the reasoning of *Sega* in *Sony v. Connectix*, where the court held that Connectix's copying of Sony's BIOS firmware, which controls the Sony PlayStation console's ability to read Sony PlayStation games, to create their own console that could read and play Sony PlayStation games, was a noninfringing fair use.[133] This mirrors how the original

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[128] 17 U.S.C. § 107.

[129] *See Campbell v. Acuff-Rose Music, Inc.*, 510 U.S. 569, 579 (1994) (internal quotation marks omitted); *see also* Pierre N. Leval, *Toward a Fair Use Standard*, 103 Harv. L. Rev. 1105, 1111 (1990).

[130] *See Authors Guild v. Google, Inc.*, 804 F.3d 202, 214 (2d Cir. 2015).

[131] *See Sega Enters. Ltd. v. Accolade, Inc.*, 977 F2d 1510, 1522-23 (9th Cir. 1992) (holding that using copyrighted material to study functional requirements was fair use).

[132] *Id.*

[133] *See Sony Computer Entm't Inc. v. Connectix Corp.*, 203 F.3d 596, 599, 609 (9th Cir. 2000).

CatGenie firmware is used to create modified firmware with new functionality. As discussed above, the modified firmware only functions on the CatGenie when the SHA 1 checksum value matches the value in the original firmware. The SHA 1 checksum value is only obtainable through the use of the copyrighted work. Further, to control the physical functions of the CatGenie with modified firmware, the owner needs to know which aspects of the copyrighted work control those physical functions. That is possible only by analyzing the entirety of the code to isolate the corresponding parts. To create the modified firmware with new purpose and expression, owners must use the original firmware to obtain the SHA 1 checksum value and the methods to control the physical portions of the CatGenie litterbox.

The use of the copyrighted original firmware of the CatGenie in the modified firmware is to continue to use the physical functions of the CatGenie and discover the SHA 1 checksum value needed to ensure the modified firmware does not break the CatGenie. Under established caselaw, this is a transformative purpose supporting a finding of fair use.

2. The Nature of the Copyrighted Work

The second statutory factor considers the nature of the copyrighted work.[134] If the work is factual or functional in nature, there is more latitude to copy without infringing.[135] As discussed in *Sony*, if the copying of the original firmware was necessary for the modified use, that supports a finding of fair use.[136] The work in question here is the code that controls the functions of the CatGenie litterbox, which determines how often the cleaning process runs. This code is copyrighted but is minimally creative in nature. Moreover, the code is being accessed only to expand on the functioning of the physical CatGenie device. The creative, protectable elements of the code are merely incidental to this use.

This is similar to what occurred in *Sony*, where Connectix had to access all of Sony's code to understand the code's functional aspects in order to build an emulator that could play Sony games.[137] In this instance, to understand how to best customize the cleaning function of the CatGenie, owners need to analyze the functional aspects of the code controlling the CatGenie. Just as the Ninth Circuit found in *Sony*, the only way to access the functional aspects of the CatGenie code is by copying the entire work.[138] Since functional aspects were "expressly denied copyright protection by Congress," they may be copied without infringing on the copyright to examine the functionality of the original code.[139] Because the CatGenie firmware is a work that is not solely expressive, but rather contains functional elements, and the owner is accessing the original firmware within the CatGenie only for those functional elements, the second fair use factor supports a finding of fair use.[140]

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[134] 17 U.S.C. § 107.

[135] *See Sega*, 977 F.2d at 1524.

[136] *See Sony*, 203 F.3d at 603.

[137] *See id.* at 603-05.

[138] *See id.* at 603.

[139] *See id.* at 605 (citing *Sega*, 977 F.2d at 1526).

[140] *See Sega*, 977 F.2d at 1524.

3. The Amount and Substantiality of the Portion Used

The third fair use factor examines the amount of the copyrighted work used in an effort to determine whether the "quantity and value of the materials used are reasonable in relation to the purpose of the copying."[141] The use of an entire work does not preclude an activity from being a fair use.[142] The amount taken only need be "reasonable" and for a legitimate purpose.[143]

In *Sony* and *Sega*, the Ninth Circuit found that copying a software program in its entirety in order to understand its functional components was necessary to achieving a favored purpose, and was therefore fair.[144] Similarly, in *Kelly v. Arriba Soft*, the court emphasized that copying anything less than an entire work would be insufficient in order to allow users to recognize images in a visual search engine.[145] In *Perfect 10,* the court concluded that Google's use of Perfect 10's images was reasonable in light of its purpose of communicating information to its users.[146] In both cases, the court found this copying to be fair use. And in *Authors Guild, Inc. v. Google*, in which the plaintiffs participated in the scanning and electronic storage of numerous books in their entirety, the court held that the copying was reasonable in light of its purpose.[147]

The reasoning of these cases applies equally here. Without the ability to copy and view the entirety of the code, improving the functionality of the CatGenie would be impossible. Namely, functionality may be found throughout a piece of software, and, as the checksum value in the modified firmware's code must be identical to the checksum value in the original firmware's code, owners need to view the original code in its entirety to identify the checksum value so they can match it when installing the modified firmware. Even though the entire the work is copied, the use is still a fair use because copying the entire work is needed to achieve the ultimate transformative use. The third factor thus weighs in favor of a finding of fair use.

4. Effect on the Market for the Copyrighted Work

The fourth and final statutory factor considers "the effect of the use upon the potential market for or value of the copyrighted work" by looking to see whether the new use would be a competing substitute for the original—i.e., whether purchasers would opt to acquire the copy instead of the original.[148] In this instance, the modified firmware is of no use to any owner who has not already purchased a CatGenie litterbox. Because the copyrighted work is purchasable only

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[141] *Campbell*, 510 U.S. at 586-87.

[142] *Sega*, 997 F.2d at 1526.

[143] *Campbell*, 510 U.S. at 586.

[144] *Sega*, 977 F.2d at 1526; *Sony*, 203 F.3d at 605-06.

[145] 336 F. 3d at 820-21; *see also Field v. Google Inc.*, 412 F. Supp. 2d 1106, 1120-121 (D. Nev. 2006) (finding the third factor weighing in favor of neither party because, while Google copied entire pages in its web caching service, the amount used was necessary to the purpose).

[146] 508 F.3d at 1167-68.

[147] *Authors Guild v. Google, Inc.*, 804 F.3d 202, 221-22 (2d Cir. 2015).

[148] 17 U.S.C. § 107.

as part of the physical product itself, and the modified firmware is only useful as alternative code controlling the physical product, the potential market for the CatGenie code would not decrease in any form. If anything, having this alternative code available will likely incentivize more potential buyers to purchase the CatGenie, as they would be able to install the modified firmware onto it to better suit their needs. Thus, the fourth factor weighs in favor of a finding of fair use.

C. The Statutory Factors Support Granting an Exemption

1. The Proposed Exemption Would Increase the Availability for Use of Copyrighted Works

The preceding discussion demonstrates how the availability of copyrighted works will be improved by the proposed exemption. As described above, technical measures currently restrict the availability of copyrighted CatGenie firmware for lawful uses that cannot be achieved except through circumvention.

There will be no adverse effect on the availability of copyrighted works, since code is necessary for the CatGenie litterbox to function and is produced for non-copyright-related reasons, and because no market harm cognizable by copyright law will result from the proposed exemption. To the contrary, the requested exemption will likely give rise to the creation of additional copyrighted works that rely on the CatGenie firmware, such as noninfringing custom firmware and the various writings cited in this comment that discuss reasons for and methods of modifying CatGenie litterboxes.

2. The Proposed Exemption Would Increase the Availability for Use of Works for Non-Profit Archival, Preservation, and Educational Purposes

The proposed exemption would make the CatGenie firmware and new works based on it available for use for non-profit archival, preservation, and educational purposes. For instance, professors in veterinary, environmental, or engineering courses could utilize the CatGenie as an example of how to improve a product for cats, decrease water usage and increase efficiency, or customize a household product. Further, it has been shown that the ability to interact with technology, such as the copyrighted firmware within the CatGenie, is educational and is a common path for young people to become interested in studying science and engineering.[149]

3. Prohibiting Circumvention of the TPM Applied to CatGenie's Firmware Has a Negative Impact on Criticism, Comment, News Reporting, Teaching, Scholarship, and Research

Prohibiting this circumvention and others like it curtails all of the activities identified in the third factor. For example, without being able to access the code in CatGenie's firmware, owners are unable to fully demonstrate and test the efficiency and cost-savings possibilities of the

[149] *See, e.g.*, Steve Song, *In Praise of Taking Things Apart*, *available at* https://manypossibilities.net/2008/03/in-praise-of-taking-things-apart/ (quoting an interview with John Seely-Brown in which he said "A huge amount of the learning that a lot of us do, that formed the foundations of all the formal education that we got afterwards, could be called 'tinkering.' Because of changes in electronics and cars, a whole generation couldn't tinker.").

CatGenie litterbox. Removing the threat of legal liability for accessing the copyrighted firmware, and thus information about how the product functions, will allow more accurate research, criticism, and reporting highlighting the inefficiencies of the product—and how to avoid them—to occur.

4. Allowing Circumvention Would Not Harm the Potential Market

For the reasons discussed in the above analysis of the fourth fair use factor, the relevant markets will not suffer any harm cognizable under copyright law.

5. No Other Factors Are Relevant to Consideration of This Exemption

There are no additional factors that should be considered for this exemption. Denying or restricting an exemption to Section 1201 on the basis of factors that form no part of the inquiry into whether the ban on circumvention has or is likely to have adverse effects on noninfringing uses of copyrighted works would go against the statutory language of Section 1201, which states that an exemption "shall" be granted if noninfringing uses by "persons who are users of a copyrighted work are, or are likely to be, adversely affected."[150]

3. Printers: Encrypted and Compressed Firmware

A. The Ban on Circumvention Limits Noninfringing Uses of Printer Firmware

The ban on circumvention adversely affects the ability of printer owners to use firmware code to learn about, customize, and optimize their devices, including to ensure compatibility with third-party ink and toner.

Having the ability to use third-party ink and toner cartridges benefits consumers and competition, but printer manufacturers have a history of interfering with that ability through firmware updates.[151] By decrypting firmware (or, for HP printers, reversing the complex compression) printer owners can access and modify the code's functional elements.[152] The threat

[150] 17 U.S.C. § 1201(a)(1)(C).

[151] David Gibbons, *HPs Despicable Firmware Update Tricks Continue*, RT MEDIA (July 20, 2020), https://www.rtmworld.com/news/hps-despicable-firmware-update-tricks-continue/; Günter Born, *HP Firmware Update for Ink/Laser Printers Blocks Third-Party Cartridges*, BORN'S TECH AND WINDOWS WORLD (Nov. 8, 2020), https://borncity.com/win/2020/11/08/hp-firmware-update-for-ink-laser-printers-blocks-third-party-cartridges-nov-2020/; *The Secret Behind Printer Firmware Updates*, 1INK.COM, https://www.1ink.com/blog/the-secret-behind-printer-firmware-updates/.

[152] Michael Jordon, *Hacking Canon Pixma Printers – Doomed Encryption*, (Jun. 12, 2014), https://www.contextis.com/resources/blog/hacking-canon-pixma-printers-doomed-encryption/; Moshe Kol, Shlomi Oberman, *Unpacking HP Firmware Updates - Part 1*, (May 13, 2020), https://www.jsof-tech.com/unpacking-hp-firmware-updates-part-1/; Andrey Zagrebin, Moshe Kol & Shlomi Oberman, *Unpacking HP Firmware - Part 2*, (May 19, 2020), https://www.jsof-tech.com/unpacking-hp-firmware-updates-part-2/; Andrey Zagrebin, Moshe Kol & Shlomi Oberman, *Unpacking HP Firmware - Part 3*, (June 5, 2020), https://www.jsof-tech.com/unpacking-hp-firmware-updates-part-3/; Andrey Zagrebin, Moshe Kol & Shlomi

of liability under Section 1201 is a deterrent to device owners who want to restore their printers' compatibility with third-party cartridges by modifying the firmware.

The need for an exemption here is not obviated by the possibility of downgrading to an earlier firmware version and turning off security updates.[153] As discussed above, this approach leaves the user vulnerable to security flaws and unable to benefit from any performance improvements in the latest firmware.[154] An exemption would allow printer owners to both get critical updates and have confidence that they will be able to restore compatibility with third-party cartridges.

