

LYTRO - CHOICES IN 2013¹

It is April, 2013, and Jason Rosenthal puts down the dossier he has been provided about the history and state of Lytro, the world's first producer of a *light field camera* targeted at mass consumers. Rosenthal has just been announced as the new CEO of Lytro,² and he is contemplating the central challenge facing this innovative company: despite a breakthrough technology, a top-notch technical team, and rave reviews from the "technorati," Lytro has not yet penetrated the mass market. An initial burst of sales at the time of the product launch in 2012 has not transitioned into the type of year-on-year growth that the founders and Board were hoping to achieve.

Before considering his options, Rosenthal decides to look over the company overview one more time.

Lytro: Create Pictures That Are Worth Exploring

Lytro is the world's first producer of a light field camera targeted at mass consumers. The company's first product went on sale on October 19th, 2011, and started shipping on February 29th, 2012.

The company's underlying technology is based on *Plenoptic Technology*, and centers on the capture of a *light field*. The light field is the amount of light traveling in every direction through every point in space. Conventional cameras cannot record the light field; recording light fields requires an entirely new kind of sensor. Although the additional information from light field capture requires sophisticated light processing software to parse and analyze, this new conceptualization of an imaging system has the potential to overturn key concepts in traditional photography, and render many of the internal parts of

¹ This case was developed by Scott Stern and Kenny Ching solely for the purposes of classroom discussion. It is not intended to illustrate either effective or ineffective handling of an administrative situation, nor as a source of data. Some case details have been adapted to facilitate the learning objectives of the case. It should not be quoted, reproduced, distributed, or shared in hard copy, electronic or any other form without express permission from the authors. Feedback is welcome to sstern@mit.edu.

² <http://allthingsd.com/20130319/lytro-names-former-ning-head-rosenthal-as-ceo/>

regular cameras (such as the lens and focusing mechanisms) irrelevant. The impact is potentially transformative. A single light field e-snapshot can provide photos where focus, exposure, and even depth of field are adjustable *after* the picture is taken. Light-field photography also promises ultra-accurate facial-recognition systems, personalized 3-D televisions, and ultra-realistic images far beyond present technological capabilities.

Although plenoptic technology holds significant promise, imaging systems based on this technology have historically been large and cumbersome. To date, plenoptic technology has been used as a scientific instrument in expensive and application-specific niche areas such as radiology and life sciences research.

In his doctoral dissertation, Ren Ng was able to significantly expand the scope of this technology through miniaturization, dramatically reducing the size of the multi-lens array in a light field camera. In his 2006 Stanford dissertation, Ng demonstrated the basic elements of a light field camera that could be implemented as a palm-sized form factor (i.e., the size and weight of a traditional camera). Ng's new technology has the potential to change the entire dedicated camera market including high value-added SLR (Single Lens Reflex) products that are typically sold from \$500 and higher for a single lens! In a nutshell, a light field camera has the potential to revolutionize the world of photography.

By 2007, Ng and his co-founders established a company, Refocus Imaging, to commercialize this technology. Over its first several years, the company focused exclusively on research and development, spending more than a year refining the technology and understanding its potential application in the camera market. During this period, the company remained in stealth mode. While the company was able to close three successive rounds of venture financing (with top-tier partners such as Greylock, NEA, and Andreessen/Horowitz), the commercialization plans for the company were maintained as secret. There was no website, and very little information was released about the development of the technology, outside of a small number of technical presentations by Ng based on his doctoral dissertation.

The founding teams and its investors took a long look at how to commercialize the technology. From a technical perspective, the implications of light field technology are broad, with potential applications across a range of consumer, industrial and research settings. While some technologists have emphasized the possibility for new scientific instruments (e.g., a new type of microscope), others have pointed to the ability to decouple the process of imaging (i.e., taking a picture) from the editing and presentation of the information captured within

that image (i.e., editing and post-image processing). As recounted by Manu Kumar, one of the co-founders and first financial backer of Lytro remarked:

“One of the realizations was that camera companies are relatively old, stodgy companies, where it is very hard to really innovate and do something that is new and different. When was the last time you saw a camera company do something really radical? It’s always about adding one new feature for the next product cycle / Christmas season.”³

Based on this learning, the company decided to focus on creating a stand-alone light field camera positioned for the consumer market. The company has undertaken a series of steps that have allowed it to move from Ng’s 2006 doctoral dissertation to commercial product introduction in 2011. On the one hand, the company was able to acquire control over some key pieces of intellectual property. Ren Ng owns/co-owns 2 US patents (No. 7723662 and 7936392, each of which was initially assigned to Stanford University). The first describes how the light field approach can be beneficial for microscopy applications, while the second describes an invention (and makes claims) over a more generic set of applications, including the potential for video. The company made a conscious choice to create a standalone camera without seeking a partnership from the established players in the camera industry.

