

Olympus and the micro four-thirds camera system: disrupting the digital camera industry

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ABSTRACT

This case study describes the evolution of the digital camera industry and the development of the micro four-thirds (MFT) camera system. In 2013 the smartphone revolution was reshaping the camera industry, as many consumers stopped using compact cameras in favor of smartphones. Compact cameras were low margin items, so manufacturers began to concentrate on larger interchangeable-lens cameras with higher image quality and better margins. For decades Canon and Nikon dominated the interchangeable-lens camera market. Large interchangeable-lens cameras contributed the majority of industry profits through sales of cameras and accessories such as lenses and flash units. Olympus was challenging the established giants with two innovations – mirrorless viewfinders and smaller micro four-thirds (MFT) sensors. Mirrorless MFT designs enabled a new generation of smaller and lighter cameras. In 2013 Olympus was at a crossroads as growth stagnated. Should the company continue exclusively with its smaller sensor MFT products, or should the firm take on the industry giants and move to larger sensor cameras with potentially wider appeal and higher margins.

Keywords: disruptive innovation, technology management, strategy, innovation management

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INTRODUCTION

The year 2013 marked a sad end for a stalwart of the camera industry. Kodak began its final liquidation process after declaring bankruptcy in 2012. The company liquidated almost all of its camera and film related assets and restructured to focus on commercial printing technologies (Gara, 2013). This event came only 10 years after digital cameras first outsold film cameras and highlighted the rapid changes that were still occurring in the industry.

Although digital cameras were now ubiquitous, the camera industry continued its rapid evolution. One firm that had seen resurgence was Olympus. The company had been successful with its micro four-thirds (MFT) line of cameras in the last five years. The term “four thirds” references the relative dimensions of the sensor size. MFT sensors use relative proportions of 4x3 and traditional cameras use relative dimensions of 4x6. Consequently, images from MFT cameras are closer to a square perspective than a 4x6 rectangle.

MFT cameras also used smaller image sensors and were smaller and lighter than traditional digital single lens reflex (DSLR) cameras. Despite the smaller size, MFT cameras retained good image quality and featured interchangeable lenses. Olympus’ MFT line filled a niche between small, pocketable compact cameras and large DSLRs.

Many changes were buffeting the industry. Sales of inexpensive compact cameras were falling as consumers increasingly used smartphone cameras for everyday photos. Confirming this trend, Hiroyuki Sasa, the CEO of Olympus Corporation, had just predicted that Olympus’ compact camera sales would continue its 50% annual rate of decline into 2014 (Matsuyama & Amoano, 2013).

Nevertheless, the loss of the compact camera market was not a serious concern for most manufacturers, including Olympus. Compact cameras were low profit products that required constant updates to satisfy the fickle demands of the market (e.g. social media integration, GPS tracking, and new artistic modes for processing photos). The higher-margin items in traditional product lineups were cameras with interchangeable lenses. These cameras provided higher quality photos and were used by more serious photographers that prized image quality over compact size and ease of use. Despite the trends in the compact camera market, Hirofumi Imano, Division Manager of Product Strategy at Olympus, was optimistic, “There is still growth in the mirrorless market and more and more people are taking and sharing photos. So in terms of the imaging business overall, we have a great opportunity” (Britton, 2014b, para. 2).

A recent review of the industry’s sales data showed that although compact camera sales were decreasing dramatically, sales of interchangeable lens cameras were holding steady (Exhibit 1). Olympus’ latest micro four-thirds (MFT) cameras (which featured interchangeable lenses) had been extremely successful. Beyond the smaller sensor, MFT cameras used “mirrorless” technology to further shrink size and weight compared to DSLR offerings from other manufacturers. Micro four-thirds cameras also led to sales of lenses. Lenses were high profit items and the price of high performance lenses often exceeded those of the camera bodies that the lenses complemented.

Despite the success of MFT cameras, the head of Olympus’ Product and Marketing Planning Group, Toshiyuki (Toshi) Terada, faced several challenges in the coming years. While MFT sales had remained steady, DSLR sales from the Canon and Nikon were falling slightly (Esser, 2014a, 2014b). Would the sleeping giants respond by making more aggressive moves into competing products? Sony had entered the mirrorless market strongly with a range of cameras using larger, full-frame sensors. Many consumers were now asking if Olympus would manufacture a mirrorless camera with a larger sensor (Gampat, 2013). Terada wanted to gain as

many converts to the Olympus brand as possible. He said, “The world of interchangeable lens [cameras] has changed. This is our opportunity to grab current DSLR users [as they] switch to mirrorless...and we can expect new users” (Cheesman, 2014, para. 12). Even with the maturation of the mirrorless market, Terada did not completely rule out future DSLR cameras. “Nobody knows 10 years away... once we can get a very nice share [in mirrorless] we may expand the business to DSLR again, but at this moment we are just concentrating on mirrorless and we have no [immediate] plan to go into DSLRs” (Cheesman, 2014, para. 3).

THE DEVELOPMENT OF THE FOUR-THIRDS STANDARD

As digital camera technology improved in the late 1990s Katsuhiro Takada, a researcher at Olympus Corporation in Japan, began a project to determine the optimum size for a digital imaging sensor. Mr. Takada wanted to design a digital camera standard from the ground up, without concern for legacy standards (Olympus Corporation, 2012). Early sensors had been designed around the 35mm film standard which dated back to Thomas Edison’s early work for moving pictures (Gustavson, 2009). Even though some of the early digital sensors were smaller than the 35mm film standard, they were still optimized to work with existing lenses designed for the 35mm format (For examples of the relative sensor sizes in use today, see Exhibit 2).