Forcing printer owners to buy the manufacturer's ink and toner rather than using third-party products they already have or can obtain more cheaply is wasteful, unnecessarily costly, and anti-competitive. During the COVID-19 pandemic, the usage of home printers has grown, with children printing out school assignments daily and adults needing to print for their jobs. Ink is, of course, not a copyrighted work, and the purpose of Section 1201 is not to enforce anti-competitive business models by denying a printer owner the ability to make noninfringing uses of device software.

B. Modifying Printer Software Is Noninfringing

Modifying the printer firmware for the purpose of enabling third-party ink or toner cartridges does not infringe the copyright in firmware code because it is a fair use, and "fair use of a copyrighted work . . . is not an infringement of copyright."[155] Indeed, in a closely analogous context, the Register previously concluded that "the copying or modifying of [3D] printer software to accept non-manufacturer-approved feedstock is likely to be a fair use."[156] All of the same reasoning applies here.

1. The Purpose and Character of the Use

The first statutory factor focuses on the purpose and character of the use of the copyrighted work. Central to this inquiry is whether the new work "merely supersedes the objects of the original creation" or is transformative—that is, whether the secondary user expands on the expression,

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Oberman, *Unpacking HP Firmware - Part 4*, (June 15, 2020), https://www.jsof-tech.com/unpacking-hp-firmware-updates-part-4/.

[153] *Cf.* Günter Born, *HP Firmware Update for Ink/Laser Printers Blocks Third-Party Cartridges*, BORN'S TECH AND WINDOWS WORLD (Nov. 8, 2020), https://borncity.com/win/2020/11/08/hp-firmware-update-for-ink-laser-printers-blocks-third-party-cartridges-nov-2020/; Kevin Deldycke, *How-To Revert HP Printer Firmware Ban on 3rd-Party Toner Cartridges* (Nov. 9, 2020), https://kevin.deldycke.com/2020/11/revert-hp-printer-ban-on-third-party-ink-cartridges/.

[154] *See The Secret Behind Printer Firmware Updates*, 1INK.COM, https://www.1ink.com/blog/the-secret-behind-printer-firmware-updates/ (noting that firmware updates can also improve printing speed, patch existing bugs within the system, and allow for smoother operation).

[155] 17 U.S.C. § 107.

[156] 2018 Recommendation at 323-325; *see also* 2015 Recommendation at 367-369.

meaning, or message of the original work.[157] "[A] transformative use is one that communicates something new and different from the original or expands its utility, thus serving copyright's overall objective of contributing to public knowledge."[158]

Printer modders can use the firmware to understand its functional aspects and create their own customized firmware that increases the utility of both the original code and the hardware it controls. Courts have found that copying computer code for similar purposes constitutes fair use. In *Sega v. Accolade*, the Ninth Circuit explained that research into the functional aspects of Sega's video game software was a legitimate fair use purpose, even for a competitor seeking to develop competing games.[159] The court emphasized that the functional aspects of Sega's software were not copyrightable and recognized that copying the entire software—including copyrightable elements—was necessary for analysis.[160] Here, just as Accolade copied code from Sega's games to create new games that would interoperate with the Sega Genesis, owners wanting to create modified printer firmware require knowledge of functional elements of the original firmware, including the code that controls whether an ink or toner cartridge will be accepted. Moreover, this use fits even more firmly within the fair use framework than Sega's because installing modified firmware on your own device to customize it to your individual needs is a personal, noncommercial use.

The Ninth Circuit reaffirmed the reasoning of *Sega* in *Sony v. Connectix*, where the court held that Connectix's copying of Sony's BIOS firmware, which controls the Sony PlayStation console's ability to read Sony PlayStation games, to create their own console that could read and play Sony PlayStation games, was a noninfringing fair use.[161] This is analogous to how the original printer firmware is required for the owner to create their own customized firmware, because the owner needs to analyze the original firmware and replace existing code with their modified code to achieve the new, desired control. Under established caselaw, this is a transformative purpose supporting a finding of fair use.

2. The Nature of the Copyrighted Work

The second statutory factor considers the nature of the copyrighted work.[162] If the work is factual or functional in nature, there is more latitude to copy without infringing.[163] As discussed in *Sony*, if the copying of the original firmware was necessary for the modified use, that supports a

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[157] *See Campbell v. Acuff-Rose Music, Inc.*, 510 U.S. 569, 579 (1994) (internal quotation marks omitted); *see also* Pierre N. Leval, *Toward a Fair Use Standard*, 103 Harv. L. Rev. 1105, 1111 (1990).

[158] *See Authors Guild v. Google, Inc.*, 804 F.3d 202, 214 (2d Cir. 2015).

[159] *See Sega Enters. Ltd. v. Accolade, Inc.*, 977 F2d 1510, 1522-23 (9th Cir. 1992) (holding that using copyrighted material to study functional requirements was fair use).

[160] *Id.*

[161] *See Sony Computer Entm't Inc. v. Connectix Corp.*, 203 F.3d 596, 599, 609 (9th Cir. 2000).

[162] 17 U.S.C. § 107.

[163] *See Sega*, 977 F.2d at 1524.

finding of fair use.[164] The work in question here is the code that controls the functions of a printer. This code is copyrighted but is minimally creative in nature. Moreover, the code is being referenced only to create a modified version that allows owners to use third-party ink or toner. The creative, protectable elements of the code are merely incidental to this use.

This is similar to what occurred in *Sony*, where Connectix had to access all of Sony's code to understand the code's functional aspects in order to build an emulator to play Sony games.[165] In this instance, to understand how to create the modified firmware, owners need to analyze the functional aspects of the code controlling the printer. Just as the Ninth Circuit found in *Sony*, the only way to access the functional aspects of the printer code is by copying the entire work.[166] Since functional aspects were "expressly denied copyright protection by Congress," they may be copied without infringing on the copyright to examine the functionality of the original code.[167] Because the printer firmware is a work that is not solely expressive, but rather contains functional elements, and the owner is accessing the original firmware within the printer only for those functional elements, the second fair use factor supports a finding of fair use.[168]

3. The Amount and Substantiality of the Portion Used

The third fair use factor examines the amount of the copyrighted work used in an effort to determine whether the "quantity and value of the materials used are reasonable in relation to the purpose of the copying."[169] The use of an entire work does not preclude an activity from being a fair use.[170] The amount taken only need be "reasonable" and for a legitimate purpose.[171]

In *Sony* and *Sega*, the Ninth Circuit found that copying a software program in its entirety in order to understand its functional components was necessary to achieving a favored purpose, and was therefore fair.[172] Similarly, in *Kelly v. Arriba Soft*, the court emphasized that copying anything less than an entire work would be insufficient in order to allow users to recognize images in a visual search engine.[173] In *Perfect 10,* the court concluded that Google's use of Perfect 10's images was reasonable in light of its purpose of communicating information to its users.[174] In both

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[164] *See Sony*, 203 F.3d at 603.

[165] *See id.* at 603-05.

[166] *See id.* at 603.

[167] *See id.* at 605 (citing *Sega*, 977 F.2d at 1526).

[168] *See Sega*, 977 F.2d at 1524.

[169] *Campbell*, 510 U.S. at 586-87.

[170] *Sega*, 997 F.2d at 1526.

[171] *Campbell*, 510 U.S. at 586.

[172] *Sega*, 977 F.2d at 1526; *Sony*, 203 F.3d at 605-06.

[173] 336 F. 3d at 820-21; *see also Field v. Google Inc.*, 412 F. Supp. 2d 1106, 1120-121 (D. Nev. 2006) (finding the third factor weighing in favor of neither party because, while Google copied entire pages in its web caching service, the amount used was necessary to the purpose).

[174] 508 F.3d at 1167-68.

cases, the court found this copying to be fair use. And in *Authors Guild, Inc. v. Google*, in which the plaintiffs participated in the scanning and electronic storage of numerous books in their entirety, the court held that the copying was reasonable in light of its purpose.[175]

The reasoning of these cases applies equally here. Functionality may be found throughout a piece of software, and, as discussed previously, to create modified firmware for a printer, the owner must first analyze the manufacturer's firmware. Thus, to create their new, expressive firmware, owners must first copy that firmware in its entirety. Even though the entire the work is copied, the use is still a fair use because copying the entire work is needed to achieve the ultimate transformative use. The third factor thus weighs in favor of a finding of fair use.

4. Effect on the Market for the Copyrighted Work

The fourth and final statutory factor considers "the effect of the use upon the potential market for or value of the copyrighted work" by looking to see whether the new use would be a competing substitute for the original—i.e., whether purchasers would opt to acquire the copy instead of the original.[176] In this instance, the modified firmware is of no use to any owner who has not already purchased the printer. Because the copyrighted work is purchasable only as part of the physical product itself, and the modified firmware is only useful as alternative code controlling the physical product, the potential market for the code would not decrease in any form. Thus, the fourth factor weighs in favor of a finding of fair use.

C. The Statutory Factors Support Granting an Exemption

1. The Proposed Exemption Would Increase the Availability for Use of Copyrighted Works

The preceding discussion demonstrates how the availability of copyrighted works will be improved by the requested exemption. As described above, technical measures currently restrict the availability of copyrighted printer firmware for lawful uses that cannot be achieved except through circumvention.

There will be no adverse effect on the availability of copyrighted works, since code is necessary for printers to function and is produced for non-copyright-related reasons, and because no market harm cognizable by copyright law will result from the proposed exemption. To the contrary, the requested exemption will likely give rise to the creation of additional copyrighted works that rely on the firmware, such as new custom firmware and the various writings and videos cited in this comment that discuss reasons for and methods of modifying printers.

2. The Proposed Exemption Would Increase the Availability for Use of Works for Non-Profit Archival, Preservation, and Educational Purposes

The proposed exemption would make the printer firmware and new works based on it available for use for non-profit archival, preservation, and educational purposes. Only by accessing the firmware can one learn from or archive or preserve it.

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[175] *Authors Guild v. Google, Inc.*, 804 F.3d 202, 221-22 (2d Cir. 2015).

[176] 17 U.S.C. § 107.

Further, it has been shown that the ability to interact with technology, such as the copyrighted firmware within the printer, is educational and is a common path for young people to become interested in studying science and engineering.[177]

3. Prohibiting Circumvention of the TPM Applied to Printer Firmware Has a Negative Impact on Criticism, Comment, News Reporting, Teaching, Scholarship, and Research

Prohibiting this circumvention and others like it curtails all of the activities identified in the third factor. For example, the threat of legal liability for accessing and modifying printer firmware discourages research and comment on printer functionality.

4. Allowing Circumvention Would Not Harm the Potential Market

For the reasons discussed in the above analysis of the fourth fair use factor, the relevant markets will not suffer any harm cognizable under copyright law.

5. No Other Factors are Relevant to Consideration of This Exemption

There are no additional factors that should be considered for this exemption. Denying or restricting an exemption to Section 1201 on the basis of factors that form no part of the inquiry into whether the ban on circumvention has or is likely to have adverse effects on noninfringing uses of copyrighted works would go against the statutory language of Section 1201, which states that an exemption "shall" be granted if noninfringing uses by "persons who are users of a copyrighted work are, or are likely to be, adversely affected."[178]

4. ST-Link/V2 Programmer/Debugger: Encrypted Firmware

A. The Ban on Circumvention Limits Noninfringing Uses of ST-Link Firmware

The ban on circumvention adversely affects the ability of ST-Link/V2 programmer/ debugger owners to use ST-Link firmware code to learn about, customize, and optimize their ST-Link devices.

The functionality of unmodified ST-Link devices is limited in various ways that device purchasers wish to change or enhance. Circumvention of the firmware encryption allows owners to customize their ST-Link/V2s to their personal requirements. This could include installing new features such as the ability to utilize the ST-Link as a universal asynchronous receiver-transmitter (UART), as well as a programmer and debugger.[179] Granting an exemption for this circumvention

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[177] *See, e.g.*, Steve Song, *In Praise of Taking Things Apart*, *available at* https://manypossibilities.net/2008/03/in-praise-of-taking-things-apart/ (quoting an interview with John Seely-Brown in which he said "A huge amount of the learning that a lot of us do, that formed the foundations of all the formal education that we got afterwards, could be called 'tinkering.' Because of changes in electronics and cars, a whole generation couldn't tinker.").

