Appropriating Scientific Knowledge: Using and Providing Ultraviolet Ray Information in Japan

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ABSTRACT

In this case study, focusing on the implementation of the Sun Protection Factor (SPF) for weather forecasting in Japan, the authors investigate a process of value-adding to scientific information, which we hope could give a hint for knowledge management. Unlike the received wisdom of the "linear model" which assumes that "basic" science is eventually applied to technology or that the users of technology only passively receive what the designers and the providers have made, the Sun Protection Factor has been established as a quantitative index of ultraviolet radiation by the cosmetics industry, rather a potential user of meteorological information services. The provider of meteorological information, the Japan Weather Association (JWA), then could adopt and appropriate the framework of ultraviolet forecasting which has been presented by the cosmetics industry. The authors hope that this case study which investigates the initiative of an industry which is sensitive to the ordinary consumers, particularly to women, in the market could contribute to an understanding of how a user-friendly scientific information market could be formed and transformed.

Keywords: Process of Value-adding to Scientific Information, Knowledge Management, Initiative of Users, Ultraviolet Ray Information, SPF (Sun Protection Factor)

1. INTRODUCTION: HOW TO ADD VALUES TO SCIENTIFIC INFORMATION

It is not all the new and innovative knowledge and technologies that directly and/or eventually contribute to the society. In order to add values to the newly developed technologies and knowledge, therefore, we have to tune them into the social and cultural contexts, or *vice versa*, to which knowledge management should contribute. In this case study, the authors examine a kind of scientific information service, with which many members of a society are familiar, has been formed in the context of contemporary Japan, focusing on the ultraviolet radiation forecasting service using Sun Protection Factor (SPF).

The recent flood of information on ultraviolet rays is noteworthy in that it shows possibilities that users could influence the formation and transformation of a scientific information market. While the physical, chemical and physiological characters of ultraviolet rays have been reported by scientists [1], the meaning of the radiation has been formed and transformed in socio-cultural contexts. As Henry Randle shows, the discourse on suntanning has been influenced by fashion trends, psychosocial aspects, entrepreneurs and the tanning business, and education [2]. As the socio-cultural dimensions of ultraviolet radiation are embedded in the discourse on beauty, health, wealth and environment, various activities of social groups such as scientists, medical doctors, members of the cosmetics and medicine industries, advertisement agencies, the mass media, and the users/consumers of the information should be taken into consideration to understand the process of forming interactively the features of the scientific information on ultraviolet rays [3].

This case study, also, aims at finding out some hints for knowledge management. As part of the knowledge information industry, weather forecasting services have a wide range of information such as forecasts, warnings, and advisories [4]. However, gross sales for private weather companies in Japan have in recent years been stagnant at an annual total of thirty billion yen. It is a serious problem for the industry to find out how to

create highly value-added meteorological information and to provide it for the gradually more sophisticated needs of the users. The Japan Meteorological Agency (JMA) suggests that private weather companies should investigate the potential demand of the customers in detail and produce useful information with weather forecasting [5].

However, on the frontiers of this value-added information, the future development is unclear, as Nelly Oudshoorn and Trevor Pinch aptly express; "working out who the new users are and how they will actually interact with a new technology is a problem familiar to many innovators of new technologies [6]." In order to understand the needs of the potential users of scientific information, it seems to be ideal that users, rather than providers, are continuously emitting information and forming the market.

While the scientists and engineers are considered to be the main players in the development of science and technology, some scholars in the area of science and technology studies have shed light on the creativity of the users and consumers, who appropriate, modify, and expand the original functions and meanings which the providers and designers have embedded [6] [7] [8] [9]. Users are, in this meaning, actually intertwined with the development of technology and/or knowledge. Ruth S. Cowan emphasizes the role of consumers making choices between competing technologies as a "consumption junction," which is located at the center of a consumption-production network [10]. If users sufficiently participate in the process of market-forming, it is needless to ask whether the information from the providers is in accord with the needs of the customers, or not.

In this paper the authors shed light on the case of the Sun Protection Factor (SPF) forecasting of the Japan Weather Association (JWA), which reveals how a potential user of the meteorological information service, and/or an industry which is more sensitive to the customers, has influenced the market while providing a "provider" with a quantitative index of ultraviolet radiation. As the well-known case of Toyota's *kanban* production system shows, the flow of information can move from the downstream to the upstream.