Takada’s work led Olympus to develop the Four-Thirds (FT) system. This system was based on the Mr. Takada’s thoughts that the optimum digital camera size for ergonomic design was the size of the legendary Olympus OM-1 film camera (Olympus Corporation, 2012). The OM-1 was a landmark in camera design when it was introduced in 1973 (Gustavson, 2009). To make a digital camera with the approximate dimensions of the venerable OM-1 film camera, the Four-Thirds sensor was approximately one fourth the area of a traditional 35mm film frame (Exhibit 2). In these early years of digital development, this smaller sensor necessitated some tradeoffs in the image quality delivered by the camera (For a discussion of factors affecting the performance of image sensors, see Appendix A).



Figure 1: Olympus OM-1 Film Camera

As Takada worked on his Four-Thirds project and the digital revolution matured in the late 1990s, Olympus increasingly became a niche player in the camera industry. Its products lost luster as the juggernauts of the industry, Canon and Nikon, delivered multiple lines of cameras for every market. Moreover, the marketing departments for Canon and Nikon enlisted high-profile professional photographers as spokespersons for the brands. This status as a secondary

player in the industry led Olympus to develop the Four-Thirds project with an open standard for sensors and lenses. The open standard would be available to all companies that joined the Four-Thirds consortium. The Four-Thirds standard specified the sensor size and other relevant technology that enabled the lenses from one manufacturer to work with cameras from different manufacturers. This was in contrast to the typical strategies for Canon and Nikon. These legacy firms developed proprietary lens mounts that imposed significant switching costs for consumers if they changed brands.

Ironically, despite the pioneering research of Olympus, Panasonic (a relative newcomer to the camera industry) joined the consortium and introduced the first Four-Thirds camera in 2002, the fixed lens Lumix DMC-L1. Olympus introduced its first four-thirds camera in 2003, the E-1. The 5-megapixel E-1 used a single-lens reflex (SLR) design and featured interchangeable lenses. The E-1 was positioned to challenge SLR cameras by the industry leaders Canon and Nikon (Olympus Corporation, 2012). While the Olympus E-series did develop a small following of loyal users, it remained a niche product in the industry. The size of the E-series cameras and lenses was comparable to other products with larger sensors offered by Canon and Nikon. Panasonic's offerings in the Four-Thirds market were limited to fixed-lens cameras until the development of mirrorless technology.

MIRRORLESS TECHNOLOGY

Mirrorless technology is a separate and co-evolving technology within the camera industry that complements the smaller sensor four-thirds standard. Since the 1950s, the mainstay of the high performance camera industry has been the single-lens reflex (SLR) camera (Gustavson, 2009). In a single-lens reflex camera the photographer views and focuses the image by looking at a mirror positioned in the light path of the lens. When the shutter is pressed, the mirror is moved and the shutter is opened to expose the film or digital sensor to light. This two-step operation of the mirror flip and shutter opening causes the familiar click-clack sound of the SLR camera.

As electronic screen technology improved and became less expensive in the mid-2000s, camera makers began to replace the mirrors in some cameras with electronic viewfinders (EVFs). These viewfinders received data directly from the camera's image sensor and eliminated the need for a mirror. Early EVFs were low resolution and lagged behind the action in front of the camera; however, more recent finders provide high-resolution displays with little or no lag.



Figure 2: Olympus OM-1 Film Camera (left) with Olympus OM-D EM-5 Digital Camera (right)

THE COMBINATION OF FOUR-THIRDS AND MIRRORLESS: MICRO FOUR-THIRDS (MFT)

The elimination of the mirror and its associated prism box in SLR cameras enabled a significantly smaller camera and lens design. To take advantage of these complementary developments Olympus refined the Four-Thirds design to create the Micro Four-Thirds (MFT) standard. The sensor size remained unchanged, but the lens flange distance was reduced which enabled a new series of smaller lenses. When combined, the micro four-thirds sensor and mirrorless technology create a camera/lens combination with that is much smaller and lighter than DSLR cameras. For a comparison between traditional SLR cameras and lenses and MFT cameras and lenses see Exhibits 3 and 4.

Once again, Olympus pioneered the Micro Four-Thirds standard, but Panasonic introduced the first MFT camera with interchangeable lenses to the market in 2008 – the Lumix G-1. As the technology improved, Olympus launched a groundbreaking MFT camera in 2012, the OM-D EM-5. The OM-D camera finally allowed Olympus to provide most of the features of larger digital SLR cameras from Canon and Nikon in a form factor closer to the original OM-1 film camera from the 1970s (See Figure 2). The OM-D EM-5 gained widespread industry acclaim in 2012 with several “Camera of the Year” awards from influential camera websites like *Digital Photography Review* and *Imaging Resource*. Panasonic announced a camera with similar capabilities and a slightly larger form factor in late 2012 – the Panasonic GH-3.

A timeline is presented in Figure 3.