[178] 17 U.S.C. § 1201(a)(1)(C).

[179] Lujji, *Reverse-Engineering the ST-Link Firmware*, (Oct. 13, 2016), https://lujji.github.io/blog/reverse-engineering-stlink-firmware/; Lujji, *Reverse-Engineering the*

would open up new opportunities for owners of the ST-Link to customize their own physical devices, which should not be limited by a TPM that prevents access to the functional elements of a copyrighted work controlling the physical device.

B. Modifying the ST-Link Programmer/Debugger Is Noninfringing

Modifying the ST-Link firmware for the purpose of modifying the device's functionality does not infringe ST-Link's copyright in its software code because it is a fair use and "fair use of a copyrighted work . . . is not an infringement of copyright."[180]

1. The Purpose and Character of the Use

The first statutory factor focuses on the purpose and character of the use of the copyrighted work. Central to this inquiry is whether the new work "merely supersedes the objects of the original creation" or is transformative—that is, whether the secondary user expands on the expression, meaning, or message of the original work.[181] "[A] transformative use is one that communicates something new and different from the original or expands its utility, thus serving copyright's overall objective of contributing to public knowledge."[182]

ST-Link modders use the ST-Link firmware to understand its functional aspects and create their own customized firmware that adds new functions and increases the utility of both the original code and the hardware it controls. Courts have found that copying computer code for similar purposes constitutes fair use. In *Sega v. Accolade*, the Ninth Circuit explained that research into the functional aspects of Sega's video game software was a legitimate fair use purpose, even for a competitor seeking to develop competing games.[183] The court emphasized that the functional aspects of Sega's software were not copyrightable and recognized that copying the entire software—including copyrightable elements—was necessary for analysis.[184] Here, just as Accolade copied code from Sega's games to create new games that would interoperate with the Sega Genesis, owners wanting to create modified ST-Link firmware require knowledge of functional elements and attributes of the original ST-Link firmware. In the case of the ST-Link, the owner cannot expand on the original work without using the original work, since there is a limited amount of storage for the modified firmware.[185] This requires each owner to identify which

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ST-Link Firmware – Part 2, (Oct. 17, 2016), https://lujji.github.io/blog/reverse-engineering-stlink-firmware-part2/.

[180] *Id.*

[181] *See Campbell v. Acuff-Rose Music, Inc.*, 510 U.S. 569, 579 (1994) (internal quotation marks omitted); *see also* Pierre N. Leval, *Toward a Fair Use Standard*, 103 Harv. L. Rev. 1105, 1111 (1990).

[182] *See Authors Guild v. Google, Inc.*, 804 F.3d 202, 214 (2d Cir. 2015).

[183] *See Sega Enters. Ltd. v. Accolade, Inc.*, 977 F2d 1510, 1522-23 (9th Cir. 1992) (holding that using copyrighted material to study functional requirements was fair use).

[184] *Id.*

[185] Lujji, *Reverse-Engineering the ST-Link Firmware*, (Oct. 13, 2016), https://lujji.github.io/blog/reverse-engineering-stlink-firmware/; Lujji, *Reverse-Engineering the*

portions of the original firmware they want to remove to implement their own modifications. These decisions allow the owners to create something new, with a different purpose than the original firmware. Moreover, this use fits even more firmly within the fair use framework than Sega's because installing modified firmware on your own device to customize it to your individual needs is a personal, noncommercial use.

The Ninth Circuit reaffirmed the reasoning of *Sega* in *Sony v. Connectix*, where the court held that Connectix's copying of Sony's BIOS firmware, which controls the Sony PlayStation console's ability to read Sony PlayStation games, to create their own console that could read and play Sony PlayStation games, was a noninfringing fair use.[186] This is analogous to how the original ST-Link firmware is required for the owner to create their own customized firmware. As the amount of storage within the ST-Link is limited, the owner needs to analyze the original firmware and replace existing code with their modified code to achieve the new, desired control. Thus, to create the modified firmware with new purpose and expression, owners must use the original firmware to determine how much space they have to work with in the ST-Link.

The use of the copyrighted ST-Link firmware is required to create modified firmware, because it allows the modder to determine the amount of storage the original firmware occupies to design the modified firmware to function within that amount of storage. Under established caselaw, this is a transformative purpose supporting a finding of fair use.

2. The Nature of the Copyrighted Work

The second statutory factor considers the nature of the copyrighted work.[187] If the work is factual or functional in nature, there is more latitude to copy without infringing.[188] As discussed in *Sony*, if the copying of the original firmware was necessary for the modified use, that supports a finding of fair use.[189] The work in question here is the code that controls the functions of the ST-Link device. This code is copyrighted but is minimally creative in nature. Moreover, the creative, protectable elements of the code are merely incidental to the reason for using the work, which is to determine the amount of storage space required by different firmware components. Analyzing this factual characteristic of the original firmware is no different than determining how many words exist in a book: that process needs the entirety of the book but does not utilize its expressive elements.[190]

ST-Link Firmware – Part 2, (Oct. 17, 2016), https://lujji.github.io/blog/reverse-engineering-stlink-firmware-part2/.

[186] *See Sony Computer Entm't Inc. v. Connectix Corp.*, 203 F.3d 596, 599, 609 (9th Cir. 2000).

[187] 17 U.S.C. § 107.

[188] *See Sega*, 977 F.2d at 1524.

[189] *See Sony*, 203 F.3d at 603.

[190] Matthew Sag, *Copyright and Copy-Reliant Technology*, 103 NW. U. L. REV.1607, 1608 (2009); *see also Kelly v. Arriba Soft Corp.*, 336 F.3d 811, 818 (9th Cir. 2003) (where the use of images in a search engine was "unrelated to any aesthetic purpose").

This is similar to what occurred in *Sony*, where Connectix had to access all of Sony's code to understand the code's functional aspects in order to build an emulator that could play Sony games.[191] To understand how to best customize the ST-Link, owners need to analyze the functional aspects of the code controlling the ST-Link. Just as the Ninth Circuit found in *Sony*, the only way to access the functional aspects of the ST-Link code is by copying the entire work.[192] Since functional aspects were "expressly denied copyright protection by Congress," they may be copied without infringing on the copyright to examine the functionality of the original code.[193] Because the ST-Link firmware is a work that is not solely expressive, but rather contains functional and factual elements, and the owner is accessing the original firmware within the ST-Link only for those functional and factual elements, the second fair use factor supports a finding of fair use.[194]

3. The Amount and Substantiality of the Portion Used

The third fair use factor examines the amount of the copyrighted work used in an effort to determine whether the "quantity and value of the materials used are reasonable in relation to the purpose of the copying."[195] The use of an entire work does not preclude an activity from being a fair use.[196] The amount taken only need be "reasonable" and for a legitimate purpose.[197]

In *Sony* and *Sega*, the Ninth Circuit found that copying a software program in its entirety in order to understand its functional components was necessary to achieving a favored purpose, and was therefore fair.[198] Similarly, in *Kelly v. Arriba Soft*, the court emphasized that copying anything less than an entire work would be insufficient in order to allow users to recognize images in a visual search engine.[199] In *Perfect 10,* the court concluded that Google's use of Perfect 10's images was reasonable in light of its purpose of communicating information to its users.[200] In both cases, the court found this copying to be fair use. And in *Authors Guild, Inc. v. Google*, in which the plaintiffs participated in the scanning and electronic storage of numerous books in their entirety, the court held that the copying was reasonable in light of its purpose.[201]

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[191] *See id.* at 603-05.

[192] *See id.* at 603.

[193] *See id.* at 605 (citing *Sega*, 977 F.2d at 1526).

[194] *See Sega*, 977 F.2d at 1524.

[195] *Campbell*, 510 U.S. at 586-87.

[196] *Sega*, 997 F.2d at 1526.

[197] *Campbell*, 510 U.S. at 586.

[198] *Sega*, 977 F.2d at 1526; *Sony*, 203 F.3d at 605-06.

[199] 336 F. 3d at 820-21; *see also Field v. Google Inc.*, 412 F. Supp. 2d 1106, 1120-121 (D. Nev. 2006) (finding the third factor weighing in favor of neither party because, while Google copied entire pages in its web caching service, the amount used was necessary to the purpose).

[200] 508 F.3d at 1167-68.

[201] *Authors Guild v. Google, Inc.*, 804 F.3d 202, 221-22 (2d Cir. 2015).

The reasoning of these cases applies equally here. Functionality may be found throughout a piece of software, and, as discussed previously, to create modified firmware for the ST-Link, the owner must first determine how much storage space the original firmware takes up and how much space the portions they want to replace occupies. This is only determinable by copying the entirety of the original firmware and analyzing it once it has been decrypted. Thus, to create their new, expressive firmware, owners must first copy the original firmware in its entirety. Even though the entire the work is copied, the use is still a fair use because copying the entire work is needed to achieve the ultimate transformative use. The third factor thus weighs in favor of a finding of fair use.

4. Effect on the Market for the Copyrighted Work

The fourth and final statutory factor considers "the effect of the use upon the potential market for or value of the copyrighted work" by looking to see whether the new use would be a competing substitute for the original—i.e., whether purchasers would opt to acquire the copy instead of the original.[202] In this instance, the modified firmware is of no use to any owner who has not already purchased an ST-Link/V2 programmer/debugger. Because the copyrighted work is purchasable only as part of the physical product itself, and the modified firmware is only useful as alternative code controlling the physical product, the potential market for the ST-Link code would not decrease in any form. If anything, having the option to install alternative code available will likely incentivize more potential buyers to purchase the ST-Link device, as they would be able to install the modified firmware onto it that expands its utility and better suits their needs. Thus, the fourth factor weighs in favor of a finding of fair use.

C. The Statutory Factors Support Granting an Exemption

1. The Proposed Exemption Would Increase the Availability for Use of Copyrighted Works

The preceding discussion demonstrates how the availability of copyrighted works will be improved by the proposed exemption. As described above, technical measures currently restrict the availability of copyrighted ST-Link firmware for lawful uses that cannot be achieved except through circumvention.

There will be no adverse effect on the availability of copyrighted works, since code is necessary for the ST-Link to function and is produced for non-copyright-related reasons, and because no market harm cognizable by copyright law will result from the proposed exemption. To the contrary, the requested exemption will likely give rise to the creation of additional copyrighted works that rely on the ST-Link firmware, such as the various writings cited in this comment that discuss reasons for and methods of modifying ST-Link devices.

2. The Proposed Exemption Would Increase the Availability for Use of Works for Non-Profit Archival, Preservation, and Educational Purposes

The proposed exemption would make the ST-Link firmware and new works based on it available for use for non-profit archival, preservation, and educational purposes. For example, if

[202] 17 U.S.C. § 107.

an exemption is granted, university engineering courses could benefit from the ability to customize the ST-Link firmware. At its core, the ST-Link/V2 device serves to program and debug different microcontrollers. Granting the ability to owners of ST-Link devices to access, modify, and improve on the code controlling the ST-Link increases the usefulness of the device in electrical engineering classes across the country. Allowing professors to circumvent the TPM to modify the firmware lets them utilize the ST-Link in their courses either by allowing their students to learn first-hand or by modifying the firmware to satisfy whatever microcontroller requirements are relevant for their class.

Further, it has been shown that the ability to interact with technology generally, such as the copyrighted firmware within the ST-Link, is educational and is a common path for young people to become interested in studying science and engineering.[203]

3. Prohibiting Circumvention of the TPM Applied to ST-Link's Firmware Has a Negative Impact on Criticism, Comment, News Reporting, Teaching, Scholarship, and Research

Prohibiting this circumvention and others like it curtails all of the activities identified in the third factor. For example, without being able to access the copyrighted code in the ST-Link/V2, owners are unable to demonstrate through testing how to improve the device, and researchers are limited in their ability to customize and create new products utilizing the ST-Link's ability to program and debug microcontrollers. By exempting the circumvention of the TPM preventing access to the copyrighted code in the original ST-Link firmware, researchers across the country that own ST-Link devices would be able to customize their tool to optimize their research on the limits of control a microcontroller can have on a product. By allowing for the ST-Link to be customized to meet each individual researcher's requirements, their research can be done more efficiently and more effectively.

4. Allowing Circumvention Would Not Harm the Potential Market

For the reasons discussed in the above analysis of the fourth fair use factor, the relevant markets will not suffer any harm cognizable under copyright law.