2. QUANTITATIVE ULTRAVIOLET INDICES: THE UV INDEX AND THE SUN PROTECTION FACTOR

Ultraviolet (UV) radiation, a solar radiation which is invisible to us, is part of the electromagnetic spectrum emitted by the sun. Whereas UV-C radiation (wavelengths of 100-280 nanometers) is absorbed by the atmospheric ozone, most radiation in the UV-A range (315-400 nanometers) and about 10% of the UV-B radiation (280-315 nanometers) reach the earth's surface. Both UV-A and UV-B are of major importance to human health [11].

Although in this paper the authors focus on the Sun Protection Factor (SPF) as a quantitative index for the intensity of ultraviolet radiation, another index, the Global Solar UV Index (UVI) was developed by several international authorities such as the World Health Organization (WHO), the World Meteorological Organization (WMO), the United Nations Environment Programme (UNEP), and the International Commission on Non-Inonizing Radiation Protection (ICNIRP) [12]. Then, what is the difference between the two indices for the intensity of ultraviolet radiation?

According to the World Health Organization (WHO), the UV Index is defined as "a measure of the intensity of ultraviolet radiation on the earth's surface that is relevant to effects on the human skin," and is calculated "using the International Commission on Illumination (CIE) reference action spectrum for UV-induced erythema on the human skin." The Index number is determined by the intensity of ultraviolet radiation while "reporting burn times is not recommended" in order not to announce "the wrong message to the public [12]." The UV Index, which was set by scientific authorities, assumes an "average skin" without full consideration for individual skin.

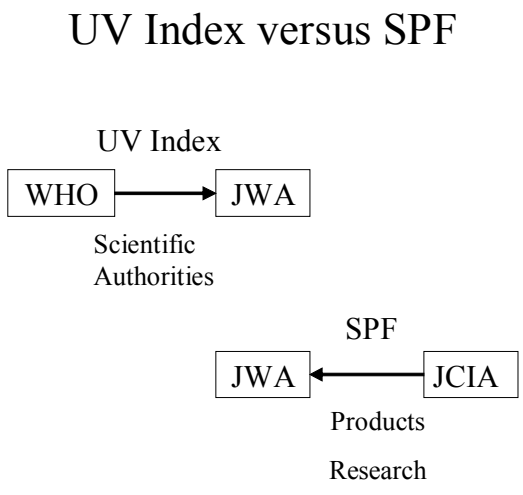
On the other hand, the Sun Protection Factor (SPF) explicitly refers to the burning time of individual human skin which the UV Index does not do. The SPF rating is calculated by comparing the amount of time needed to produce a sunburn on protected skin to the amount of time needed to cause a sunburn on unprotected skin [13].

SPF = (the amount of time needed to produce a sunburn on protected skin) ÷ (the amount of time needed to cause a sunburn on unprotected skin)

Sunscreens may contain physical or chemical barriers against the sun's rays. While physical barriers reflect or scatter the UV rays, chemical barriers act by absorbing the UV radiation before it hits the skin. Today's sunscreens filter UV radiation in the UV-A and

the UV-B range. The common SPF label on the tube stands for the Sun Protection Factor, a measure of how much UV-B the sunscreen can block. The numbers range from 2 upwards. A sunscreen blocks out both UV-A and UV-B and has an SPF of 15 or higher. To date there is no international standard to label the degree of protection from UV-A [14].

By definition, SPF index is heavily dependent on the products of the cosmetics makers: without the sunscreen creams, the Sun Protection Factor cannot be defined. While the UV Index ignores the variety of individual skin, the SPF could be simply applied to anyone's skin care [Fig. 1].



[Fig. 1] A Comparison of UV Index and SPF

Compared to UV Index, therefore, SPF could be evaluated as an easier and more pragmatic criterion according to which people, mostly the customers of cosmetics, can decide what they should do against the harmful radiation if they can find out the same number on their sunscreens as the number which they heard form the forecasters.

