“高温への挑戦”の歴史的概観と新時代重要課題への対応

Historical Overview of “Battles against High Temperatures” and How to Address Crucial Issues in the Ongoing Innovation

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第1部　耐火物進展の足跡を振り返る

1･1　現代文明に不可欠の物資・耐火物

耐火物は，食物料理の“窯”のための“火に強い土”から進化して，耐火物の主用途は，製鉄を中心とする金属精錬となった。バイブル的冶金書「デ・レ・メタリカ」（A・アグリコラ著，1556 年刊）は，金属精錬に必須不可欠の“3 重要資材”として下記を明示しており，この認識は今日も変わらない：

① 金属原料鉱石
② 木炭（現代はコークス）
③ 耐火物

現在の耐火物の用途は，ガラス，セメント，非鉄金属から半導体の製造まで多様であるが，世界の耐火物生産量の約 80 %は，鉄鋼業で消費されている。本講演では鉄鋼用耐火物を中心に，その歴史を要約する。

1･2　欧州産業革命の“陰の主役”：　けい石れんがとタールドロマイトれんが

古代の製鉄炉には不定形耐火物（粘土+木炭粉）が多用されたが，15 世紀に木炭高炉が出現し，“史上最初の耐火れんが”として“焼成粘土れんが”が使用され始めた。しかし，近代的耐火物の出発点は，18 世紀に始まった産業革命である。

この産業革命は，蒸気機関と革新的鉄鋼生産技術に象徴され，その背景にベッセマー転炉，平炉，アーク炉，コークス炉の実用化を成功させた“けい石れんが”，さらにトーマス転炉を誕生させた“タールドロマイトれんが”がある。

特に，けい石れんがは，20 世紀半ばまで“King of Refractories”と呼ばれ，耐火物の最重要材質で

Part 1　Looking back on the historical development of refractories

1･1　Refractories, the vital materials for our modern civilization

Originating from the heat-resistant clay for food-cooking ovens, refractories have been evolved and mainly applied to smelting iron and other metals. The bible for metallurgy, “De Re Metallica” authored by G. Agricola, published in 1556, clearly defined the following three materials as the indispensable ones for metal smelting: metal ore, charcoal (coke for today) and refractories. This principle stays valid even today.

At present, refractories are being applied to a really wide range of industries, including glass, cement, non-ferrous metal and semiconductors.

About 80 % of the refractories produced in the entire world is, however, consumed in the steel industry. This lecture is focused on the historical development of refractories for the steel industry.

1･2　The hidden star players in the Industrial Revolution : silica brick and tar- dolomite brick

The iron-making furnaces in the ancient times were usually lined with monolithic mixes of clay and charcoal powders. In the 15th Century, when the charcoal blast furnace appeared, the first “refractory bricks” in history were applied to the lining. They were burnt fireclay bricks. The start of the modern refractories, however, was when the Industrial Revolution began in the 18th Century.

The Industrial Revolution is symbolized by the steam engine and the revolutionary iron and steelmaking processes. It must be seriously remembered that the latter novel processes were first successfully enabled with the newly-developed refractories : silica brick and tar-dolomite brick. Silica bricks were applied to Bessemer converters, open hearth furnaces, arc furnaces and coke ovens. Tar-dolomite bricks were the key to the invention of the Thomas converter process.

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あった。けい石れんがを W.W.ヤングが発明し，英国ニース工場で生産を開始した 1856 年が，” 近代耐火物産業の発足年 “とされている。

Especially, silica bricks had been the most important refractories, and called “King of Refractories” until 1950s. The year 1856, when W.W. Young, the inventor of silica brick, launched the production line at his Neath Plant in England is defined as “the starting year of the modern refractories industry”.