5. No Other Factors are Relevant to Consideration of This Exemption

There are no additional factors that should be considered for this exemption. Denying or restricting an exemption to Section 1201 on the basis of factors that form no part of the inquiry into whether the ban on circumvention has or is likely to have adverse effects on noninfringing uses of copyrighted works would go against the statutory language of Section 1201, which states that an exemption "shall" be granted if noninfringing uses by "persons who are users of a copyrighted work are, or are likely to be, adversely affected."[204]

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[203] *See, e.g.*, Steve Song, *In Praise of Taking Things Apart*, *available at* https://manypossibilities.net/2008/03/in-praise-of-taking-things-apart/ (quoting an interview with John Seely-Brown in which he said "A huge amount of the learning that a lot of us do, that formed the foundations of all the formal education that we got afterwards, could be called 'tinkering.' Because of changes in electronics and cars, a whole generation couldn't tinker.").

[204] 17 U.S.C. § 1201(a)(1)(C).

5. Feiyu Camera Gimbal: Encrypted Firmware

A. The Ban on Circumvention Limits Noninfringing Uses of Feiyu Tech Firmware

The ban on circumvention adversely affects the ability of Feiyu gimbal owners to use Feiyu firmware code to learn about, customize, and optimize their Feiyu gimbals.

Feiyu gimbals are able to stabilize a camera in motion. In its original configuration, however, the gimbal's functionality cannot serve all of a user's needs. For example, it requires modification to be capable of working with a camera producing high-quality HD SDI video or to add features such as expanded camera control speeds and positioning capabilities.[205] These functional features of the device can be altered only by circumventing the encryption that controls access to the Feiyu firmware.

B. Modifying the Feiyu Camera Gimbal Is Noninfringing

Modifying the Feiyu firmware for the purpose of enhancing the device's capabilities does not infringe Feiyu's copyright in its software code because it is a fair use, and "fair use of a copyrighted work . . . is not an infringement of copyright."[206]

1. The Purpose and Character of the Use

The first statutory factor focuses on the purpose and character of the use of the copyrighted work. Central to this inquiry is whether the new work "merely supersedes the objects of the original creation" or is transformative—that is, whether the secondary user expands on the expression, meaning, or message of the original work.[207] "[A] transformative use is one that communicates something new and different from the original or expands its utility, thus serving copyright's overall objective of contributing to public knowledge."[208]

Feiyu gimbal modders like Micah Scott use the Feiyu firmware to understand its functional aspects and create their own customized firmware that adds new functions and increases the utility of both the original code and the hardware it controls. Courts have found that copying computer code for similar purposes constitutes fair use. In *Sega v. Accolade*, the Ninth Circuit explained that research into the functional aspects of Sega's video game software was a legitimate fair use

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[205] UnNamedRE.com, *004 – OxOFF the Rails, An Interview with Micah Elizabeth Scott*, https://unnamedre.com/episode/4 (The relevant section of the podcast starts at 17:55); scanlime, *Feiyu Gimbal Serial Hack – scanlime:021*, https://www.youtube.com/watch?v=zLIaJBqcjNI (The relevant section of the video starts at 50:30).

[206] *Id.*

[207] *See Campbell v. Acuff-Rose Music, Inc.*, 510 U.S. 569, 579 (1994) (internal quotation marks omitted); *see also* Pierre N. Leval, *Toward a Fair Use Standard*, 103 Harv. L. Rev. 1105, 1111 (1990).

[208] *See Authors Guild v. Google, Inc.*, 804 F.3d 202, 214 (2d Cir. 2015).

purpose, even for a competitor seeking to develop competing games.[209] The court emphasized that the functional aspects of Sega's software were not copyrightable and recognized that copying the entire software—including copyrightable elements—was necessary for analysis.[210] Here, just as Accolade copied code from Sega's games to create new games that would interoperate with the Sega Genesis, owners wanting to create modified firmware that adds new functionality to their Feiyu gimbals must access the original code that controls the physical operation of the device and understand its functional elements. Moreover, this use fits even more firmly within the fair use framework than Sega's because installing modified firmware on your own device to customize it to your individual needs is a personal, noncommercial use.

The Ninth Circuit reaffirmed the reasoning of *Sega* in *Sony v. Connectix*, where the court held that Connectix's copying of Sony's BIOS firmware, which controls the Sony PlayStation console's ability to read Sony PlayStation games, to create their own console that could read and play Sony PlayStation games, was a noninfringing fair use.[211] This mirrors how the original Feiyu firmware is used to create modified firmware with new functionality. As discussed above, the modified firmware can only function on the Feiyu gimbal if the initial firmware has been decrypted and downloaded onto a computer. The only way to access the code and decrypt it is to copy the entirety of the work. To control the physical functions of the Feiyu gimbal with modified firmware, the owner needs to know which aspects of the copyrighted work control those physical functions. That is only possible by analyzing the code to isolate the corresponding controls, and functionality may be found throughout a piece of software.

Ms. Scott's gimbal modification project also highlights how firmware modding can serve the education goals of fair use doctrine. Ms. Scott has explained that her hope is that her "videos, the code, or the design file might inspire you to build something new or ask some new questions about the devices around you."[212] Through her work and art she hopes to "inspire people to understand and modify the technology in their lives" and "help people break into an increasingly complicated field."[213] She has also made her modified firmware freely and publicly available for purchasers of the Feiyu gimbal.[214]

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[209] *See Sega Enters. Ltd. v. Accolade, Inc.*, 977 F2d 1510, 1522-23 (9th Cir. 1992) (holding that using copyrighted material to study functional requirements was fair use).

[210] *Id.*

[211] *See Sony Computer Entm't Inc. v. Connectix Corp.*, 203 F.3d 596, 599, 609 (9th Cir. 2000).

[212] Micah Elizabeth Scott, *scanlime032 – Early Flyer View*, https://scanlime.org/tag/tuco-flyer/ (The relevant section of the video starts at 7:22).

[213] Micah Elizabeth Scott, scanlime032 – Early Flyer View, https://scanlime.org/tag/tuco-flyer/ (The relevant section of the video starts at 7:54).

[214] scanlime, *fygimbal*, GITHUB, https://github.com/scanlime/fygimbal

2. The Nature of the Copyrighted Work

The second statutory factor considers the nature of the copyrighted work.[215] If the work is factual or functional in nature, there is more latitude to copy without infringing.[216] As discussed in *Sony*, if the copying of the original firmware was necessary for the modified use, that supports a finding of fair use.[217] The work in question here is the code that determines how the Feiyu gimbal controls the camera and allows the external read out of its sensors. This code is copyrighted but is minimally creative in nature. Moreover, the code is being accessed only to expand on the functioning of the physical Feiyu device. The creative, protectable elements of the code are merely incidental to this use.

This is similar to what occurred in *Sony*, where Connectix had to access all of Sony's code to understand the code's functional aspects in order to build an emulator that could play Sony games.[218] In this instance, to understand how to best customize the control of the gimbal mounted camera and read out of the gimbal's sensors, users need to analyze the functional aspects of the code controlling the Feiyu gimbal. Just as the Ninth Circuit found in *Sony*, the only way to access the functional aspects of the Feiyu code is by copying the entire work.[219] Since functional aspects were "expressly denied copyright protection by Congress," they may be copied without infringing on the copyright to examine the functionality of the original code.[220] Because the Feiyu firmware is a work that is not solely expressive, but rather contains functional elements, and the owner is accessing the original firmware within the Feiyu gimbal only for those functional elements, the second fair use factor supports a finding of fair use.[221]

3. The Amount and Substantiality of the Portion Used

The third fair use factor examines the amount of the copyrighted work used in an effort to determine whether the "quantity and value of the materials used are reasonable in relation to the purpose of the copying."[222] The use of an entire work does not preclude an activity from being a fair use.[223] The amount taken only need be "reasonable" and for a legitimate purpose.[224]

In *Sony* and *Sega*, the Ninth Circuit found that copying a software program in its entirety in order to understand its functional components was necessary to achieving a favored purpose,

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[215] 17 U.S.C. § 107.

[216] *See Sega*, 977 F.2d at 1524.

[217] *See Sony*, 203 F.3d at 603.

[218] *See id.* at 603-05.

[219] *See id.* at 603.

[220] *See id.* at 605 (citing *Sega*, 977 F.2d at 1526).

[221] *See Sega*, 977 F.2d at 1524.

[222] *Campbell*, 510 U.S. at 586-87.

[223] *Sega*, 997 F.2d at 1526.

[224] *Campbell*, 510 U.S. at 586.

and was therefore fair.[225] Similarly, in *Kelly v. Arriba Soft*, the court emphasized that copying anything less than an entire work would be insufficient in order to allow users to recognize images in a visual search engine.[226] In *Perfect 10,* the court concluded that Google's use of Perfect 10's images was reasonable in light of its purpose of communicating information to its users.[227] In both cases, the court found this copying to be fair use. And in *Authors Guild, Inc. v. Google*, in which the plaintiffs participated in the scanning and electronic storage of numerous books in their entirety, the court held that the copying was reasonable in light of its purpose.[228]

The reasoning of these cases applies equally here. Without the ability to copy and view the entirety of the code, improving the functionality of the Feiyu gimbal would be impossible. The original firmware must be decrypted to be accessible, and the complete encrypted code must be copied off the Feiyu gimbal onto a computer to decrypt it. Only once this decryption has occurred can owners take the original firmware and modify it to meet their needs. Owners cannot determine which portion of the encrypted code they require access to until all of the code has been decrypted. Even though the entire the work is copied, the use is still a fair use because copying the entire work is needed to achieve the ultimate transformative use. The third factor thus weighs in favor of a finding of fair use.

4. Effect on the Market for the Copyrighted Work

The fourth and final statutory factor considers "the effect of the use upon the potential market for or value of the copyrighted work" by looking to see whether the new use would be a competing substitute for the original—i.e., whether purchasers would opt to acquire the copy instead of the original.[229] In this instance, the modified firmware is of no use to anyone who does not already have a Feiyu gimbal. Because the copyrighted work is purchasable only as part of the physical product itself, and the modified firmware is only useful as alternative code controlling the physical product, the potential market for the Feiyu code would not decrease in any form. If anything, having this alternative code available will likely incentivize more potential buyers to purchase Feiyu gimbals, as they would be able to install the modified firmware onto it to better suit their needs. Thus, the fourth factor weighs in favor of a finding of fair use.

C. The Statutory Factors Support Granting an Exemption

1. The Proposed Exemption Would Increase the Availability for Use of Copyrighted Works

The preceding discussion demonstrates how the availability of copyrighted works will be improved by the proposed exemption. As described above, technical measures currently restrict

[225] *Sega*, 977 F.2d at 1526; *Sony*, 203 F.3d at 605-06.

[226] 336 F. 3d at 820-21; *see also Field v. Google Inc.*, 412 F. Supp. 2d 1106, 1120-121 (D. Nev. 2006) (finding the third factor weighing in favor of neither party because, while Google copied entire pages in its web caching service, the amount used was necessary to the purpose).

[227] 508 F.3d at 1167-68.

[228] *Authors Guild v. Google, Inc.*, 804 F.3d 202, 221-22 (2d Cir. 2015).

[229] 17 U.S.C. § 107.

the availability of copyrighted Feiyu firmware for lawful uses that cannot be achieved except through circumvention.

There will be no adverse effect on the availability of copyrighted works, since code is necessary for the Feiyu gimbal to function and is produced for non-copyright-related reasons, and because no market harm cognizable by copyright law will result from the proposed exemption. To the contrary, the requested exemption will likely give rise to the creation of additional copyrighted works that rely on the Feiyu firmware, such as the various writings and videos cited in this comment that discuss reasons for and methods of modifying Feiyu Gimbals.

2. The Proposed Exemption Would Increase the Availability for Use of Works for Non-Profit Archival, Preservation, and Educational Purposes

An exemption for circumvention of TPMs in software-enabled devices increases the availability of the software for educational purposes. Circumvention of the TPM for the Feiyu gimbal is one example. As Ms. Scott herself has stated, her goal in circumventing the TPM in the camera gimbal is to "inspire you to build something new or ask some new questions about the devices around you."[230] Through her work and art she hopes to inspire people to understand and modify the technology in their lives and help people break into an increasingly complicated field.[231] She has published at least four educational videos on the topic, all of which could be used by non-profit organizations similarly seeking to create art.[232]

Further, it has been shown that the ability to interact with technology, such as the copyrighted firmware within the Feiyu camera gimbal, is educational and is a common path for young people to become interested in studying science and engineering.[233]

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[230] Micah Elizabeth Scott, *scanlime032 – Early Flyer View*, https://scanlime.org/tag/tuco-flyer/ (relevant section of the video starts at 7:22).