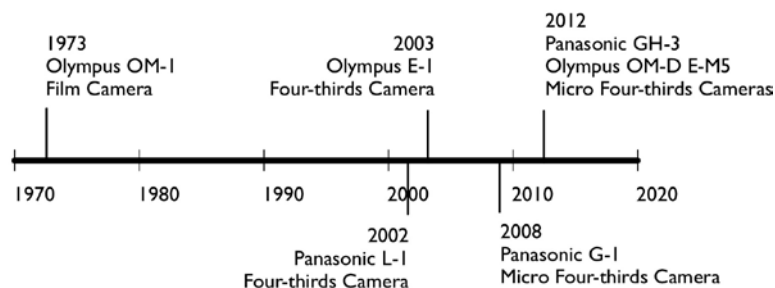


Figure 3: Timeline of the Development of Four-thirds and Micro Four-thirds Technology

THE CAMERA INDUSTRY

The digital camera industry had approximately \$17.5 billion in sales worldwide in 2012 (Camera & Imaging Products Association, 2013). Despite these strong sales, industry watchers knew that the smartphone revolution would have a severe impact on revenues in the future. Sales of compact cameras were already under pressure in 2011 and by 2013 the slowdown was causing ripples throughout the industry. In June 2013 Canon reported that compact camera sales were off 26% from the prior year. Nikon indicated that compact camera sales were down 30% for the same period. Despite these warning signs, the large camera manufacturers hoped to improve results with higher margin interchangeable lens cameras. (Back, 2013).

Canon and Nikon were the two leading manufacturers in the industry. Combined, these firms controlled approximately 31% of the market in 2010; however, in the interchangeable lens sector the firms dominated with approximately 75% market share. Canon led all firms in the

interchangeable lens camera market with 45% share, followed by Nikon with 30% and Sony with 12% (Sawa & Yasu, 2011). Industry market share is depicted in Exhibit 5.

Even with the encroachment of cell phone cameras in the industry, Canon executives did not see an immediate threat. Canon executive, Go Tokura, said, “Despite the fact that these are hard times for the camera market, nothing has really changed in our approach. The pressure is on for us to distinguish our DSLRs from smartphones and compacts so if anything we're putting more effort behind our research and development” (Britton, 2014a, para. 14). In fact, Canon managing director, Masaya Maeda, felt that smart phones would help his company and said, “Realistically, thanks to the global prevalence of smartphones there are more photographs being taken. And as such I anticipate an organic growth of people who are using their smartphone and come to want to take better photographs. Regardless of what device they're using, whether it's a smartphone or a compact camera or DSLR, I'd like to encourage people to take more and more pictures” (Britton, 2014a, para. 10).

Market leaders Canon, Nikon, and Sony offered a full range of digital cameras, from compacts to full frame SLRs. Panasonic and Olympus offered compacts and mirrorless cameras, while Fuji offered niche products including compacts and high-end mirrorless cameras. Large digital SLRs were significantly more profitable than compact cameras. Margins on SLR cameras were often 15-25%, while compact camera margins were typically 5% or less (Back, 2013).

The Mirrorless Landscape

Olympus and Panasonic participated in the interchangeable lens mirrorless market with their MFT lines, but other companies offered mirrorless cameras in a variety of sensor sizes. Canon entered the market for interchangeable lens mirrorless cameras with its EOS-M camera in 2012. The EOS-M used a slightly larger sensor (compared to MFT) but was criticized for its “slow autofocus performance, lack of a viewfinder, and poor customization options” (McMahon, 2012). Canon only offered 2 dedicated lenses for the EOS-M system at introduction, but the camera was compatible (with an adapter) with the company's extensive line of SLR lenses. By 2013, Sansmirror.com was reporting that the EOS-M had been withdrawn from the U.S. market (Hogan, 2013). At introduction, the EOS-M was priced at approximately \$800 with a lens, but by mid-2013 the camera was heavily discounted at retailers to \$400 or less.

Nikon entered the interchangeable lens mirrorless market in 2011 with its Nikon 1 system. This system was based on a sensor size smaller than MFT. The system was lauded for its fast autofocus performance, but Nikon only provided a few lenses for its proprietary Nikon 1 lineup at introduction. By 2013 the Nikon 1 system had 9 lenses but was lagging in sales (Hogan, 2013). Nikon 1 cameras were priced from \$300 to \$600, without lenses.

Sony had a range of mirrorless products using a variety of sensor sizes. Sony's highest performing mirrorless camera, the RX-1 used the same size sensor as the professional SLR models produced by Canon and Nikon. The RX-1 was a premium product with a fixed lens and priced at \$2800. Sony's primary entry into the mirrorless interchangeable lens market was its NEX system. The NEX sensors were slightly larger than the MFT standard, but less than the largest “full-frame” sensors that were the same size as traditional 35mm film. The Sony NEX cameras ranged in price from \$400 to \$800 without lenses. Sony offered a dozen dedicated NEX lenses and the system was compatible with Sony's A-mount lenses for its larger Digital SLR cameras.

Fujifilm also had strong entries in the interchangeable lens mirrorless market. Its premium X-series cameras were based ranged in price from \$700 to \$1200. The X-series

cameras were supported with 7 high quality lenses and used a proprietary lens mount. The Fujifilm cameras were highly regarded by camera review sites, such as *Digital Photography Review*, but the high price of the Fujifilm offerings limited the market penetration of these cameras.

Both Panasonic and Olympus offered a range of MFT cameras with prices from \$300 to \$1200. Since all MFT lenses worked with both manufacturers' cameras, the MFT lineup consisted of over three dozen lenses in a variety of focal lengths. Although the MFT system had been well received in the trade, both companies were struggling for profitability in their camera divisions.