1・3　日本での産業革命とその知的遺産

登り窯で日本最初の粘土れんがが焼成され，佐賀反射炉を築造・稼働させた 1851 年が，日本の産業革命そして近代耐火物生産の “元年” で，以後 , 粘土れんが製造・反射炉築造が全国に拡大し，釜石コークス高炉 (1857)，八幡製鉄所創業 (1901)，黒崎窯業社創業 (1919), 等々に進展した。その起爆剤となったとも言える活動に，オランダ語技術書「大砲鋳造法」（ヒュゲーニン著，1826 刊）の和訳版「鐵鋼鋳鑑」への翻訳・造語活動がある。また，この活動は，大変な労苦であったが，多くの高度人材を育成した。

日本では，同様の専門用語の翻訳・造語活動が，すべての分野で，2 世紀にわたり継続されており，この偉大な遺産のお陰で，どの専門分野でも “日本語術語で考える” ことができる。

1·3 The Industrial Revolution in Japan and its intellectual legacy

In 1851, the Saga Clan constructed a reverberatory furnace and put it into operation for the first time in Japan. The refractory bricks (fireclay bricks) for the furnace had been fired in the ascending kiln (Noborigama). The year 1851 is regarded as” the starting year” of the Japanese Industrial Revolution and of the modern refractories production in Japan. Since then, the similar movement spread throughout Japan. This initial movement was followed by many other significant movements like the coke-fed blast furnace (Kamaishi, 1857), the start-up of Yawata Steelworks (1901), Krosaki Harima Corp.(1919), and so forth. This Revolution seemed to be triggered by the activities of publishing a Japanese translation “Tekkou Chuukan” from a Dutch book, titled “ How to cast iron cannons” authored by U. Huguenin, published in 1826. The translators had to go through lots of hardships including the coinage, which trained them to be highly sophisticated technological experts.

Similar translation activities have been continuously carried out in every field for the past two centuries. Thanks to this great legacy, we Japanese people in any field can “think things in our own language”.

1・4　世界大戦と耐火物

異常事態で実現した耐火物技術の代表例として，近代的不定形耐火物第一号 “プラスティック”（耐火煉瓦不足対策，第一次大戦，米国），“安定ドロマイトれんが”（製鋼炉用クロマグレンガ代替, 第二次大戦, 英国），そして炭鉱の採炭副産物の “耐火粘土”（当時の粘土れんが原料の約 25 %，第二次大戦直後, 日本）などがある。

1·4 The World Wars and refractories

Some typical examples of the refractories technologies affected by the abnormal situations are : (a) the invention of the first modern monolithic, “plastic” (as a countermeasure against the brick shortage, WWI, USA) (b) the application of stabilized dolomite bricks to steelmaking furnaces(as the substitute for chrome magnesia bricks, WWⅡ,UK) (c) the utilization of by-product clay from coal mines (about 25% of the needed raw materials for fireclay bricks, right after WWⅡ, Japan).

1・5　“追いつけ，追い越せ” の戦後・前半（1945 ～ 1970 年代）

日本鉄鋼業での先進基幹技術（大型高炉冷却法，LD 転炉，溶鋼脱ガス，連続鋳造法など）の積極的導入を成功に導いた “日本の耐火物技術の貢献” は，特記されるべきである。その背景として原料を含めたメーカー／ユーザー間の緊密なコラボレーションに注目したい。3 ～ 6 年のライフサイクルで，頻繁に耐火物

1·5 First half of “Catch up and overtake” postwar period (1945 ～ 1970s)

The Japanese steel industry eagerly imported the advanced key technologies, such as cooling system for large-sized blast furnaces, LD converter, vacuum degassing of molten steel, and continuous casting of steel, from the advanced countries. It is worth special mention that the great success in the introduction of those technologies owed a lot to the efforts made by the Japanese refractories community. Especially the close collaboration between

材質が改良・変更された。特殊成型法，高温焼成法など耐火物製造技術の進歩に負うところも，きわめて大きい。

耐火物材質と使用環境の多様化を反映して，耐火物の試験・研究法も多様化した。各種の新しい試験法(スラグ吸収軟化試験, 溶鋼と耐火物の濡れ性測定，等々）が試みられた。また，1910 年代から欧州で活用され，J.H.Chesters が「医学での遺体解剖に相当する重要手法」と推奨した“使用後耐火物の調査による損耗機構の解明”による耐火物開発の方法論が，1960 年代から日本で普及した。この時期の欧米情報（特に各種文献類）の恩恵も忘れてはならない。