[231] Micah Elizabeth Scott, *scanlime032 – Early Flyer View*, https://scanlime.org/tag/tuco-flyer/ (relevant section of the video starts at 7:54).

[232] scanlime, *Feiyu Gimbal Serial Hack – scanlime:021*, https://www.youtube.com/watch?v=zLIaJBqcjNI&list=PLhbhmdpDp9xEeO6E-ihfqqt8nycOP4S8r&index=3&ab_channel=scanlime; scanlime, *Smart Camera Gimbal Bot – scanlime:027*, https://www.youtube.com/watch?v=1euT7GsUuhY; scanlime, *Winch Bot – scanlime:026*, https://www.youtube.com/watch?v=s3O0jKvxUIM&ab_channel=scanlime; Micah Elizabeth Scott, *scanlime032 – Early Flyer View*, https://scanlime.org/tag/tuco-flyer/.

[233] *See, e.g.*, Steve Song, *In Praise of Taking Things Apart*, *available at* https://manypossibilities.net/2008/03/in-praise-of-taking-things-apart/ (quoting an interview with John Seely-Brown in which he said "A huge amount of the learning that a lot of us do, that formed the foundations of all the formal education that we got afterwards, could be called 'tinkering.' Because of changes in electronics and cars, a whole generation couldn't tinker.").

3. Prohibiting Circumvention of the TPM Applied to Feiyu's Firmware Has a Negative Impact on Criticism, Comment, News Reporting, Teaching, Scholarship, and Research

Prohibiting this circumvention and others like it curtails all of the activities identified in the third factor. For example, the threat of legal repercussions for circumventing the TPMs used by Feiyu serves as a deterrent to exploring other ways to improve on the Feiyu gimbal's operation, as Ms. Scott hoped to inspire others to do.[234]

4. Allowing Circumvention Would Not Harm the Potential Market

For the reasons discussed in the above analysis of the fourth fair use factor, the relevant markets will not suffer any harm cognizable under copyright law.

5. No Other Factors Are Relevant to Consideration of This Exemption

There are no additional factors that should be considered for this exemption. Denying or restricting an exemption to Section 1201 on the basis of factors that form no part of the inquiry into whether the ban on circumvention has or is likely to have adverse effects on noninfringing uses of copyrighted works would go against the statutory language of Section 1201, which states that an exemption "shall" be granted if noninfringing uses by "persons who are users of a copyrighted work are, or are likely to be, adversely affected."[235]

6. Kindle Paperwhite E-Reader: Password-Protected Firmware

A. The Ban on Circumvention Limits Noninfringing Uses of Kindle Firmware

The ban on circumvention adversely affects the ability of Kindle Paperwhite e-reader owners to use Kindle firmware code to learn about their e-readers, customize their features, and optimize their performance for specific reading materials.

The Kindle is currently limited to the functions encoded by Amazon, which limits the creativity of owners to customize their e-readers and maximize usability.[236] In its out-of-the-box configuration, the Kindle has limited screensavers, limited fonts, and limited apps, as well as not being optimized for reading comics.[237]

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[234] Micah Elizabeth Scott, *scanlime032 – Early Flyer View*, https://scanlime.org/tag/tuco-flyer/ (relevant section of the video starts at 7:22).

[235] 17 U.S.C. § 1201(a)(1)(C).

[236] RyanYammyYam, *What Are The Advantages of 'Jailbreaking' a Kindle Paperwhite?*, REDDIT (July 7, 2014), https://www.reddit.com/r/kindle/comments/2a1re4/what_are_the_advantages_of_jailbreaking_a_kindle/ (custom screensavers, fonts, and applications); Iris Yan, *Kindle Jailbreak Apps and Hacks*, EPUBOR (Apr. 15, 2020), https://www.epubor.com/kindle-jailbreak-appsand-hacks.html (improved comics viewing).

[237] *Id*.

These features of the Kindle Paperwhite e-reader can be altered only by circumventing the password protection that controls access to the Kindle firmware. If this circumvention were permitted by a clear exemption, Kindle owners would be able to customize and optimize their e-readers through a range of creative modifications.

B. Modifying the Kindle Paperwhite Is Noninfringing

Modifying the Kindle firmware for the purpose of adding new features to the device and optimizing its capabilities does not infringe Amazon's copyright in its software code because doing so is a fair use, and "fair use of a copyrighted work . . . is not an infringement of copyright."[238]

1. The Purpose and Character of the Use

The first statutory factor focuses on the purpose and character of the use of the copyrighted work. Central to this inquiry is whether the new work "merely supersedes the objects of the original creation" or is transformative—that is, whether the secondary user expands on the expression, meaning, or message of the original work.[239] "[A] transformative use is one that communicates something new and different from the original or expands its utility, thus serving copyright's overall objective of contributing to public knowledge."[240]

Kindle modders use the Kindle firmware to understand its functional aspects and create their own customized firmware that adds new functionality and increases the utility of both the original code and the hardware it controls. Courts have found that copying computer code for similar purposes constitutes fair use. In *Sega v. Accolade*, the Ninth Circuit explained that research into the functional aspects of Sega's video game software was a legitimate fair use purpose, even for a competitor seeking to develop competing games.[241] The court emphasized that the functional aspects of Sega's software were not copyrightable and recognized that copying the entire software—including copyrightable elements—was necessary for analysis.[242] Here, just as Accolade copied code from Sega's games to create new games that would interoperate with the Sega Genesis, owners wanting to create modified Kindle firmware require knowledge of functional elements of the original Kindle firmware. To install the modified firmware for the Kindle e-reader, a significant portion of the original firmware must be copied out as a blueprint for the modified code, as it is not readable on the Kindle. Then, once the original firmware is modified, the owner can determine how they want to incorporate any additional changes to the existing firmware. These additions include expanding upon the Kindle's ability to support a range of creative and practical

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[238] *Id.*

[239] *See Campbell v. Acuff-Rose Music, Inc.*, 510 U.S. 569, 579 (1994) (internal quotation marks omitted); *see also* Pierre N. Leval, *Toward a Fair Use Standard*, 103 Harv. L. Rev. 1105, 1111 (1990).

[240] *See Authors Guild v. Google, Inc.*, 804 F.3d 202, 214 (2d Cir. 2015).

[241] *See Sega Enters. Ltd. v. Accolade, Inc.*, 977 F2d 1510, 1522-23 (9th Cir. 1992) (holding that using copyrighted material to study functional requirements was fair use).

[242] *Id.*

customizations.[243] Moreover, this use fits even more firmly within the fair use framework than Sega's because installing modified firmware on your own device to customize it to your individual needs is a personal, noncommercial use.

The Ninth Circuit reaffirmed the reasoning of *Sega* in *Sony v. Connectix*, where the court held that Connectix's copying of Sony's BIOS firmware, which controls the Sony PlayStation console's ability to read Sony PlayStation games, to create their own console that could read and play Sony PlayStation games, was a noninfringing fair use.[244] This mirrors how the original Kindle firmware is used to create modified firmware with new functionality. As discussed above, the modified firmware can only function on the Kindle if the password protection on the initial firmware has been circumvented, the update firmware modified, and then installed onto the e-reader. The only way to access the code and circumvent the signature validation is to copy a portion of the work and modify it.

The Ninth Circuit confirmed their initial ruling in *Sega* in *Sony v. Connectix*, where they found that Connectix's copying of the entirety of Sony's BIOS firmware, which controls the ability to read Sony PlayStation games by the Sony PlayStation to create their own console to read and play Sony PlayStation games on, was a noninfringing fair use.[245] This mirrors how the modified firmware uses the original firmware within the Kindle e-reader. As discussed above, the modified firmware can only function on the Kindle if the password protection on the initial firmware has been circumvented, the update firmware modified, and then installed onto the e-reader. The only way to access the code and circumvent the signature validation is to copy a portion of the work and modify it.

2. The Nature of the Copyrighted Work

The second statutory factor considers the nature of the copyrighted work.[246] If the work is factual or functional in nature, there is more latitude to copy without infringing.[247] As discussed in *Sony*, if the copying of the original firmware was necessary for the modified use, that supports a finding of fair use.[248] The work in question here is the code that controls the functions of the Kindle e-reader, including the visual customizations and unique applications available to a Kindle owner. This code is copyrighted but is minimally creative in nature. Moreover, the code is being accessed only to expand on the functioning of the Kindle device. The creative, protectable elements of the code are merely incidental to this use.

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[243] RyanYammyYam, *What Are The Advantages of 'Jailbreaking' a Kindle Paperwhite?*, REDDIT (July 7, 2014), https://www.reddit.com/r/kindle/comments/2a1re4/what_are_the_advantages_of_jailbreaking_a_kindle/ (custom screensavers, fonts, and applications); Iris Yan, *Kindle Jailbreak Apps and Hacks*, EPUBOR (Apr. 15, 2020), https://www.epubor.com/kindle-jailbreak-appsand-hacks.html (improved comics viewing).

[244] *See Sony Computer Entm't Inc. v. Connectix Corp.*, 203 F.3d 596, 599, 609 (9th Cir. 2000).

[245] *See Sony*, 203 F.3d at 599, 609.

[246] 17 U.S.C. § 107.

[247] *See Sega*, 977 F.2d at 1524.

[248] *See Sony*, 203 F.3d at 603.

This is similar to what occurred in *Sony*, where Connectix had to access all of Sony's code to understand the code's functional aspects in order to build an emulator that could play Sony games.[249] In this instance, to understand how to create custom firmware that will add the desired features while still allowing the Kindle to function properly, owners need to analyze the functional aspects of the code controlling the Kindle. Just as the Ninth Circuit found in *Sony*, the only way to access the functional aspects of the Kindle code is by copying the entire work.[250] Since functional aspects were "expressly denied copyright protection by Congress," they may be copied without infringing on the copyright to examine the functionality of the original code.[251] Because the Kindle firmware is a work that is not solely expressive, but rather contains functional elements, and the owner is accessing the original firmware within the Kindle only for those functional elements, the second fair use factor supports a finding of fair use.[252]

3. The Amount and Substantiality of the Portion Used

The third fair use factor examines the amount of the copyrighted work used in an effort to determine whether the "quantity and value of the materials used are reasonable in relation to the purpose of the copying."[253] The use of an entire work does not preclude an activity from being a fair use.[254] The amount taken only need be "reasonable" and for a legitimate purpose.[255]

In *Sony* and *Sega*, the Ninth Circuit found that copying a software program in its entirety in order to understand its functional components was necessary to achieving a favored purpose, and was therefore fair.[256] Similarly, in *Kelly v. Arriba Soft*, the court emphasized that copying anything less than an entire work would be insufficient in order to allow users to recognize images in a visual search engine.[257] In *Perfect 10,* the court concluded that Google's use of Perfect 10's images was reasonable in light of its purpose of communicating information to its users.[258] In both cases, the court found this copying to be fair use. And in *Authors Guild, Inc. v. Google*, in which the plaintiffs participated in the scanning and electronic storage of numerous books in their entirety, the court held that the copying was reasonable in light of its purpose.[259]

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[249] *See id.* at 603-05.

[250] *See id.* at 603.

[251] *See id.* at 605 (citing *Sega*, 977 F.2d at 1526).

[252] *See Sega*, 977 F.2d at 1524.

[253] *Campbell*, 510 U.S. at 586-87.

[254] *Sega*, 997 F.2d at 1526.

[255] *Campbell*, 510 U.S. at 586.

[256] *Sega*, 977 F.2d at 1526; *Sony*, 203 F.3d at 605-06.

[257] 336 F. 3d at 820-21; *see also Field v. Google Inc.*, 412 F. Supp. 2d 1106, 1120-121 (D. Nev. 2006) (finding the third factor weighing in favor of neither party because, while Google copied entire pages in its web caching service, the amount used was necessary to the purpose).

[258] 508 F.3d at 1167-68.