The growing and ambitious company has had to contend with the chaos and growing pains that arise from melding together a team that is drawn from diverse professional and cultural backgrounds:

“Getting the company to work requires quite literally mashing three different cultures into one. We have a bunch of people from academia, who were used to lab work, used to their own timeline. There is another group with a background in consumer electronics, who are accustomed to multi-year product life cycles and waterfall development methods. And finally there are also web folks who are very much into agile methodology, A/B testing and the launch and learn mentality.”
(Chris Macomber, Director of Product, Lytro)

Given its youth, the company prioritized the introduction of the overall technology (and its promise) in its initial product marketing strategy. Its marketing strategy rallies potential customers around the vision and promise of

³ “The Making of Lytro”, <http://k9ventures.com/blog/2011/06/22/the-making-of-lytro/>.

the technology, and emphasized that the first product is merely the first iteration of a brand new category of imaging products. The marketing strategy then additionally emphasized the value of the *initial* product for certain target customer groups. This layered approach not only helped in the marketing strategy, but also helped clarify the internal debate within the company about how and when to ship the initial product when the promise of the technology is only beginning to be realized.

In June 2011, the company emerged from secrecy with a new name. Ren Ng introduced the new company and its first product with conviction:

“Today, I am proud to announce the launch of Lytro and share our plans to bring an amazing new kind of camera to the consumer market.”⁴

The Lytro camera features an 8 GB (\$399) and 16 GB (\$499) versions, and began shipping on February 29, 2012. Relative to traditional point and shoot cameras (and certainly compared to SLR products), the Lytro camera is meaningfully different (see Figure 1). The camera features only two buttons – “Power” and “Shutter” -- and includes a glass touchscreen that allows pictures to be viewed and refocused directly on the camera. The 8 ounce camera features an 8x optical zoom lens and a constant f/2 aperture. Influenced by the “design” revolution initiated by Apple, the camera is housed in a highly stylized anodized aluminum rectangular tube. Lytro’s camera creates light field pictures with 11 “megarays,” a new term coined by them to differentiate from traditional megapixel specs. The images can only be processed by using a proprietary software platform developed by Lytro. This software was initially only available on Apple computers (OS 10.X and higher), but was made available to “high-end” Windows machines over the last year (i.e., requires Windows 7 or 8 running on a 64-bit machine). This software processing produces images using a proprietary “LFP” (i.e., Light Field Picture) file format. Lytro has built a free online platform for use by Lytro camera owners that allows Lytro owners to create galleries, share links with friends and post photos to Facebook, Twitter and Lytro’s public page. No special software or plugins are needed to view and interact with Lytro pictures in your web browser, and friends can even play with the pictures directly on their Facebook wall. However, because the images are stored in a proprietary format, the underlying plenoptic data cannot be easily extracted by users for further downstream editing work (i.e., beyond the tools provided by

⁴ “Starting the Light Field Revolution”, blog.lytro.com/news/the-light-field-revolution-by-ren-ng/

the Lytro platform). The current version of the Lytro camera does not allow for external memory or video.

Lytro was able to leverage the power of social media and traditional media exposure to generate significant interest in their initial product offerings. Reviews by the “technorati” were largely positive. Many early customers laud the sheer inventiveness, innovation and technological breakthrough achieved.⁵ However others have pointed to features which are “missing” in the Lytro but are standard in traditional digital cameras, such as video and a much higher pixel count.⁶ Some reviewers suggest that the Lytro technology would be more compelling if it was integrated into a smartphone, rather than offered as an (increasingly rare) standalone point and shoot camera.⁷ Indeed, the Chaos Collective recently released a “hack” that allows essentially any DSLR camera to have some of the functionality of the Lytro.⁸

Though the management team was initially buoyed by the early buzz, they are aware that the long-term prognosis remains uncertain. At the high end of the market, the industry is fixated on high pixel counts, powerful zoom lenses, and an ever-expanding array of more specialized features. For most camera enthusiasts, light field imaging just is not yet on the agenda. And, for most consumers, a camera has simply become a feature of their mobile phone! In addition, professional photographers, whose living is tied to the ability to capture images in real time that are not easily replicated by casual photographers, may be resistant to a technology that undermines their own craft. For more casual users, Lytro is still experimenting with how to identify how to create value for casual photographers over present-day imaging technologies:

“There’s definitely a lot of education (on light field imaging) that needs to be done.” (Charles Chi, Lytro)