1・6　“追いつけ，追い越せ”の戦後半世紀・後半（1970 年代～ 2000）

終戦直後，欧米先進国から 15 ～ 20 年もの遅れが指摘されていた日本の耐火物技術が，先進国に追いついたこの時期，各種の独自開発技術（マグ・カーボンれんが，溶射補修法など）も実用され，その成果は転炉寿命の最長記録（10,110 回，君津，1976 年），全国での原単位の顕著な低減（1970 年／ 2000 年：29.1 ／ 9.0 kg / t-steel），不定形耐火物比率の急速な上昇（1970 年／ 2000 年：18.9 ／ 63.5 %）などに象徴される。

耐火物技術協会が欧文誌“TAIKABUTSU Overseas”を 1981 年創刊し，さらに“東京国際会議”を 2 回（1983，1986）開催した。これらの国際活動は UNITECR 体制設立への一つの背景となり，初回 UNITECR が 1989 年秋米国・アナハイムで開催された。

1・7　耐火物の問題で発展を阻まれた鉄鋼プロセス（代表例）

(a) バッセ法およびクルップ・レン法（ロータリーキルン式製鉄法）

1930 年代，両法とも各国で工場が稼働したが，内張耐火物の損耗があまりにも激しく，結局は両法とも

the refractories makers (including the raw materials producers) and users should be appreciated. The life cycle of refractories for many applications used to be so short that the refractories quality had to be improved or changed every 3 to 6 years. The contribution made by the rapid progress in the refractories production technologies like special molding methods and high-temperature firing processes must be also highly regarded.

The type of testing method and research approach for refractories increased rapidly as a result of the diversification of quality and service condition of refractories. Various new testing methods, like the slagging-under-load test and the wettability with molten steel test, were attempted. Since the 1910s in Europe, the investigation of used refractories sampled from the furnace has been often tried to find the wear mechanisms in the lining. J.H. Chesters in 1944 highly evaluated this approach by describing “it is really useful just like the anatomy in medical science”. This methodology started to spread throughout Japan in the 1960s. In addition, it should be well memorized that we owed a lot to those excellent technical books and papers from the advanced countries.

1•6　Second half of “Catch up and overtake” postwar period (1970s ~ 2000)

The level of the Japanese refractories technology, which had been estimated 15 to 20 years behind the advanced countries in 1945, finally caught up with them. Several noticeable new technologies like magnesia-carbon bricks and flame- spray repairing process were developed. The progress in Japan could be typified by the converter lining life record (10,110 heats, Kimitsu Works 1976), the remarkable reduction in the nationwide refractories consumption (year1970／2000 : 29.1／9.0 kg / t-steel), the rapid increase in the monolithic ratio (year 1970／2000 : 18.9／ 63.5 %) and so forth.

The Technical Association of Refractories, Japan started publishing its English journal “TAIKABUTSU Overseas” in 1981 and held “Tokyo International Conference on Refractories” in 1983 and 1986. These international activities must have provided the world community with a positive background to establish a unified international conference system. The first UNITECR was held in Anaheim, USA in 1989.

1•7　Typical iron -steel making processes blocked by the refractories problems

(a) Basset Process and Krupp Renn Process (ironmaking by rotary-kilns)

The plants were operated worldwide in the 1930s, but both processes were abandoned because of the too severe and serious refractory lining erosion.

(b) Kaldo Process and Rotor Process (operated at several

に姿を消した。

(b) カルド―法, ローター法（欧州の数社などで稼働）

1950 年代，LD 転炉を超える新製鋼法として期待されたが，内張短寿命で断念。原因は，炉内の CO 燃焼による高酸素分圧であることが，米国での MgO-CaO-FeOx 系状態図研究（1965）で判明。耐火物分野での基礎研究の重要性が改めて実感された。

1・8　中断された研究開発計画（主要例）

① 連続製鋼法（日本，英国，フランスなど，1960 年代～ 70 年代）
② 高熱効率コークス炉（西独・Bergbau Forschung 社，1970 年代～ 80 年代）
③ 原子力製鉄（日本，西独，その他各国，1960 年代～ 80 年代）

1・9　今後の日本耐火物産業界への期待

(a) 引き続き，世界最高レベルの技術力の保持・創出に努めてほしい。そのためには，原料産業や鉄鋼業など耐火物市場との緊密な連携・交流に加え，人材多様化，AI 利用，異分野との交流など新時代の諸環境を積極的に活用してほしい。