[259] *Authors Guild v. Google, Inc.*, 804 F.3d 202, 221-22 (2d Cir. 2015).

The reasoning of these cases applies equally here. Without the ability to copy and view the code, determining how to improve the functionality of the Kindle would be impossible, and functionality may be found throughout a piece of software. Even though the entire the work is copied, the use is still a fair use because copying the entire work is needed to achieve the ultimate transformative use. The third factor thus weighs in favor of a finding of fair use.

4. Effect on the Market for the Copyrighted Work

The fourth and final statutory factor considers "the effect of the use upon the potential market for or value of the copyrighted work" by looking to see whether the new use would be a competing substitute for the original—i.e., whether purchasers would opt to acquire the copy instead of the original.[260] In this instance, the modified firmware is of no use to any owner who has not already purchased a Kindle e-reader. Because the copyrighted work is purchasable only as part of the physical product itself, and the modified firmware is only useful as alternative code controlling the physical product, the potential market for the Kindle code would not decrease in any form. If anything, having this alternative code available will likely incentivize more potential buyers to purchase the Kindle, as they would be able to install the modified firmware onto it to better suit their needs. Thus, the fourth factor weighs in favor of a finding of fair use.

C. The Statutory Factors Support Granting an Exemption

1. The Proposed Exemption Would Increase the Availability for Use of Copyrighted Works

The preceding discussion demonstrates how the availability of copyrighted works will be improved by the proposed exemption. As described above, technical measures currently restrict the availability of copyrighted Kindle firmware for lawful uses that cannot be achieved except through circumvention.

There will be no adverse effect on the availability of copyrighted works, since code is necessary for the Kindle e-reader to function and is produced for non-copyright-related reasons, and because no market harm cognizable by copyright law will result from the proposed exemption. To the contrary, the requested exemption will likely give rise to the creation of additional copyrighted works that rely on the Kindle firmware, such as the various writings cited in this comment that discuss reasons for and methods of modifying Kindle e-readers.

2. The Proposed Exemption Would Increase the Availability for Use of Works for Non-Profit Archival, Preservation, and Educational Purposes

The proposed exemption would make the Kindle firmware and new works based on it available for use for non-profit archival, preservation, and educational purposes. For example, the availability of modified firmware would benefit many university students taking courses that critically engage with comics or graphic novels, which are becoming a more common aspect of pedagogy in schools across the country.[261] By modifying the Kindle e-reader, students can engage

[260] 17 U.S.C. § 107.

[261] *See, e.g.*, Christine DePetrillo, *NECAC: Using Comics to Make Kids Love Reading*, PUBLISHERS WEEKLY (Mar. 29, 2011), https://www.publishersweekly.com/pw/by-topic/childrens/childrens-

with graphic novels more easily.[262] Professors and students who use their Kindles for academic reading can also customize their screensavers to include their email addresses or telephone numbers, making it easier to return e-readers to their rightful owners if they are misplaced.[263] By allowing for this circumvention to occur, faculty and students will be better able to customize their Kindles to meet their academic needs.

Further, it has been shown that the ability to interact with technology, such as the copyrighted firmware within the Kindle e-reader, is educational and is a common path for young people to become interested in studying science and engineering.[264]

3. Prohibiting Circumvention of the TPM Applied to Kindle Firmware Has a Negative Impact on Criticism, Comment, News Reporting, Teaching, Scholarship, and Research

Prohibiting this circumvention and others like it curtails all of the activities identified in the third factor. For example, only through circumvention can a Kindle Paperwhite owner experiment with and evaluate improvements to the device's handling of comics and graphic novels. Further, even if a person is willing to take the risk to make these changes to their own device, the threat of legal liability remains as a deterrent to sharing their findings publicly and inform others about the improvements that are possible.

4. Allowing Circumvention Would Not Harm the Potential Market

For the reasons discussed in the above analysis of the fourth fair use factor, the relevant markets will not suffer any harm cognizable under copyright law.

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book-news/article/46650-necac-using-comics-to-make-kids-love-reading.html (discussing the first New England Comic Arts in the Classroom Conference for professors using comics as a teaching tool); Eastern Illinois University, *EIU 4171G – Comics, Manga, and Graphic Novels: The History of Graphic Narratives*, https://catalog.eiu.edu/preview_course_nopop.php?catoid=23&coid=36862 (last accessed Dec. 11, 2020) (course exploring the social, cultural, and aesthetic aspects of narrative art from cave paintings to graphic novels); *Beyond Superheroes: Comics as a New Genre for Medical Storytelling*, PENNSTATE HEALTH DAILY BRIEF (Jan. 19, 2012), https://pennstatehealthnews.org/topics/beyond-superheroes-comics-as-a-new-genre-for-medical-storytelling/ (discussing the use of graphic novels in Graphic Storytelling and Medical Narratives course).

[262] Iris Yan, *Kindle Jailbreak Apps and Hacks*, EPUBOR (Apr. 15, 2020), https://www.epubor.com/kindle-jailbreak-appsand-hacks.html.

[263] Montalex, "Comment #3," MOBILEREAD (Feb. 16, 2019), https://www.mobileread.com/forums/showthread.php?t=315299.

[264] *See, e.g.*, Steve Song, *In Praise of Taking Things Apart*, *available at* https://manypossibilities.net/2008/03/in-praise-of-taking-things-apart/ (quoting an interview with John Seely-Brown in which he said "A huge amount of the learning that a lot of us do, that formed the foundations of all the formal education that we got afterwards, could be called 'tinkering.' Because of changes in electronics and cars, a whole generation couldn't tinker.").

5. No Other Factors are Relevant to Consideration of This Exemption

There are no additional factors that should be considered for this exemption. Denying or restricting an exemption to Section 1201 on the basis of factors that form no part of the inquiry into whether the ban on circumvention has or is likely to have adverse effects on noninfringing uses of copyrighted works would go against the statutory language of Section 1201, which states that an exemption "shall" be granted if noninfringing uses by "persons who are users of a copyrighted work are, or are likely to be, adversely affected."[265]

7. Aibo Robotic Companion: Encrypted Firmware

A. The Ban on Circumvention Limits Noninfringing Uses of Aibo Firmware

The ban on circumvention adversely affects the ability of Aibo owners to use Aibo firmware code to learn about, customize, and add new functionality to their Aibo devices.

While the Aibo is useful with its current firmware, there are additional tasks and tricks that owners can use to fully customize their Aibo robotic companion. By circumventing the encryption controlling access to the Aibo firmware, owners can able to customize their Aibo much in the same way that other dog owners can teach their animals new tasks and tricks. For the Aibo, this could include installing new features such as the ability to "dance, speak, obey wireless commands, and share the video used for Aibo's vision."[266] An exemption for this circumvention would provide new opportunities for owners of the Aibo to customize their own robotic companions, which should not be limited because a TPM prevents access to the copyrighted work controlling the physical device.

B. Modifying the Aibo Is Noninfringing

Modifying the Aibo firmware for the purpose of modifying the Aibo's functionality does not infringe Sony's copyright in its firmware code because doing so is a fair use and "fair use of a copyrighted work . . . is not an infringement of copyright."[267]

1. The Purpose and Character of the Use

The first statutory factor focuses on the purpose and character of the use of the copyrighted work. Central to this inquiry is whether the new work "merely supersedes the objects of the original creation" or is transformative—that is, whether the secondary user expands on the expression, meaning, or message of the original work.[268] "[A] transformative use is one that communicates

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[265] 17 U.S.C. § 1201(a)(1)(C).

[266] Christopher Soghoian, *Caveat Venditor: Technologically Protected Subsidized Goods and the Customers Who Hack Them*, 6 NW. J. TECH & INTELL. PROP. 46, 56 (2007), https://scholarlycommons.law.northwestern.edu/njtip/vol6/iss1/3/.

[267] *Id.*

[268] *See Campbell v. Acuff-Rose Music, Inc.*, 510 U.S. 569, 579 (1994) (internal quotation marks omitted); *see also* Pierre N. Leval, *Toward a Fair Use Standard*, 103 Harv. L. Rev. 1105, 1111 (1990).

something new and different from the original or expands its utility, thus serving copyright's overall objective of contributing to public knowledge."[269]

Aibo modders use the Aibo firmware to understand its functional aspects and create their own customized firmware that adds new functions and increases the utility of both the original code and the hardware it controls. Courts have found that copying computer code for similar purposes constitutes fair use. In *Sega v. Accolade*, the Ninth Circuit explained that research into the functional aspects of Sega's video game software was a legitimate fair use purpose, even for a competitor seeking to develop competing games.[270] The court emphasized that the functional aspects of Sega's software were not copyrightable and recognized that copying the entire software—including copyrightable elements—was necessary for analysis.[271] Here, just as Accolade copied code from Sega's games to create new games that would interoperate with the Sega Genesis, owners wanting to create modified Aibo firmware require knowledge of functional elements and attributes of the original Aibo firmware. In the case of the Aibo, the owner cannot expand on the original work without using the original work, because there is a limited amount of storage for the modified firmware. This requires each owner to determine the amount of storage the original firmware occupies and identify which portions of the original firmware they want to add to or remove to implement their own modifications. These decisions allow the owners to create something new, with a different purpose than the original firmware. Moreover, this use fits even more firmly within the fair use framework than Sega's because installing modified firmware on your own device to customize it to your individual needs is a personal, noncommercial use.

The Ninth Circuit reaffirmed the reasoning of *Sega* in *Sony v. Connectix*, where the court held that Connectix's copying of Sony's BIOS firmware, which controls the Sony PlayStation console's ability to read Sony PlayStation games, to create their own console that could read and play Sony PlayStation games, was a noninfringing fair use.[272] This is analogous to how the original Aibo firmware is required for the owner to create their own customized firmware. As the amount of storage within the Aibo is limited, the owner needs to analyze the original firmware and replace existing code with their modified code to achieve the new, desired control. Thus, to create the modified firmware with new purpose and expression, owners must use the original firmware to determine how much space they have to work with in the Aibo.

The use of the copyrighted Aibo firmware is required to create modified firmware, because it allows the modder to determine the amount of storage the original firmware occupies to design the modified firmware to function within that amount of storage. Under established caselaw, this is a transformative purpose supporting a finding of fair use.

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[269] *See Authors Guild v. Google, Inc.*, 804 F.3d 202, 214 (2d Cir. 2015).

[270] *See Sega Enters. Ltd. v. Accolade, Inc.*, 977 F2d 1510, 1522-23 (9th Cir. 1992) (holding that using copyrighted material to study functional requirements was fair use).

[271] *Id.*

[272] *See Sony Computer Entm't Inc. v. Connectix Corp.*, 203 F.3d 596, 599, 609 (9th Cir. 2000).

2. *The Nature of the Copyrighted Work*

The second statutory factor considers the nature of the copyrighted work.[273] If the work is factual or functional in nature, there is more latitude to copy without infringing.[274] As discussed in *Sony*, if the copying of the original firmware was necessary for the modified use, that supports a finding of fair use.[275] The work in question here is the code that controls the functions of the Aibo device, which determines how the Aibo interacts with its owner and the environment. This code is copyrighted but is minimally creative in nature. Moreover, the creative, protectable elements of the code are merely incidental to the reasons for using the work, which are to understand the functional aspects of the code required to control the Aibo and to determine the amount of storage space required by different firmware components. Analyzing these functional and factual characteristics of the original firmware is no different than determining how many words exist in a book: that process needs the entirety of the book but does not utilize its expressive elements.[276]

This is similar to what occurred in *Sony*, where Connectix had to access all of Sony's code to understand the code's functional aspects in order to build an emulator that could play Sony games.[277] To understand how to best customize the Aibo, owners need to analyze the functional aspects of the code controlling the Aibo using Sony's proprietary memory sticks. Just as the Ninth Circuit found in *Sony*, the only way to access the functional aspects of the Aibo code is by copying the entire work.[278] Since functional aspects were "expressly denied copyright protection by Congress," they may be copied without infringing on the copyright to examine the functionality of the original code.[279] Because the Aibo firmware is a work that is not solely expressive, but rather contains functional and factual elements, and the owner is accessing the original firmware within the Aibo only for those functional and factual elements, the second fair use factor supports a finding of fair use.[280]

3. *The Amount and Substantiality of the Portion Used*

The third fair use factor examines the amount of the copyrighted work used in an effort to determine whether the "quantity and value of the materials used are reasonable in relation to the purpose of the copying."[281] The use of an entire work does not preclude an activity from being a

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[273] 17 U.S.C. § 107.