From a competitive standpoint, Lytro has entered an industry dominated by a small number of famously aggressive incumbent players such as Nikon and Canon (see Figure 2). SLR cameras and their accessories maintain incredibly high margins, and are a significant source of profitability for the major camera makers (i.e., their profits are disproportionately located in these top-tier products

⁵ <http://news.wing.com/node/952>; <http://www.theverge.com/2012/2/29/2821763/lytro-review>;
<http://www.engadget.com/2012/03/08/lytro-camera-review>

⁶ http://reviews.cnet.com/digital-cameras/lytro-light-field-camera/4505-6501_7-35045210.html;
<http://www.dpreview.com/reviews/lytro/5>

⁷ <http://www.slashgear.com/lytro-review-round-up-29216324/>

⁸ <http://www.techhive.com/article/2029356/lytro-hack-turns-any-dslr-into-a-light-field-camera.html>

rather than in the “point-and-shoot” market). While there have been few start-ups in the camera industry over the past decade, none pose the type of broad technological and competitive threat that Lytro offers. Not simply a matter of technological leadership, incumbents have fashioned a sophisticated and highly interdependent ecosystem including lenses, batteries, and other accessories. While Lytro offers a radical departure, traditional players are addressing the problems associated with the weight and bulk of SLR cameras through the creation of smaller form factor cameras with SLR capabilities.

Even the intellectual property terrain is not quite as straightforward as it might seem. Mitsubishi Electric has been awarded a patent that claims to cover a 4D light-field camera design (No. 7,965,936), and Samsung has filed for a patent that describes a technology that offers SLR capability in the simple point and shoot camera (US2011/0169921).

Moreover, Lytro is not the only start-up on the camera scene. A smaller German company, Raytrix, has already produced and sold light field cameras for industrial and scientific imaging applications. And some competitors are already emerging in the area of light field consumer photography. Pelican Imaging Corp. has been compared to Lytro although their reported application is targeted towards mobile devices (smartphones and tablets).⁹ Established companies on the periphery of imaging, such as Adobe, are threatening to enter the market with a 100 megapixel light-field camera.¹⁰ Perhaps most disturbingly, Toshiba has announced an initiative to bring the power of plenoptic photography to smartphones with the intention of marketing the technology to leading smartphone producers sometime during 2013.¹¹

While Lytro has initially entered the market with a relatively closed system, the company has yet to make a long-term commitment in terms of the degree of accessibility and openness that will be incorporated into the camera and platform. Some potential competitors suggest that the early emphasis on a proprietary system is receiving pushback from other industry players:

“If you buy a Lytro camera and you want to do, say, 3-D video, you can’t, unless Lytro provides the software. I’m afraid Lytro may be shooting themselves in the foot. At first it looks like they’re gaining competitive

⁹ <http://www.pelicanimaging.com/>

¹⁰ http://www.time4.com/time4/microsites/popsci/howitworks/lightfield_camera.html

¹¹ <http://www.extremetech.com/electronics/144227-toshibas-refocusing-smartphone-camera-spells-more-trouble-for-lytro>

advantage, but it's actually closing the door for collaboration and progress." (Tudor Georgiev, Qualcomm)

While Lytro initially captured positive buzz and the attention of the technorati, the product has not yet "taken off" in the way that the founding team initially hoped. Though sales are still reasonably strong, the Lytro has not yet had a game-changing impact. . The Board has decided to bring in more seasoned executive leadership to drive Lytro to the next level.

Conclusion

As Jason Rosenthal puts down this report, he reflects on the size of the challenge that he faces. In the medium term (e.g., the next twelve months, through April, 2014), the Lytro technology is essentially fixed in the form of its unique cylindrical design, but the company still has significant latitude in which consumers to target, and how to target them effectively. Over the longer term, Rosenthal can redirect Lytro in even more fundamental ways, including the choice between (a) focusing on a more advanced version of the current camera, (b) bringing a new camera to market that would be aimed at professional photographers, or (c) abandoning the digital images market entirely and focusing on video and virtual reality applications.

Appendix

Figure 1 – Lytro light field camera (2012)



Figure 2

Worldwide Digital Camera Market Shares by Vendor

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Vendor	2010	2009

Canon	19	19
Sony	17.9	16.9
Nikon	12.6	11.1
Samsung	11.1	10.9
Kodak	7.4	8.8
Panasonic	7.6	7.6
Olympus	6.1	6.2
Fuji	4.9	5.4
Casio	4	4.7
PENTAX	1.5	1.7
Vivitar	1.2	0.7
Other	6.7	7