(b) 日本の耐火物産業の将来は ,その グローバル化活動の成否に大きく依存すると確信する。　特に，工業化を目指す新興国での耐火物技術への期待は大きい。

(c) 今後の発展に不可欠の最重要の資源は “人材” である。リーダー層を含めた人材育成の具体策等は，下記の当講演・第二部にゆずる。

(d) 耐火物分野に従事の各位におかれては，「現代文明を根底で支えている」ことに,“誇りと自負” をもって活躍されますよう。

第２部　イノベーション成功のために取り組むべき諸課題

２・１　イノベーション時代が始まった

日本は高度経済成長の後，1980 年代中頃から各種の社会・産業上の問題が目立ち始めた。その典型例は，産業界での技術の “自前主義” である。「ジャパン・アズ・ナンバーワン」の著者・ボーゲル教授が，その日本語版の序言での「日本にも，アメリカと同様に “傲慢” になる危険性がある」との警告が，残念な

plants in Europe)

In the 1950s, these steelmaking processes were highly expected to surpass the LD process. Because of their shorter lining life, however, they were finally given up. A basic research in 1965, based on MgO-CaO-FeOx phase diagram, clarified that the problem comes from high oxygen partial pressure caused by burning CO inside the vessel. The importance of basic research was deeply realized again.

1•8　Halfway-abandoned typical R & D projects

(a) Continuous steelmaking process (Japan, UK, France, etc. 1960s~'70s)
(b) Coke oven with high thermal efficiency (West Germany, Bergban Forschung GmbH, 1970s ~'80s)
(c) Nuclear energy – driven iron-making (Japan, Germany, etc. 1960s ~'80s)

1•9　Expectations for the future Japanese refractories industry

(a) Every effort should be made to stay at the world-class level and to create valuable technologies. Much closer cooperation with the raw materials industry and the market industries like the steel industry will be needed. In addition, the latest business environments such as personnel diversification, AI applications and active interchanges with different fields should be positively utilized.

(b) The future of the Japanese refractories industry will definitely depend on its globalized activities. Especially in the developing countries, refractories technology is highly expected to play a vital role for their industrialization.

(c) The most essential resource for the future growth is competent persons. How to nurture the employees including their leaders will be specifically discussed in Part Ⅱ.

(d) Those who work in the refractories field should be “proud and self-confident” of their contribution by supporting the modern civilization at its very bottom.

Part 2　Crucial issues to be addressed for the successful innovation

2•1　The age of innovation started

Since the middle of the 1980s, just after the rapid economic growth, Japan started to suffer a variety of social and industrial problems. A typical case was the “Not-Invented-Here Syndrome” in the Japanese industry. Prof. Ezra Vogel's warning “the Japanese people might also become arrogant” in his ”Japan as Number One” (published 1979) really unfortunately came true.

On the other hand, the following two traditional Japanese business environments, which had been notorious

ことに的中した。

一方，欧米から批判されていた日本での“悪名高い”下記の研究開発業務方式が，欧米で再評価され，採用され始めた：

① 研究と開発の両業務の直結・統合

② “大部屋方式”のオフィス環境

そして，“大革新の時代”が始まった。

2・2 進行中イノベーションの注目すべき特徴

① その進行が急速で，世界的規模である。

② デジタル革命が含まれている。.

③ 多くの点で，多様性が重視され，分野間の連携・融合が加速されている。

以下が，重視すべき諸課題についての議論である。

2・3 新しい活動環境への移行

(a) 両世紀での注目動向の比較

20 世紀：専門分野がタテ割・細分化。各分野が孤立・閉鎖の環境で高度に進歩した。

21 世紀：各分野が開放・連携的で，相互の交流・融合で新しい成果を目指す。

特に，日本では，永年の伝統的な終身雇用的業務環境で，労働流動性が格別に低い閉鎖的業務環境（“たこつぼ症候群”と愛称）が定着しているため，21 世紀型への移行には，相当の努力が求められよう。

(b) 周知の具体的方策として，企業の M&A，従業員の副業奨励，シリコンバレー型の“出会いの場”としての拠点都市構想などがある。

(c) 講師は，自身の個人的体験から，積極的な学協会活動，大学講師，海外出張などの”社外での他流試合“を強く推奨する。

2・4 創造性の活用と起業活動の促進

(a) 創造性工学の創始者・ヴァン・ファンジェは「創造とは，既存のもの（考え方，方法，物質，業務形態など）を新しく組み合わせることである」と定義しており，その意味で 21 世紀は“創造の世紀”とも言

and severely criticized by the Western people, were reappraised and adopted by them: ①The activities of Research and Development are closely connected or mixed together. ② A big working room is shared by many members, instead of their own single room.