[274] *See Sega*, 977 F.2d at 1524.

[275] *See Sony*, 203 F.3d at 603.

[276] Matthew Sag, *Copyright and Copy-Reliant Technology*, 103 NW. U. L. REV.1607, 1608 (2009); *see also Kelly v. Arriba Soft Corp.*, 336 F.3d 811, 818 (9th Cir. 2003) (where the use of images in a search engine was "unrelated to any aesthetic purpose").

[277] *See id.* at 603-05.

[278] *See id.* at 603.

[279] *See id.* at 605 (citing *Sega*, 977 F.2d at 1526).

[280] *See Sega*, 977 F.2d at 1524.

[281] *Campbell*, 510 U.S. at 586-87.

fair use.[282] The amount taken only need be "reasonable" and for a legitimate purpose.[283]

In *Sony* and *Sega*, the Ninth Circuit found that copying a software program in its entirety in order to understand its functional components was necessary to achieving a favored purpose, and was therefore fair.[284] Similarly, in *Kelly v. Arriba Soft*, the court emphasized that copying anything less than an entire work would be insufficient in order to allow users to recognize images in a visual search engine.[285] In *Perfect 10,* the court concluded that Google's use of Perfect 10's images was reasonable in light of its purpose of communicating information to its users.[286] In both cases, the court found this copying to be fair use. And in *Authors Guild, Inc. v. Google*, in which the plaintiffs participated in the scanning and electronic storage of numerous books in their entirety, the court held that the copying was reasonable in light of its purpose.[287]

The reasoning of these cases applies equally here. As discussed previously, to create modified firmware for the Aibo, the owner must determine which new tasks or tricks they wish to create, decrypt the Aibo firmware to analyze, purchase a proprietary memory stick from Sony, and load the memory stick with code that modifies the original firmware. This is only determinable by copying the entirety of the original firmware and analyzing it once it has been decrypted. Thus, to create new, expressive firmware, an owner like AiboHack must first copy the original firmware in its entirety. Even though the entire the work is copied, the use is still a fair use because copying the entire work is needed to achieve the ultimate transformative use. The third factor thus weighs in favor of a finding of fair use.

4. Effect on the Market for the Copyrighted Work

The fourth and final statutory factor considers "the effect of the use upon the potential market for or value of the copyrighted work" by looking to see whether the new use would be a competing substitute for the original—i.e., whether purchasers would opt to acquire the copy instead of the original.[288] For the Aibo, the modified firmware only functions on the physical product, on which the original copyrighted work comes installed, and will only be useful for the specific tasks and tricks for which the owner creates the modified firmware to function. Because the copyrighted work can only be acquired as part of the physical product itself and the modified firmware is only useful to those who already have the physical product, the potential market for the Aibo firmware would not decrease in any form.

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[282] *Sega*, 997 F.2d at 1526.

[283] *Campbell*, 510 U.S. at 586.

[284] *Sega*, 977 F.2d at 1526; *Sony*, 203 F.3d at 605-06.

[285] 336 F. 3d at 820-21; *see also Field v. Google Inc.*, 412 F. Supp. 2d 1106, 1120-121 (D. Nev. 2006) (finding the third factor weighing in favor of neither party because, while Google copied entire pages in its web caching service, the amount used was necessary to the purpose).

[286] 508 F.3d at 1167-68.

[287] *Authors Guild v. Google, Inc.*, 804 F.3d 202, 221-22 (2d Cir. 2015).

[288] 17 U.S.C. § 107.

To the contrary, there is evidence that the market for owner-created tasks and tricks *expands* the market for Aibo, Sony's proprietary memory sticks, and even other Sony products. As one Aibo owner protested in response to Sony's initial DMCA demand letter, "If it had not been for AiboPet's information, his invaluable knowledge and his generosity in sharing it with the Aibo community, I would not have purchased an Aibo, all the various software, [memory] sticks and yes, even my computer, a Sony VAIO, which I only purchased because of its stick reader."[289] Older generation Aibos are no longer available from Sony, but the popularity of AiboPet's customizations suggest that owners will likely be more interested in newer generation Aibos if similar modifications are made available.

C. The Statutory Factors Support Granting an Exemption

1. The Proposed Exemption Would Increase the Availability for Use of Copyrighted Works

The preceding discussion demonstrates how the availability of copyrighted works will be improved by the proposed exemption. As described above, technical measures currently restrict the availability of copyrighted Aibo firmware for lawful uses that cannot be achieved except through circumvention.

There will be no adverse effect on the availability of copyrighted works, since code is necessary for the Aibo robotic companion to function and is produced for non-copyright-related reasons, and because no market harm cognizable by copyright law will result from the proposed exemption. To the contrary, the requested exemption will likely give rise to the creation of additional copyrighted works that rely on the Aibo firmware, such as the various writings cited in this comment that discuss reasons for and methods of modifying Aibo robotic companions.

2. The Proposed Exemption Would Increase the Availability for Use of Works for Non-Profit Archival, Preservation, and Educational Purposes

The proposed exemption would make the Aibo firmware and new works based on it available for use for non-profit archival, preservation, and educational purposes. For example, while the Aibo is a robotic companion, it is also an opportunity to experiment with artificially intelligent robotics—some scholars have already used Aibo for this sort of research.[290] Enabling Aibo owners to access, modify, and improve on the code controlling the Aibo increases the usefulness of the device in robotics, computer science, and sociotechnical systems classes across the country. If professors can circumvent the TPM controlling access to the Aibo firmware, they can utilize the Aibo in their courses by allowing their students to learn first-hand through modifying the firmware to experiment with creating new, creative tasks and tricks for the Aibo.

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[289] David Labrador, *Teaching Robot Dogs New Tricks*, SCIENTIFIC AMERICAN (Jan. 21, 2002), https://www.scientificamerican.com/article/teaching-robot-dogs-new-t/.

[290] Iulia Dobai, Leon Rothkrantz & Charles van der Mast, *Personality Model for a Companion Aibo*, ACE '05: Proceedings of the 2005 ACM SIGCHI International Conference on Advances in Computer Entm't Tech, at 438 (June 2005), https://doi.org/10.1145/1178477.1178575.

Further, it has been shown that the ability to interact with technology, such as the copyrighted firmware within the Aibo, is educational and is a common path for young people to become interested in studying science and engineering.[291]

3. Prohibiting Circumvention of the TPM Applied to Aibo's Firmware Has a Negative Impact on Criticism, Comment, News Reporting, Teaching, Scholarship, and Research

Prohibiting this circumvention and others like it curtails all of the activities identified in the third factor. Without being able to access the copyrighted code in the Aibo, owners are literally unable to teach an old dog new tricks. By exempting the circumvention of the TPM preventing access to the copyrighted code in the original firmware of the Aibo, owners and researchers with an Aibo would be able to customize these robotic companions to optimize their research into artificially intelligent robots.

4. Allowing Circumvention Would Have No Negative Effect on the Potential Market

For the reasons discussed in the above analysis of the fourth fair use factor, the relevant markets will not suffer any harm cognizable under copyright law—and in fact are more likely to benefit from it.

5. No Other Factors Are Relevant to Consideration of This Exemption

There are no additional factors that should be considered for this exemption. Denying or restricting an exemption to Section 1201 on the basis of factors that form no part of the inquiry into whether the ban on circumvention has or is likely to have adverse effects on noninfringing uses of copyrighted works would go against the statutory language of Section 1201, which states that an exemption "shall" be granted if noninfringing uses by "persons who are users of a copyrighted work are, or are likely to be, adversely affected."[292]

8. Tytera MD380 Radio: Encrypted Firmware

A. The Ban on Circumvention Limits Noninfringing Uses of Tytera Firmware

The ban on circumvention adversely affects the ability of Tytera MD380 owners to use Tytera firmware code to add new functionality to their Tytera radios that would make them more useful and efficient.

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[291] *See, e.g.*, Steve Song, *In Praise of Taking Things Apart*, *available at* https://manypossibilities.net/2008/03/in-praise-of-taking-things-apart/ (quoting an interview with John Seely-Brown in which he said "A huge amount of the learning that a lot of us do, that formed the foundations of all the formal education that we got afterwards, could be called 'tinkering.' Because of changes in electronics and cars, a whole generation couldn't tinker.").

[292] 17 U.S.C. § 1201(a)(1)(C).

The Tytera MD380 allows users to communicate to communicate using Digital Mobile Radio through either a public talk group or a private contact.[293] In its present configuration, it is only possible to monitor one talk group at a time, so to be aware of multiple separate discussions, the owner has to constantly change the radio settings.[294]

Device owners can increase the utility of their Tytera MD380 radios by allowing for the monitoring of different public digital radio channels simultaneously.[295] However, to do so requires circumventing the TPMs controlling access to the Tytera firmware. Circumvention is also required to install additional features that the Tytera MD380 radio does not support in unmodified form, such as setting different buttons for alternate functions or creating a large private talk channel rather than a public channel.[296]

B. Modifying the Tytera Radio Is Noninfringing

Modifying the Tytera firmware for the purpose of expanding the radio's functionality does not infringe Tytera's copyright in its software code because doing so is a fair use, and "fair use of a copyrighted work . . . is not an infringement of copyright."[297]

1. The Purpose and Character of the Use

The first statutory factor focuses on the purpose and character of the use of the copyrighted work. Central to this inquiry is whether the new work "merely supersedes the objects of the original creation" or is transformative—that is, whether the secondary user expands on the expression, meaning, or message of the original work.[298] "[A] transformative use is one that communicates something new and different from the original or expands its utility, thus serving copyright's overall objective of contributing to public knowledge."[299]

Tytera MD380 modders use the Tytera firmware to understand its functional aspects and create their own customized firmware that adds new functions and increases the utility of both the original code and the hardware it controls. Courts have found that copying computer code for similar purposes constitutes fair use. In *Sega v. Accolade*, the Ninth Circuit explained that research into the functional aspects of Sega's video game software was a legitimate fair use purpose, even

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[293] phasenoise, *Jailbreak firmware now available for cheap digital walkie-talkie allowing DMR scanning*, LIVEJOURNAL (Jan. 29, 2016, 9:30 AM), https://phasenoise.livejournal.com/1142.html.

[294] *Id.*

[295] *Id.*

[296] Travis Goodspeed, *Python Tools and Patched Firmware for the TYT-MD380*, https://github.com/travisgoodspeed/md380tools.

[297] *Id.*

[298] *See Campbell v. Acuff-Rose Music, Inc.*, 510 U.S. 569, 579 (1994) (internal quotation marks omitted); *see also* Pierre N. Leval, *Toward a Fair Use Standard*, 103 Harv. L. Rev. 1105, 1111 (1990).

[299] *See Authors Guild v. Google, Inc.*, 804 F.3d 202, 214 (2d Cir. 2015).

for a competitor seeking to develop competing games.[300] The court emphasized that the functional aspects of Sega's software were not copyrightable and recognized that copying the entire software—including copyrightable elements—was necessary for analysis.[301] Here, just as Accolade copied code from Sega's games to create new games that would interoperate with the Sega Genesis, owners wanting to create modified Tytera firmware require access to the functional elements of the original Tytera firmware that control the device's operation. Moreover, this use fits even more firmly within the fair use framework than Sega's because installing modified firmware on your own device to customize it to your individual needs is a personal, noncommercial use.

The Ninth Circuit reaffirmed the reasoning of *Sega* in *Sony v. Connectix*, where the court held that Connectix's copying of Sony's BIOS firmware, which controls the Sony PlayStation console's ability to read Sony PlayStation games, to create their own console that could read and play Sony PlayStation games, was a noninfringing fair use.[302] This mirrors how the original Tytera firmware is used to create modified firmware with new functionality. As discussed above, the modified firmware can only be created on the Tytera MD380 radio when the initial firmware has been decrypted and downloaded onto a computer, as it is not readable on the radio. The only way to access the code and decrypt all of it is to copy the entirety of the work. To control the physical aspects of the Tytera MD380 radio with modified firmware, the owner needs to know which aspects of the copyrighted work control those physical functions. That is only possible by analyzing the code to isolate the corresponding controls. Thus, to create the modified firmware with new purpose and expression, owners must use the original firmware.