MARKET ACCEPTANCE OF MIRRORLESS AND MFT CAMERAS

The sales of cameras of all types were down in 2012 and the first half 2013, but most of the decline was from the erosion of the compact camera market by smartphones. Sales of compact cameras were down 26% and 30% from the previous in the second quarter of 2013 at Canon and Nikon, respectively. Sales of high-end cameras were also down, but only by 4-5% (Back, 2013). In the first half of the year, sales of mirrorless interchangeable lens cameras were also down, but mirrorless cameras maintained approximately 18% of the interchangeable lens camera market according to the Camera & Imaging Products Association (CIPA).

Professional Acceptance of Mirrorless Cameras

Professional photographers demand the highest image quality standards for publication and client needs. Acceptance of mirrorless and MFT cameras was slow to take hold in the industry. In this segment, the small size of the cameras was sometimes seen as a hindrance. Giulio Sciorio was an early professional convert to MFT. He originally adopted Olympus cameras, but now serves as a Lumix Luminary for Panasonic. As a Lumix Luminary, Sciorio serves as a brand ambassador for the company and provides feedback to the company on its products during the development phase. He also has access to pre-production cameras and lenses for evaluation and publicity purposes. He discusses his early trepidation on the switch to MFT with this comment, "Since [commercial] photography is a long-term relationship-based sale, not a one time retail-based sale, you want to be sure that your client is confident that you will do the job right." (Sciorio, 2012) Sciorio overcame his clients' hesitations by clearly communicating two points:

- 1) The camera is fast and small, with a large chip so the quality is very high.
- 2) Since the camera is small, the subjects were more relaxed than if I shot with a large SLR, and since it was also very fast I was able to capture the moment quickly and move on.

(Sciorio, 2012)

In addition to client acceptance of the smaller cameras, most professional photographers were concerned with image quality issues associated with smaller sensors. Was the quality good enough? And even if the quality was good enough, would one be better off with a camera that captured even more megapixels? Trey Ratcliffe is an influential professional travel photographer and runs a widely read photography site, *Stuck in Customs*. He described his journey to mirrorless this way:

I went through an extensive process comparing the Sony [NEX] system to the Nikon system. I was a hard-core Nikon guy... and I might only be in these places only one time, so I figured that I want to come away with the best possible images. So why would anybody who wants the best images “downgrade” their camera to a mirrorless camera? Well the truth of it is, the camera is increasingly irrelevant in the equation of making a good photo. It’s all in the technology, it’s in the software, it’s in the raw file, it’s in the post-processing, it’s in [Adobe] Lightroom, it’s in other tools you might use... So the idea that you can’t get an equal image [compared to a DSLR] straight out of the camera, first of all, is a ridiculous notion. Secondly, you can do so much more with a mirrorless system than you can with a DSLR system. Once you go totally, pure digital, and you’re no longer reflecting an image back through a prism, you have an enormous scope of things that you can do with these cameras that you can’t do with DSLRs. I find that my photos, for example, now are much sharper than they ever have been, because it’s just so easy for me to zoom in and see exactly what it looks like on the sensor.

(Van Johnson, 2013)

Despite some high profile conversions in the professional community, two types of photographers were not likely to switch to MFT systems for exclusive use in the near term, sports and wildlife photographers. These photographers required lightning fast autofocus systems that could track high-speed subjects. MFT autofocus tracking systems were still much too slow for these types of subjects.

Moreover, although some professionals were enthusiastic about mirrorless, others had objections to the smaller MFT format. Lloyd Chambers writes for his influential blog Diglloyd that the MFT format has drawbacks compared to the formats used by Sony and Fujifilm. He sums up his objections with two points:

Sensor quality lags. I’ll take the far smaller Sony sensor any day over the aging [MFT] sensor.

Lens quality: Olympus and Panasonic deliver lenses that range from mediocre to quite good. But not one truly excellent MFT lens exists. *Not one*, and I mean that: some get pretty close but with varying annoying compromises.

(Chambers, 2013)

Nevertheless, increasing numbers of professional photographers were considering the mirrorless technology. Giulio Sciorio reflected on his transition to mirrorless cameras in an interview by saying:

I just really wanted to have fun again, and rethink how, as a commercial photographer, I shoot. Because the [MFT] gear is good enough, and it’s been good enough for a while... The cameras do the heavy lifting. If the camera is doing the heavy lifting, what remains as a creative professional? It’s my creativity and my personality.

(Van Johnson, 2013)

Even if the mirrorless cameras offer compelling features, conversion for a professional is a major investment. A professional’s camera equipment is a sunk cost and buying new cameras, lenses, and other accessories for a new system is a major capital expenditure for the business.

Despite the reputation of high-profile professional photographers for having the latest gear, many sole proprietor photographers only upgrade cameras and other equipment when absolutely necessary.

Sciorio was pleased with his transition to the MFT Lumix cameras and said,

It's the photographer that makes the image --regardless if you are on an iPhone or a [Lumix camera]. Every camera can technically make a good image – clean, well-exposed, sharp. The camera is doing the technical heavy lifting for us. So what's left? I think it's the creativity of the person behind the camera. How can I use this tool, this hammer, in front of me to create as much content as possible with the least amount of effort? I want to be able to convey what's in my right brain, my heart, to other people... If I can quickly communicate that with the least amount of effort, first, as an artist I'm more expressed, and that fulfills me. Secondly, as a business owner, I can create more services and products for my clients, which helps me grow my business.