Now, we are in the age of great innovation.

2•2 The noticeable features of the ongoing innovation

① It is progressing very rapidly on a global scale.

② The digital revolution covers every part of the innovation.

③ The diversification is favored in many aspects and the cooperation or unification between different fields is accelerated.

The discussions about the vital problems are as follows.

2•3 Changeover to the innovative business environments

(a) The noteworthy trend comparison between the two centuries :

20th century: All the fields were vertically split into smaller groups. Every group made great progress in its isolated situation.

21st century: Every field is getting open about the collaboration with other fields looking for innovative fruits.

Especially in Japan, where the traditional lifetime employment custom is still prevailing with its low labor mobility, people tend to confine themselves to their isolated work environments (nicknamed as “octopus pot syndrome”).

Particularly much efforts for the changeover will be needed.

(b) Some well-known practical measures are as follows:

① corporate M&A ② encouraging the second job ③ establishing base cities (Japanese versions of “Silicon Valley” as the spots for encountering).

(c) The lecturer, based on his personal experiences, highly recommends the younger generations to make the best use of “an open competition outside their companies” such as taking part positively in activities for academic societies or technical associations, giving talks at universities, taking overseas business trips, and so forth.

2•4 Utilization of creativity and promotion of start-up activities

(a) Van Fange, the founder of “Creativity Engineering” defined “ Creation is to newly combine the existing things like ideas, methods, materials, business, etc. “. Therefore the 21st Century could be called “the

えよう。

(b) 過去の諸研究から作成の下記"創造成果概念式"の通り，創造には知識，発想，意欲の 3 要素が必要で，熱烈な意欲に加え，多様な知識，奇抜な発想が望まれる。

創造の成果 ＝ Σ（知識） x Σ（発想）
x Σ（意欲）

(c) 明治以来，日本語の創造的発想への非適性が批判されてきたが，1990 年代からはむしろ創造的発想に最適との見方が多くなっている。外国語の併用はさらに好ましい。

(d) 日本での事業化・起業活動は，他先進諸国に比べて，極めて低調である。この背景の一つは，起業活動リスクへの先天的とも言える過剰な警戒感であろう。さらに資金提供などの起業支援体制の未成熟が指摘される。最近の未来志向の動きが期待される。

2・5 これからの自己啓発のための重要課題

(a) 従来から重視の「関連基礎の学習」などに加え，次の 3 点セットを勧めたい：「一般教養」
「外国語（特に英語）」「デジタル常識」

(b)「一般教養」（米国大学でのリベラルアーツ）は，異分野間の "接着剤" として，また "創造的発想反応" の "触媒" として不可欠である。

(c) 外国語の学習は本来目的の"国際的コミュニケーション力の向上" に加えて，次記の諸点の向上が期待できる：＊一般教養 ＊国際感覚 ＊創造性 ＊母国語力 ＊認知症予防力 ＊人生充実度

将来，超高性能の翻訳機が出現しても，外国語は学習する価値十分と言える。

(d) デジタル常識の習得には，国語教育と類似の対応が必要であろう。

2・6 産官学連携と企業内研究所の役割

(a) 西部開拓以来の伝統を誇る米国の産学連携に学ぶべきところが多い。日本の場合，人事交流の慢性的不足が，大きな障害となっている。

(b) 企業内研究所の機能が，R&D 機能に下記が加わり，多様化されよう：＊来訪者等との交流拠点 ＊高度センター機能（IT 計測，分析，等々） ＊企業内の大学院・シンクタンク

Century for Creation".

(b) For creation, the three factors (knowledge, idea, passion) are needed, as the following conceptual formula based on the past studies shows:

Fruits of creation = Σ Knowledge x Σ Idea
x Σ Passion

In addition to a strong passion, diversified knowledge and novel ideas are needed.

(c) Since the Meiji era, the Japanese language had been criticized because of its unsuitability for creative thinking. Since the 1990s, however, many experts have been of the opinion that Japanese is the best language for creative thinking, and that additional use of other languages will be better.