3. THE COSMETICS INDUSTRY AND THE DEVELOPMENT OF THE SUN PROTECTION FACTOR

While the UV index has been devised and recommended by international scientific authorities, the development of the Sun Protection Factor (SPF) has been initiated by cosmetics industry. In 1990, the Japan Cosmetic Industry Association established a committee for SPF, and two years later, the Association announced a new version of SPF based on its own research. In 2000, the Association amended the standard and set a maximum of SPF50+ [15]. SPF became a standard of ultraviolet radiation for the cosmetics industry.

Shiseido, one of the major cosmetics company in Japan, seems to have played an important role in standardizing SPF in Japan. The company, which began research on the "science for beauty" in the 1920s [16], put the first "Shiseido Sunscreen" on sale in 1954 [17]. While suntanning was in vogue in Japan also during the decades of the 1960s and 1970s [18], from the 1970s onwards, the harmful effects of ultraviolet rays were reported [19]. In 1972, the company sponsored an international conference on the relationship between solar radiation and the skin [15].

Even though it is in the United States that the first sunscreen with an indication of the SPF index appeared in 1977 [20] [21], the Factor, which is heavily dependent on the individual skin, had to be adapted in Japan. Shiseido started to develop its own SPF index, and in 1980, for the first time in Japan, the company began to sell its first sunscreen on which an SPF number was inscribed [15].

During the decade of the 1980s have the concepts of *bihaku* (the beautiful white) been established, which elevated the public interests in ultraviolet rays. Even though in Japan from the ancient era white skin has been the symbol of the privileged few who do not have to work outside and thus has represented the beautiful, from the 1960s to the 1970s tanned skin as a symbol of traveling abroad came to be in vogue [22]. However, as the growth of Japanese economy until the 1980s has weakened the efficacy of cultural/social meaning of tanned skin, and coupled with gradual concern about the menace of ozone holes, white skin became again the focus of public attention. *Bihaku*, which was coined and propagated by another major cosmetics company Kanebo, does not only mean cutting ultraviolet rays but also include controlling the actions of melanin and improving skin care. Since the last years of the 1980s, the public understandings about ultraviolet rays and about bihaku have been integrated [23].

At the same time, as the products with SPF indication have increased and have gradually become known to the people, the problem of standardizing the number has been raised. In 1989 an international conference on "Successful Aging" was held and many papers about the effects of ultraviolet rays on human skin were published. It was in the next year, 1990, that the Japan Cosmetic Industry Association established a special committee for SPF, and in 1992 the committee announced the SPF standard for the Association. A new attention to the harmful effects on the human immunity urged more research on the topic, and in the last year of the twentieth century the Association amended the SPF standard [24].

As history has shown us, the quantified standard of SPF has been established by the cosmetics industry corresponding to the rise of interest in white skin and the increase in cautions against ultraviolet radiation. At the same time, the industry also has tried to spread the potential market of SPF products, with distributing appropriate information on ultraviolet rays. For example, using its own ultraviolet sensors, Shiseido presents "UV Live" on its homepage. Also, the company explains ultraviolet rays in very simple terms that almost any person could understand: UV-A is represented as "ultraviolet radiation around our lives" while UV-B is expressed as "affinity to sun burning [24]."

The quantified index of SPF, which became well known to ordinary people, in particular to women as the customers of cosmetics, eventually came to be used by the providers of scientific information service. In 2005, a weather forecast firm in Japan, the Japan Weather Association, started to produce ultraviolet forecasts using the SPF index [25].