(Sciorio, Personal Communication, 2013)

Amateur Acceptance of Mirrorless Cameras

Early growth in the mirrorless segment was stagnating by mid-2013 in the consumer market. Sales trends were similar to those of the larger DSLR segment. In Japan, the cameras had first been targeted to women because of the smaller form factor. The *Wall Street Journal* described the trend:

The new cameras especially are a hit among Japanese women. Budding female photo enthusiasts in the country are known as Camera Girls, and manufacturers are targeting them with nontraditional camera colors such as "fiery pink" and "sensual brown." The companies also offer accessories such as camera straps and cases meant to appeal to women.

(Wakabayashi, 2012)

Olympus' early marketing efforts in the U.S. mirrorless arena also targeted women with some success; however, as the market matured the firm realized it would have to promote image quality and other features beyond size to appeal to male consumers. After all, men purchased 75% of all digital SLR cameras in the U.S. (Wakabayashi, 2012).

Nevertheless, female consumers were an important demographic, especially new mothers. New mothers were going beyond taking pictures of their own children and opening their own photography businesses. This phenomenon gave rise to the term MWAC – Mom With a Camera (Fairfield, 2007).

Despite some success, acceptance of mirrorless cameras among U.S. consumers has been slow. One camera salesman described the situation in an interview with *USA Today*:

"People who buy mirrorless are the ones looking for it," he said. In the USA, DSLRs still rule the roost, with options from the big two —Nikon and Canon — winning the hearts, minds and wallets of those wanting a "real" camera. To be sure, DSLRs do have their advantages, including traditional optical viewfinders and generally more reliable autofocus.

(Nystedt, 2013, para. 4)

Part of the issue for potential MFT consumers may have been simply confusion caused by the name micro four-thirds. Trey Ratcliffe shared his feelings about the naming convention: In fact, people ask why I chose Sony NEX over micro four-thirds, and my reason is actually incredibly embarrassing now that I look back on it. But it was because when people were talking about micro four-thirds, I just literally did not know what it meant. It's such a weird word. The whole fraction of four-thirds is strange. Why is the numerator so much bigger than the denominator? Why is the word "micro" in front of it? ... The naming system is a big turn-off to a lot of people that want to get into this.

(Van Johnson, 2013)

Other barriers to acceptance of smaller format cameras may include camera snobbery. Even though many consumers purchase large Digital SLR (DSLR) cameras, they are not necessarily using these high-performance devices to their fullest potential. Stephen Withers (2012) reports that a survey of 1000 non-professional DSLR users found that "72% of those consumers purchase the cameras for family photos or fun... [Moreover], 65% of those aged 18-29 regard their DSLR as a status symbol even though the photos are largely seen in low resolution on Facebook, etc. One-third of users admit they don't know how to use their camera" (paras. 5-6).

POTENTIAL NEW DEVELOPMENTS IN THE CAMERA INDUSTRY

As the industry evolved, several technological advancements were on the near horizon. These included larger sensors, 4K video, and improved autofocus performance.

Larger Sensors

As mirrorless technology improved, the natural evolution for the camera industry was to move to larger sensors. Larger sensors enabled a higher megapixel count and improvements in a variety of photographic dimensions. See Appendix A.

Improved Video Performance

As consumers and professionals turned from traditional print media to screen media, the market demanded improved video performance. Most cameras now delivered 1080p HD video, but the industry was rapidly evolving to the so-called 4K video standard. In addition to higher resolution, 4K video cameras enabled picture capture of video frames in the 8 to 9 megapixel range. This meant that photographers could shoot video and then take frames from the video files that rivaled traditional still-picture cameras in quality. Panasonic was leading in this segment with several MFT cameras that delivered 4K video. Olympus had not introduced a 4K MFT camera. Giulio Sciorio has evolved his photography business into a "hybrid" image business. He combines still and video images for hybrid photos featuring motion. Sciorio said that "the Lumix cameras truly bring video and still photography into one unit." Improved video performance would enable small budget, sole proprietor photographers into the up-scale video market traditionally dominated by big production companies.

Improved Autofocus Performance

Autofocus performance of mirrorless cameras lagged traditional DSLRs significantly. Nevertheless, new “hybrid” autofocus technology promised to close, but not eliminate, the autofocus gap. Nikon had already introduced a mirrorless camera with hybrid autofocus, and Olympus was rumored to be integrating it into its next camera as well. Nevertheless, traditional “mirrored” cameras would likely have an edge in autofocus performance for at least the next few years.

THE PATH FORWARD FOR OLYMPUS

The future of the camera industry was highly uncertain in 2013. Clearly, the compact camera market would continue to shrink. Growth in interchangeable lens cameras was also likely to slow in the coming years, but industry observers were uncertain whether mirrorless cameras would displace DSLRs in the immediate future.

Olympus was recovering from a major financial scandal that caused a financial restatement in Fiscal Year 2012 (Tabuchi, 2011; Woodford, 2012). The company showed steady earnings with the exception of FY 2012, but revenues were declining (Olympus Corporation, 2014a). The Imaging Systems division had lost money in the last two years, but its margins were improving (see Exhibits 6 and 7). The strategic direction from company executives indicated that the company should focus on mirrorless cameras and reduce its reliance on low cost compact cameras (Britton, 2014b).

Rumors were swirling in the industry that Canon would move further up-market to sensors larger than the traditional 35mm standard (Cade, 2013). Nikon’s president had just announced that the company intended to increase profits by focusing on digital SLR cameras and limiting marketing and sales expenses for its mirrorless line (Kimura, 2013).