(d) The venturing activities on new businesses in Japan have been much slower than those in other advanced countries. It seems to be one of the key backgrounds that many Japanese people, as innate worriers, tend to avoid risk-taking. Another problem can be the shortage of the social supporting systems like funding institutions. The latest proactive move in this country is highly expected.

2•5 Some essential subjects for future self - enlightenment

(a) In addition to the traditionally emphasized subjects such as "the basics relevant to the present jobs", the following 3-subject set will be suggested :

① general culture (the liberal arts) ② foreign languages (esp. English) ③ common knowledge of digital technology

(b) The general culture is essential for combining different fields as the glue, and for creating reactions as the catalysts.

(c) Beside the internationally communicable skills, learning foreign languages has the favorable or improving effects on the following items :

＊ general culture ＊ cosmopolitan viewpoint ＊ creativity ＊ mother tongue skills ＊ preventive power against dementia ＊ life fulfillment. Even if a super-performance translation machine is developed in the future, learning foreign languages will be surely worthwhile.

(d) The education for common digital technology seems to need the similar system to that for the mother tongue.

2•6 Industry – government – academia cooperation and the future roles to be played by corporate research laboratories

(a) As for the cooperation, Japan has much to learn from the U.S., which has accumulated a lot of successful results since they opened up the West.

In Japan, the chronic shortage of personnel interchange poses a big obstacle.

(b) The activities of corporate laboratories will be

(c) 海外立地研究所には, 現地の高度人材のリクルート拠点機能も期待される。

2･7　理工系女性の活躍推進

(a) わが国での女性の社会進出は，明治維新に開始された。しかし，その進展はきわめて緩慢で，そのため“男性中心の社会”の時代が永く続いた。日本での女性就業率は，最近，漸く先進諸国の水準に到達したところである。

(b) しかし，理工系分野では，一部の特定分野（医療，食品など）を除き，その就業率は , 先進諸国に比べ，依然としはるかに低い。因みに，2018 年時点でのわが国の国立大学・工学部での女子学生比率は 15.0 %に留まっている。

(c) 最も期待されるのは，労働力不足対策よりも，イノベーションに不可欠の女性ならではの下記の特質能力の発揮であり，今こそ女性の出番である。

＊多様性処理力　＊連携・融合・再統合力　＊広角的感知力　＊外国語を含む異文化消化力　＊柔軟発想・忍耐力

(d) 今後の重要な課題は多いが, 最重要課題は, リーダー層での女性比率の向上である。かねてより注目されてきた「30 %閾地仮説」（リーダー層中の女性比率が約 30 %に達すると，女性の活躍が顕著に本格化する）が，昨今，英国での“30 %クラブ”活動などにより実証されつつある。

(e) わが国での理工系分野での女子就業の遅れは，“女性というイノベーション向きの高度人材を温存している”とも言えるが，好機を逸してはならない。

2･8　新時代が期待するリーダー像を考える

(a) 組織リーダーの 3 大責務（＊現業務の順調な推進，＊人材の育成と士気高揚 , ＊将来計画の策定）の中で，現在，格別重視されるのが，研究開発テーマなど“将来計画の策定である。戦後の”追いつけ”時代には研究開発テーマを含め“将来計画”についての信頼できる活用可能な情報が，先進諸国から入

diversified with the following additional functions to the original R&D activities : ＊ meeting place with visitors ＊ centers for special technologies(IT, analysis, measurement, etc.) ＊ in-house graduate schools and think tanks

(c) The overseas - situated corporate laboratories are expected to function as recruiting branches for the talented persons living there.

2･7 Promotion of the activities by woman scientists and engineers

(a) In Japan, the involvement of women in public life started in the Meiji era. But its progress has been so slow that this country has gone through a “male-dominated society” for a long time. Very recently, the employment rate of Japanese women has finally reached those of other advanced countries.

(b) Regarding the employment rate for women scientists and engineers, however, Japan is still far behind other advanced nations with the exceptions of some specific fields like the medical area and the food processing industry.

The percentage of women students in the department of engineering at the Japanese national universities in 2018, for instance, is as low as 15.0 %.