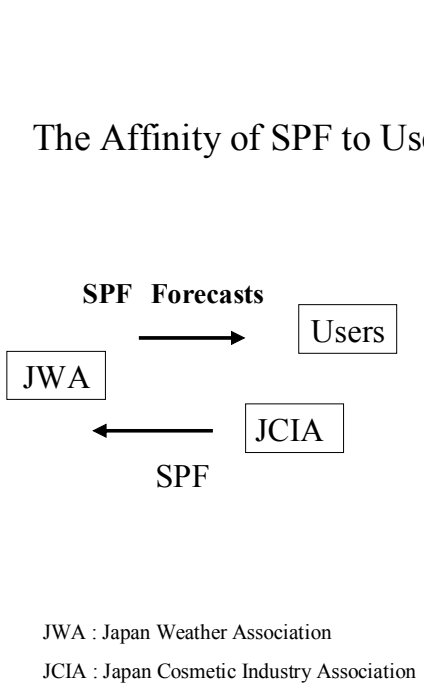
4. UV FORECASTING USING THE SUN PROTECTION FACTOR

During the summer of 2005, an ultraviolet ray forecast using SPF began with a female weather forecaster who belongs to the Japan Weather Association (JWA). While forecasting weather on TV, the forecaster realized that some advice on the measures against ultraviolet rays would also be necessary for her audience [26]. Although ultraviolet information had been broadcast since 1997, at the outset the information given by the media focused on the menace of the invisible radiation rather than on helping the everyday lives of the people [27] [28]. As a woman who used cosmetics every day, the forecaster found that the Sun Protection Factor index could be a useful standard which deserved to be forecast every day. Furthermore, according to a survey, 95% of women were aware of the Sun Protection Factor [26]. In other words, SPF had a good reason to be regarded as an appropriate index which had high value for the potential users of the ultraviolet forecast.

As we have seen in the last section, by the turn of the century, the SPF standard was established. With the quantitative index presented by the cosmetics industry in hand, the Japan Weather Association started to develop its own technology to forecast SPF every day. Using the experience and knowledge of the meteorological experts, plus the cooperation of dermatologists, the Japan Weather Association succeeded in creating its own algorithm to measure SPF [26].

The development process was conducted by the collaboration of various persons. The marketers, information system engineers, weather forecasters, and business managers of the Japan Weather Association discussed what kind of information would be desirable for the users of the information, especially focusing on the viewpoint of women [26]. It could be said that the female users implicitly and explicitly intervened in the designing process.

In the case of the UV index, the standard was given by the international scientific authorities. On the contrary, the SPF was developed and made sophisticated by the cosmetics industry. This history accounts for the difference between the two quantitative indices on ultraviolet radiation. While the UV index which was given from a higher authority does not fully consider the variety of individual skin, the Sun Protection Factor developed by a consumer goods industry could teach lay people concretely what they should and/or could do with the ultraviolet information. Consequently, the Japan Weather Association, a provider of meteorological information, adopted and appropriated SPF as a useful tool for its own ultraviolet forecasting. It could be said that the cosmetics industry which is sensitive to ordinary consumers in the market created a kind of scientific information which could easily be utilized by the providers as well as the users of ultraviolet forecast.



[Fig. 2] The Affinity of SPF to Users

Fig. 2 shows the easiness for the customers to use SPF forecasts. Since SPF forecasts share the same standard with the SPF numbers inscribed on the cosmetics, the users of the forecasts can easily understand what the numbers of the ultraviolet forecast meant. In this meaning, SPF forecast could be understood as user-friendly scientific information, particularly to the customers of the SPF cosmetics.

5. CONCLUSION

In this paper, we have examined a process in which a kind of scientific information created by a consumer goods industry was then adopted and appropriated by a provider of scientific information. It is through this process that the SPF forecasting of the Japan Weather Association has been implemented.

Even though we cannot tell if the cosmetics industry is a potential and/or actual user of the Japan Weather Association or not, we can instead say that the SPF index which was designed by the cosmetics industry had more affinity with the customers and thus could be evaluated as a more user-friendly information. The authors, furthermore, think that giving attention to the interactions between designers and users let us not overlook the roles of women who have been under-represented in the development of technologies and knowledge. In this paper, we saw that the viewpoint of women was crucial when the Japan Weather Association started its SPF Forecasting.

In terms of knowledge management, this case study could also be meaningful. If we admit that profits are dependent on the reciprocal ability to interpret the changes in the way goods and services are used in social relations [29], to understand the rising of a new scientific information service could provide us with some hints when we want to appropriate scientific knowledge into socio-cultural contexts and/or when we try to create socially appropriate scientific knowledge.

Since the SPF forecasting service just started from the summer of 2005, there has not been sufficient time for the authors to judge if it has been successful or not. However, it would not be impossible that the scientific information devised from the viewpoint of ordinary people could be more successful in the market than that given from the higher authority.

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