Olympus’ leaders had made it clear that his company should continue to focus on mirrorless cameras; however, that left a broad range of issues for Toshi Terada to consider. Should the company move upmarket to larger sensors? This would require development funds for new lenses. Should the company continue to focus on the MFT format and lose potential sales to consumers looking for increased image quality? Should Terada argue for development of SLR cameras with the potential for better autofocus performance? There were many factors to consider as the company planned its future.

Appendix A: Factors Affecting Digital Camera Performance

Sensor Size

The primary driver of image quality in digital cameras is related to the physical size of the image sensor. If two sensors have the same number of megapixels, the larger sensor will have better a signal-to-noise ratio, which improves overall image quality and low-light (high ISO) performance. The typical sensor sizes are depicted in Exhibit 2. The FX (or full frame) sensor size is the same size as 35mm film negative, 24mm high by 36mm wide. The size was first used by Thomas Edison in the late 19th century for his early movie cameras and became a popular standard with the introduction of German-made Leica compact cameras in the 1920s (Gustavson, 2009). The term 35mm comes from the total height of the film, the edges of which have perforations used to advance the film with mechanical cogs in the camera.

Crop Factor

The 35mm standard is often referred to as a “full frame” sensor in digital cameras. The standard lens focal length in a 35mm system is 50mm. A 50mm lens on 35mm film approximates the field of view of the human eye. Lenses with focal lengths greater 50mm are referred to as telephoto lenses, and lenses with focal lengths less than 50mm are referred to as wide-angle lenses. When the imaging surface is smaller than 35mm, this increases the effective focal length of a given lens. Sports and wildlife photographers benefit from the crop factor of smaller cameras, since they can reach more distant subjects with a given lens. On the other hand, landscape photographers often use wide-angle lenses to photograph scenic vistas. Landscape photographers often need expensive specialty wide-angle lenses on smaller sensor cameras. In general a larger crop factor enables smaller lenses. Exhibit 2 shows the relative sensor sizes for a variety of cameras.

Depth of Field

The trade-off for increased field of view with smaller lenses is an increase in depth of field. Depth of field refers to the portion of an image that is in focus. Images with a wide depth of field will have most (if not all) of the area of an image in focus. Images with a narrow (or shallow) depth of field will have only a narrow area of the image in focus.

Landscape photographers often like a wide depth of field. This provides a sharp image across the frame when shooting panoramas such as mountains and cityscapes. On the other hand, portrait photographers often like to use a narrow depth of field. This allows the subject to be isolated with a pleasantly out of focus background. A depiction of the difference between a narrow depth of field and a wide depth of field is shown in Exhibit 8.

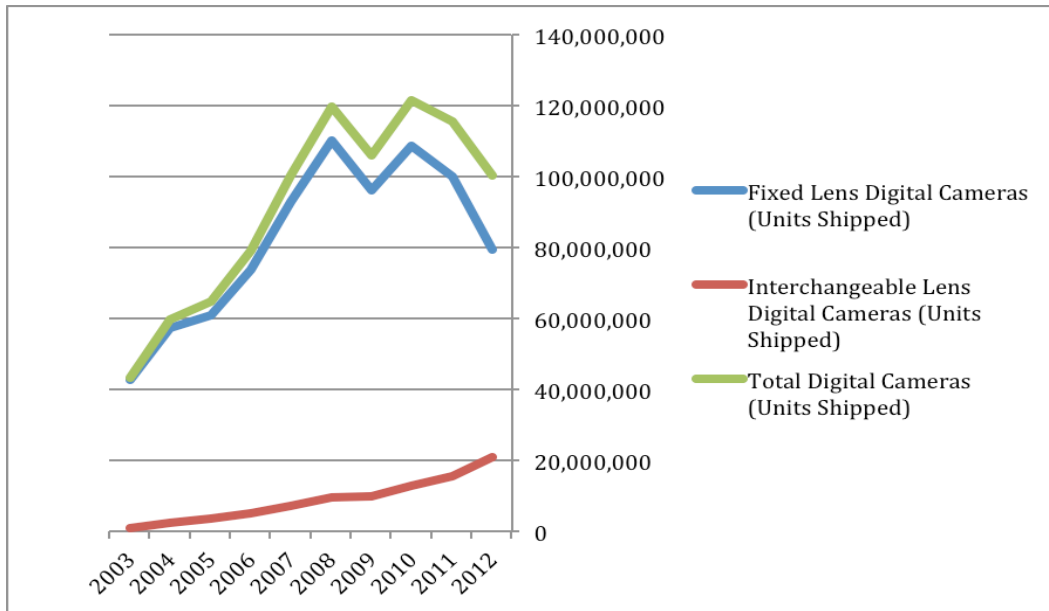


Exhibit 1: Unit Sales of Digital Cameras (2003-2012) (Source: Camera & Imaging Products Association)