(c) What is much more hoped from women should be their innate talents, which are essential to the innovation, rather than the measures against labor shortage. Now is the time for women’s turn. The main noticeable women’s natural talents are : ＊ skills for diversity ＊ abilities for collaboration and reassembling ＊ wide-angle sensing ability ＊ digesting capabilities for overseas cultures, including languages ＊ flexible way of thinking and perseverance

(d) Among many issues to cope with, the most desirable one will be to raise the ratio of women in the leader class or the manager group. The 30 % threshold hypothesis meaning “the activities done by women members can jump when the ratio of women in the manager class of an organization reaches around 30%” is recently being proved by “the 30 % Club campaign” in the U.K. and its followers in other countries.

(e) The regretfully marked delay of Japan’s women involvement in the science and technology fields might imply that this country is preserving abundant talented human resources for the innovation called “Women”. However, Japan should not miss the right timing.

2･8 Some images of hopeful leaders for the innovative fields

(a) Among the leader’s 3 key duties [＊ perfect promotion of the present business ＊ education and encouragement for subordinates ＊ designing the future plans], the most necessary one today is “designing the future plans including R&D themes”. During the past “catch-up-with the advanced nations” times after the

手できた。しかし，今日では，すべての分野の各リーダーが，将来計画を独力で策定しなければならない。リーダーは，荒海を漂う船の“水先案内“のように，その責任は極めて重大である。

(b) 将来のリーダーを目指す世代への参考指針

① リーダーになる前から，リーダーシップ，マネジメントに関心を持ち，平素から研究する。たとえば，現在の上司をよく研究する，優れたリーダーの伝記から学ぶ，等々。

② 公的資格重視のグローバル化時代では，然るべき公的資格（Dr. 学位，技術士など）の取得が望ましい。

(c) 文化圏ごとのリーダーシップ評価対象の相違にも留意。例えば，：

＊日本：リーダーはあくまで“役割り”。リーダーの“徳・人格”が重要。合意形成・チームワーク発揮を重視するマネジメント。

＊欧米：リーダーは“地位高き権力者”であり，権力行使能力が重要。権力に応じた責任が求められる。－大いなる権力に，大いなる責任。(noblesse oblige) －

(d) 新時代・日本のリーダーに期待したいことは：

① “水先案内”としての格別の重責担当に，誇りをもって臨んでほしい。

② 伝統的な“強固チームワーク指向のマネジメント”は今後も重視・継承してほしい。さらに，新時代に適合するための革新を，勇気をもって断行されたい。特に，多様性の尊重，そして“たこつぼ型孤立閉鎖的活動”からの脱却に注力を。

③ 自己啓発を常に忘れず，“徳･力兼備”の多能型リーダーを目標に。

④ リーダー後継者の育成も忘れずに。

参考資料

当講演の内容の多くは，下記の講師による著作，研究論文等からの引用である：

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World War Ⅱ, plenty of their reliable and useful information was available for making the future plans. Today, however, every Japanese leader in any field must think out those plans by himself. Their duties are really crucial like the pilot of a ship drifting in rough seas.

(b) Some helpful suggestions for the would-be leaders

① Long before you are appointed, you should be interested in and study “ leadership and management”. As some specific approaches, it could be effective to analyze your present leader’s management style, and to learn from the biographies about excellent leaders.

② In today’s globalized business environments, it is desirable for every leader to possess any appropriate official qualifications such as doctorial degrees and consulting engineers.

(c) It should be kept in mind that the evaluation standards for leadership depend on the cultural backgrounds. For instance:

Japan : Leaders are considered as one of jobs or duties. Their personalities and morality are considered important. The capability to build up teamwork is especially demanded.

The West : Leaders are the elites. The skills to exercise their power are particularly expected. At the same time, taking their responsibilities is strictly requested, as they say “noblesse oblige”.

(d) Expectations from the leaders in the ongoing Japanese innovation:

① Be proud of carrying out the specially vital duty as “the pilot of the ship”.

② The traditional “solid teamwork-oriented” management style should be treasured and handed down to the next generation. In addition, the management renovations to cope with the innovative times should be bravely carried out. The emphasis should be placed especially on “high regards for diversity” and “getting away from the octopus pot syndrome”.

③ Always make every effort to enlighten yourself, aiming at becoming a versatile leader who owns both morality and power.

④ Remember that you must train your successors.

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