2. The Nature of the Copyrighted Work

The second statutory factor considers the nature of the copyrighted work.[303] If the work is factual or functional in nature, there is more latitude to copy without infringing.[304] As discussed in *Sony*, if the copying of the original firmware was necessary for the modified use, that supports a finding of fair use.[305] The work in question here is the code that controls how the Tytera MD380 radio monitors different radio channels. This code is copyrighted but is minimally creative in nature. Moreover, the code is being accessed only to expand on the Tytera device's channel-monitoring capabilities. The creative, protectable elements of the code are merely incidental to this use.

This is similar to what occurred in *Sony*, where Connectix had to access all of Sony's code to understand the code's functional aspects in order to build an emulator that could play Sony

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[300] *See Sega Enters. Ltd. v. Accolade, Inc.*, 977 F2d 1510, 1522-23 (9th Cir. 1992) (holding that using copyrighted material to study functional requirements was fair use).

[301] *Id.*

[302] *See Sony Computer Entm't Inc. v. Connectix Corp.*, 203 F.3d 596, 599, 609 (9th Cir. 2000).

[303] 17 U.S.C. § 107.

[304] *See Sega*, 977 F.2d at 1524.

[305] *See Sony*, 203 F.3d at 603.

games.[306] In this instance, to understand how to best customize the monitoring function of the Tytera MD380, users need to analyze the functional aspects of the code controlling the Tytera MD380. Just as the Ninth Circuit found in *Sony*, the only way to access the functional aspects of the Tytera code is by copying the entire work.[307] Since functional aspects were "expressly denied copyright protection by Congress," they may be copied without infringing on the copyright to examine the functionality of the original code.[308] The Tytera firmware is primarily a functional work, and the device owner is accessing the original firmware within the Tytera MD380 only for those functional elements. The second fair use factor thus supports a finding of fair use.[309]

3. The Amount and Substantiality of the Portion Used

The third fair use factor examines the amount of the copyrighted work used in an effort to determine whether the "quantity and value of the materials used are reasonable in relation to the purpose of the copying."[310] The use of an entire work does not preclude an activity from being a fair use.[311] The amount taken only need be "reasonable" and for a legitimate purpose.[312]

In *Sony* and *Sega*, the Ninth Circuit found that copying a software program in its entirety in order to understand its functional components was necessary to achieving a favored purpose, and was therefore fair.[313] Similarly, in *Kelly v. Arriba Soft*, the court emphasized that copying anything less than an entire work would be insufficient in order to allow users to recognize images in a visual search engine.[314] In *Perfect 10,* the court concluded that Google's use of Perfect 10's images was reasonable in light of its purpose of communicating information to its users.[315] In both cases, the court found this copying to be fair use. And in *Authors Guild, Inc. v. Google*, in which the plaintiffs participated in the scanning and electronic storage of numerous books in their entirety, the court held that the copying was reasonable in light of its purpose.[316]

The reasoning of these cases applies equally here. Without the ability to copy and view the entirety of the code, improving the functionality of the Tytera MD380 radio would be impossible. The original firmware must be decrypted to be accessible, and the complete encrypted code must

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[306] *See id.* at 603-05.

[307] *See id.* at 603.

[308] *See id.* at 605 (citing *Sega*, 977 F.2d at 1526).

[309] *See Sega*, 977 F.2d at 1524.

[310] *Campbell*, 510 U.S. at 586-87.

[311] *Sega*, 997 F.2d at 1526.

[312] *Campbell*, 510 U.S. at 586.

[313] *Sega*, 977 F.2d at 1526; *Sony*, 203 F.3d at 605-06.

[314] 336 F. 3d at 820-21; *see also Field v. Google Inc.*, 412 F. Supp. 2d 1106, 1120-121 (D. Nev. 2006) (finding the third factor weighing in favor of neither party because, while Google copied entire pages in its web caching service, the amount used was necessary to the purpose).

[315] 508 F.3d at 1167-68.

[316] *Authors Guild v. Google, Inc.*, 804 F.3d 202, 221-22 (2d Cir. 2015).

be copied off the Tytera radio onto a computer to decrypt it. Only once this decryption has occurred can owners take the original firmware and modify it to meet their needs. Owners cannot determine which portion of the encrypted code they require access to until all of the code has been decrypted. Even though the entire the work is copied, the use is still a fair use because copying the entire work is needed to achieve the ultimate transformative use. The third factor thus weighs in favor of a finding of fair use.

4. Effect on the Market for the Copyrighted Work

The fourth and final statutory factor considers "the effect of the use upon the potential market for or value of the copyrighted work" by looking to see whether the new use would be a competing substitute for the original—i.e., whether purchasers would opt to acquire the copy instead of the original.[317] In this instance, the modified firmware is of no use to anyone who does not already have a Tytera radio. Because the copyrighted work is purchasable only as part of the physical product itself, and the modified firmware is only useful as alternative code controlling the physical product, the potential market for the Tytera code would not decrease in any form. If anything, having this alternative code available will likely incentivize more potential buyers to purchase Tytera radios, as they would be able to install the modified firmware onto it to better suit their needs. Thus, the fourth factor weighs in favor of a finding of fair use.

C. The Statutory Factors Support Granting an Exemption

1. The Proposed Exemption Would Increase the Availability for Use of Copyrighted Works

The preceding discussion demonstrates how the availability of copyrighted works will be improved by the proposed exemption. As described above, technical measures currently restrict the availability of copyrighted Tytera MD380 firmware for lawful uses that cannot be achieved except through circumvention.

There will be no adverse effect on the availability of copyrighted works, since code is necessary for the Tytera MD380 radio to function and is produced for non-copyright-related reasons, and because no market harm cognizable by copyright law will result from the proposed exemption. To the contrary, the requested exemption will likely give rise to the creation of additional copyrighted works that rely on the Tytera firmware, such as the various writings and videos cited in this comment that discuss reasons for and methods of modifying Tytera radios.

2. The Proposed Exemption Would Increase the Availability for Use of Works for Non-Profit Archival, Preservation, and Educational Purposes

The proposed exemption would make the Tytera firmware and new works based on it available for use for non-profit archival, preservation, and educational purposes. For example, training for local public safety and emergency personnel could be enhanced by showing them how to utilize the modified firmware for the Tytera radio to monitor multiple public channels at once. This is relevant as numerous public safety organizations utilize the Motorola Digital Radio system

[317] 17 U.S.C. § 107.

that the Tytera MD380 radio uses for its communications.[318] Professors could also utilize the Tytera as an example in an engineering course on how to customize different household items to increase efficiency and to convey lessons regarding radio signals.

Further, it has been shown that the ability to interact with technology, such as the copyrighted firmware within the Tytera MD380 radio, is educational and is a common path for young people to become interested in studying science and engineering.[319]

3. Prohibiting Circumvention of the TPM Applied to the Tytera Radio Has a Negative Impact on Criticism, Comment, News Reporting, Teaching, Scholarship, and Research

Prohibiting this circumvention and others like it curtails all of the activities identified in the third factor. In the case of the Tytera MD380, the ban on circumvention has a direct impact on news reporting, comment, and criticism in communities whose public safety organizations utilize the Motorola Digital Rights network. Many local police, fire, emergency, and public security groups throughout the United States communicate using the same Motorola Digital Radio system that the Tytera MD380 radio uses for its communications.[320] By allowing an owner of a Tytera MD380 radio the ability to modify the firmware to monitor the different public channels of these emergency departments, they will be more able to comment and criticize on the efficiencies of their local safety organizations. By being able to monitor the different public channels simultaneously, media would have the ability to more accurately report on what is happening within their communities, as well as better hold emergency departments accountable for which calls they respond to and which they do not.

4. Allowing Circumvention Would Not Harm the Potential Market

For the reasons discussed in the above analysis of the fourth fair use factor, the relevant markets will not suffer any harm cognizable under copyright law.

5. No Other Factors are Relevant to Consideration of This Exemption

There are no additional factors that should be considered for this exemption. Denying or restricting an exemption to Section 1201 on the basis of factors that form no part of the inquiry into whether the ban on circumvention has or is likely to have adverse effects on noninfringing

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[318] *MOTOTRBO Public Safety Systems*, THE RADIOREFERENCEWIKI, https://wiki.radioreference.com/index.php/MOTOTRBO_Public_Safety_Systems (last visited Dec. 11, 2020).

[319] *See, e.g.*, Steve Song, *In Praise of Taking Things Apart*, *available at* https://manypossibilities.net/2008/03/in-praise-of-taking-things-apart/ (quoting an interview with John Seely-Brown in which he said "A huge amount of the learning that a lot of us do, that formed the foundations of all the formal education that we got afterwards, could be called 'tinkering.' Because of changes in electronics and cars, a whole generation couldn't tinker.").

[320] *MOTOTRBO Public Safety Systems*, THE RADIOREFERENCEWIKI, https://wiki.radioreference.com/index.php/MOTOTRBO_Public_Safety_Systems (last visited Dec. 11, 2020).

uses of copyrighted works would go against the statutory language of Section 1201, which states that an exemption "shall" be granted if noninfringing uses by "persons who are users of a copyrighted work are, or are likely to be, adversely affected."[321]

Conclusion

The ban on circumvention adversely affects consumers in their repair, diagnosis, and modification of the functionality of a broad range of software-enabled devices. The evidence presented in this comment—which necessarily represents only cases where someone was willing to risk legal liability by circumventing a possible TPM and speaking about it publicly—demonstrates that the analysis is sufficiently similar and the impact is sufficiently widespread that the entire requested class should be exempted. For all of the foregoing reasons, EFF requests that the Copyright Office grant a general exemption for the repair, diagnosis, or noninfringing modification of software for controlling any software-enabled device.

[321] 17 U.S.C. § 1201(a)(1)(C).

Exhibit A

Move over photo to zoom

SONY Programmable Memory Stick AIBO 16Mb PMS Card

Condition: **Used**
"*good working condition*"

Quantity: 1 **Last one** / 1 sold

Price: **US $65.00**

Buy It Now

Add to cart

Add to Watchlist

Last item available	More than 49% sold	Longtime member

Shipping: **$4.25** Standard Shipping from China/Hong Kong/Taiwan to worldwide | See details
International shipment of items may be subject to customs processing and additional charges.
Item location: Moscow, Russian Federation
Ships to: Worldwide See exclusions

Delivery: Varies
Please allow additional time if international delivery is subject to customs processing.

Payments:

PayPal CREDIT

Special financing available. | See terms and apply now

Earn up to 5x points when you use your eBay Mastercard®. Learn more

Returns: Seller does not accept returns | See details

Related sponsored items 1/2

Sony Aibo Official Accessories Paw Pa…

$46.00

Free shipping

Out of Print Carrying Bag for SON Sony…

$271.95

Free shipping

Star Team Zem-21 Robot Figure In…

$79.99

+ $10.00 shipping

Sonic Man Electronic Robot Made IN Hong…

$50.90

+ $14.66 shipping

Vintag SMOk

$582

+ $30.

Description **Shipping and payments**

Seller assumes all responsibility for this listing.

Last updated on Nov 18, 2020 04:22:48 PST View all revisions

Item specifics

Condition: **Used :**

Seller Notes: “good working condition”

Year: 2002

Brand: Sony

Up for sale

SONY Programmable Memory Stick 16Mb PM
for Aibo robot dog ERS7 210 311

Standard air shipping

Explore more sponsored options:

Sony Aibo Electric dog pet Collars CC-…

$124.99

Free shipping

Last one

Sony Aibo dog Robot pet Foot pads…

$35.00

+ $30.00 shipping

Popular

Sony Aibo Charging Station Battery AC…

$172.00

Free shipping

Sony Aibo Plush dog pet CC-AIBO-ST Toy…

$128.00

+ $22.00 shipping

SONY Plush

$103

Free s

People who viewed this item also viewed 1/2

Sony Hello AIBO soft-ware for ERS-210 an…

$59.99
+ $9.99 shipping

Sony AIBO Friend soft-ware for ERS-311, 31…

$59.99
+ $9.99 shipping

SONY Official aibo CC-AIBO-ST Plush Doll…

$127.00
Free shipping
Last one

SONY towel unopened item color white…

$78.00
+ $20.00 shipping

Sony
ERF-F

$110
Free s

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