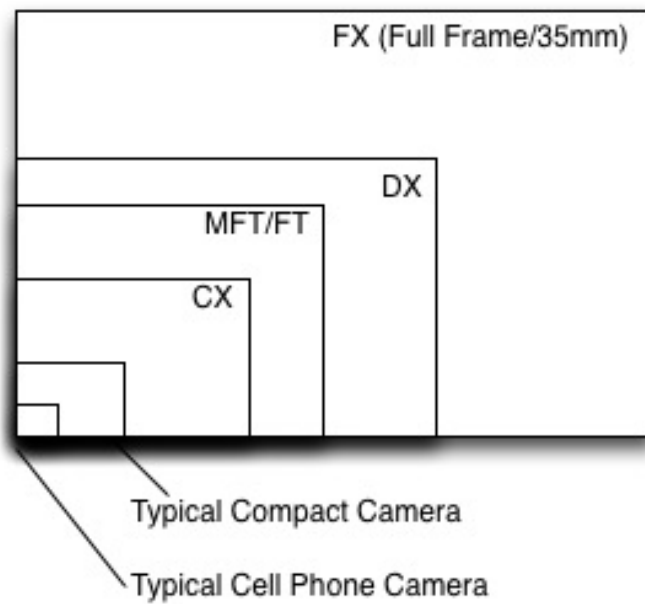


Exhibit 2: Image Sensors - Relative Size Comparison

Camera and Lens Specification Comparisons

Camera Comparisons

Mirrorless Cameras

Camera	Sensor Size	Megapixels	Weight	Price
Canon EOS-M	DX	18.0	10.5 oz	\$600
Fuji X-Pro 1	DX	16.3	15.9 oz	\$1199
Nikon 1 V2	CX	14.2	13.5 oz	\$800
Olympus OM-D EM-5	MFT	16.1	15.0 oz	\$999
Panasonic GH-3	MFT	16.1	19.4 oz	\$1199
Sony NEX 7	DX	24.3	12.5 oz	\$1098

Digital SLR (mirrored) Cameras

Camera	Sensor Size	Megapixels	Weight	Price
Canon EOS 5D Mark III	FX	22.3	30.3 oz	\$3500
Canon EOS 1D X	FX	18.1	54.4 oz	\$6800
Nikon D300S	DX	12.3	30.0 oz	\$1700
Nikon 7100	DX	24.1	23.8 oz	\$1200
Nikon D800	FX	36.3	31.7 oz	\$3000
Nikon D4	FX	16.2	41.6 oz	\$6000
Sony A99	FX	24.3	28.7 oz	\$2800

Lens Comparisons

70-200mm FX Equivalent Lens	Size	Weight	Price
Canon (FX)	3.5 x 7.8 in	52.6 oz	\$2500
Nikon (FX)	3.4 x 8.1 in	54.3 oz	\$2400
Panasonic (MFT)	2.7 x 3.9 in	12.7 oz	\$1500

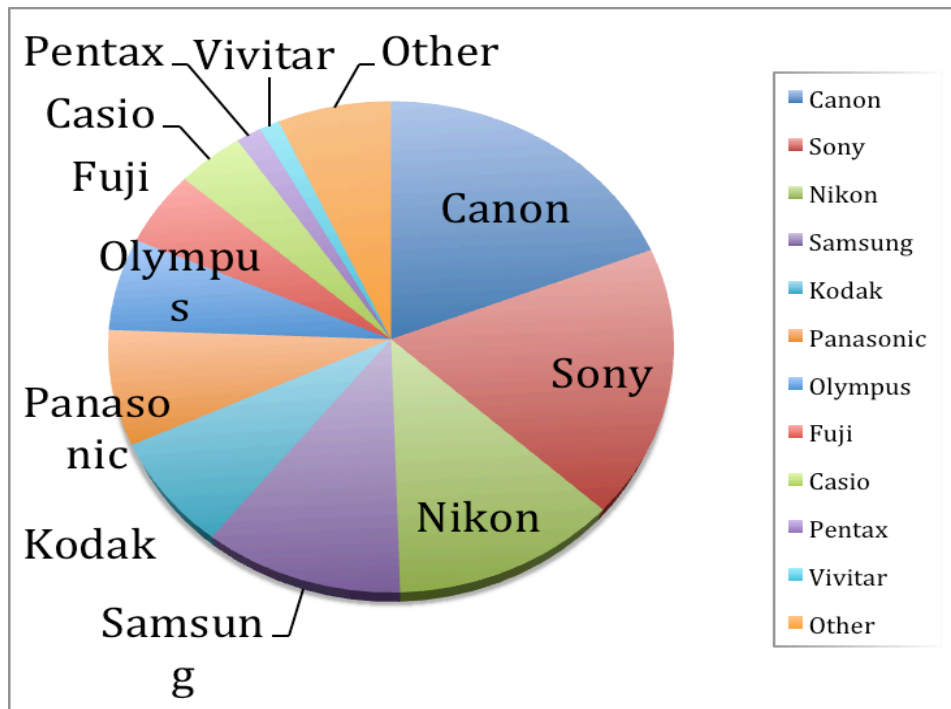
24-70mm FX Equivalent Lens	Size	Weight	Price
Canon (FX)	3.5 x 4.4 in	28.4 oz	\$2300
Nikon (FX)	3.3 x 5.2 in	31.7 oz	\$1890
Panasonic (MFT)	2.7 x 2.9 in	10.8 oz	\$1300

Exhibit 3: Camera and Lens Comparisons – mid 2013 (Source: manufacturer's websites)

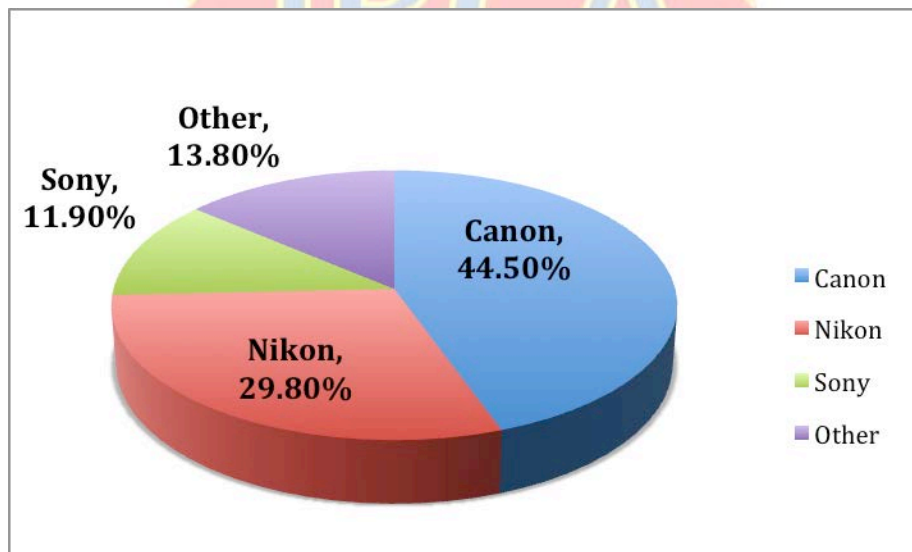


Exhibit 4: Size Comparison of Lenses (L-R: Panasonic 12-35, Nikon 17-55, Panasonic 35-100, Nikon 70-200)

The two lenses on the left are equivalent lenses (24-70mm full-frame focal length) and the two lenses on the right are equivalent (70-200mm full-frame focal length). The smaller lenses are for the Panasonic MFT system and the larger lenses are for the Nikon SLR system. See Exhibit 2 for dimensions and weights.



Total Digital Camera Market Share – 2010 (Sawa & Yasu, 2011)



Interchangeable Lens Camera Market Share – 2010 (Sawa & Yasu, 2011)

Exhibit 5: Digital Camera Market Share (Total and Interchangeable Lens)

For the fiscal years ended March 31

(Millions of Yen)

	2010	2011	2012	2013	2014
Net Sales	883,086	847,105	848,548	743,851	713,286
Costs of Sales	474,801	459,420	464,743	365,653	272,830
Gross Profit	408,285	387,685	383,805	378,198	440,456
S.G.A. Expenses	347,125	349,306	348,287	343,121	367,011
Operating Income	61,160	38,379	35,518	35,077	73,445
Other Income	6,518	8,179	7,392	9,555	4,327
Other Expenses	21,603	23,343	25,045	31,586	26,859
Other Income / Expenses	-15,085	-15,164	-17,653	-22,031	-22,532
Ordinary income	46,075	23,215	17,865	13,046	50,913
Extraordinary income	51,986	6,118	322	22,454	1,154
Extraordinary loss	7,358	9,395	27,682	16,358	35,642
Extraordinary Item	44,628	-3,277	-27,360	6,096	-34,488
Income Before Provision for Income Taxes	90,703	19,938	-9,495	19,142	16,425
Provision for Income Taxes	38,001	15,625	39,282	10,900	2,798
Minority Interests	175	447	208	222	0
Net Income	52,527	3,866	-48,985	8,020	13,627
Average Exchange Rates					
Yen / U.S.Dollar	92.9	85.7	79.1	83.1	100.2
Yen / Euro	131.2	113.1	109	107.1	134.4
FX Impact on Net Sales, Operating Income					
FX Impact on Net Sales	N/A	-44,875	-25,454	12,841	95,499
FX Impact on Operating Income	N/A	-14,126	-5,745	190	25,894
Consolidated Cash Flow					
Cash flow from operating activities	76,245	30,469	30,889	25,233	72,388
Cash flow from investing activities	-20,967	19,003	-35,735	33,455	-20,273
Free cash flow	55,278	49,472	-4,846	58,688	52,115
Cash flow from financing activities	17,355	-37,359	-5,761	-42,436	-39,693

(Note) Above consolidated statements of income are based on Japanese GAAP. Therefore, this information has some differences as to description from financial statements in annual report based on U.S. GAAP..

Exhibit 6: Olympus Consolidated Statements of Income (Olympus Corporation, 2014a)

Imaging Systems Business

(Millions of yen)

	Fiscal year ended March 31, 2012	Fiscal year ended March 31, 2013	Increase (Decrease)	Increase (Decrease) ratio
Net sales	128,561	107,638	(20,923)	(16.3)%
Operating income/loss	(10,760)	(23,073)	(12,313)	–

Consolidated net sales in the Imaging Systems Business amounted to ¥107,638 million (down 16.3% year on year), while operating loss amounted to ¥23,073 million (compared with an operating loss of ¥10,760 million in the previous fiscal year).

Sales of “OLYMPUS OM-D E-M5,” a high-performance mirrorless interchangeable-lens camera equipped with features including an electronic viewfinder and the world’s first 5-axis image stabilization system, grew in Japan and overseas, while “TG-1” and “TG-2,” compact cameras with high image quality equipped with the Company’s own tough quality and F2.0 bright lens, sold well. Nevertheless, there was a sharp contraction in the compact camera market due to the popularity of smartphones, leading to further falls in numbers of units sold and unit prices. Consequently, there was a decline in sales in the Imaging Systems Business overall.

As a result of the decline in sales, operating loss increased in the Imaging Systems Business, despite cost reduction efforts.

Exhibi

t 7: Olympus 2-year Financial Performance for Imaging Systems (Olympus Corporation, 2014b, p. 4)



Exhibit 8: The different depth of field characteristics of sensors

The image on the left is from a micro four-thirds camera and the image on the right is from a DSLR camera. Notice the readability difference of the sign in the background. The micro four-thirds camera has a wider depth of field (i.e. more of the image is in focus for a given setting).

Portrait photographers often prefer a narrow depth of field to isolate a subject from the background.

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