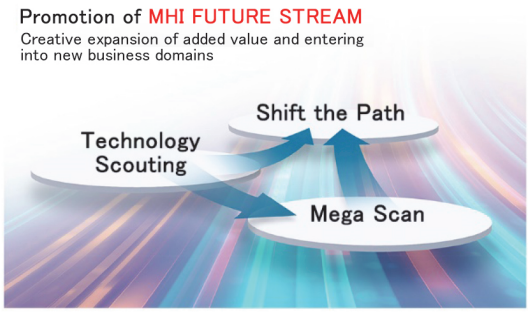
Future Visions of Our Group Drawn from "MHI FUTURE STREAM" and Our Group's Challenge to Create New Value



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In order to continuously contribute to society and people in years to come through the provision of machine systems, Mitsubishi Heavy Industries, Ltd. (MHI) Group needs to be a company that can sustainably grow with its capabilities to capture rapid changes in the social agenda, people's values and technological innovations.

"MHI FUTURE STREAM" is an activity for setting MHI Group's business direction according to several possible scenarios that are formulated based on the big picture of medium- to long-term changes in the political, economic, social and technological situations surrounding our business. This report summarizes the megatrend in the world around MHI Group and describes our challenges to realize speedy social implementation.

1. Introduction

In recent years, various events have been occurring in the fields of politics, economic, society and technology, including the complications related to social issues, diversification of people's values, technological innovations such as digitization and biotechnology, changes in people's behavior due to the coronavirus pandemic, and now on top of these, the Russian invasion of Ukraine. The business environment surrounding MHI Group is thus changing uncertainly and discontinuously.

Facing such a world represented by the term VUCA*, we need to envision the future society we are aiming for, reaffirm the role we should play, and keep changing theretoward, if we continue to fulfil our commitment to contribute and provide value to all our stakeholders.

MHI FUTURE STREAM is the activity of the above-mentioned approach for discovering the direction in which our group's business should travel.

*VUCA: Volatility, Uncertainty, Complexity and Ambiguity

2. MHI FUTURE STREAM projects

The activity of MHI FUTURE STREAM involves the following three steps: "Mega Scan", "Shift the Path" and "Technology Scouting" (**Figure 1**).

In "Mega Scan", society 10 to 20 years in the future is predicted from a broad, comprehensive perspective, based on which the scenarios of likely changes are formulated considering wide-ranging possibilities in markets and technologies to suggest possible business opportunities. At this step, numerous dialogues are held with experts and innovators both inside and outside our companies, and insight into the future and vision are created from multiple perspectives on markets and technologies. Especially in recent years, many significant movements that can affect future society have been simultaneously developing in an interconnected manner, which may be exemplified by the social agenda including sustainable growth with a view to preserving the global environment in relation to climate change and utilizing limited resources, geopolitical developments such as the Russian invasion of Ukraine, the advancement of materials and digital technologies, changes of people's behavior triggered by the coronavirus pandemic, and

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supply chain vulnerabilities exposed against the background of a globalized economy. "Mega Scan" enables us to gain insight about these changes by considering them not as a set of individual phenomena, but as the process of transition in the overall situation.

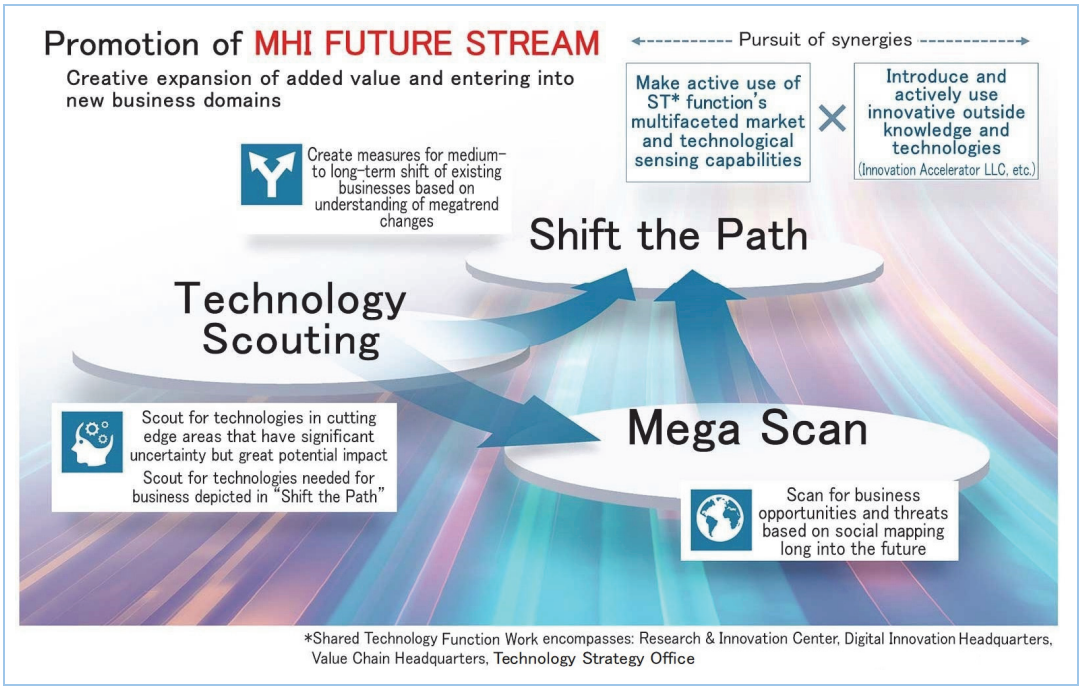

Figure 1 Three approaches of MHI FUTURE STREAM

"Shift the Path" generates innovation hypotheses of market and technologies based on the insights and perspectives from "Mega Scan", and "explores" the business opportunities found therein. "Shift the Path" deals with subjects that are difficult to find and deepen under the current business functions, such as new businesses unrelated to the existing businesses or business opportunities crossing multiple domains. Led by the agile business development team together with external partners such as startups, prototyping and trials to verify the business hypotheses are conducted to hand the results over to the "deepening" process (**Figure 2**).

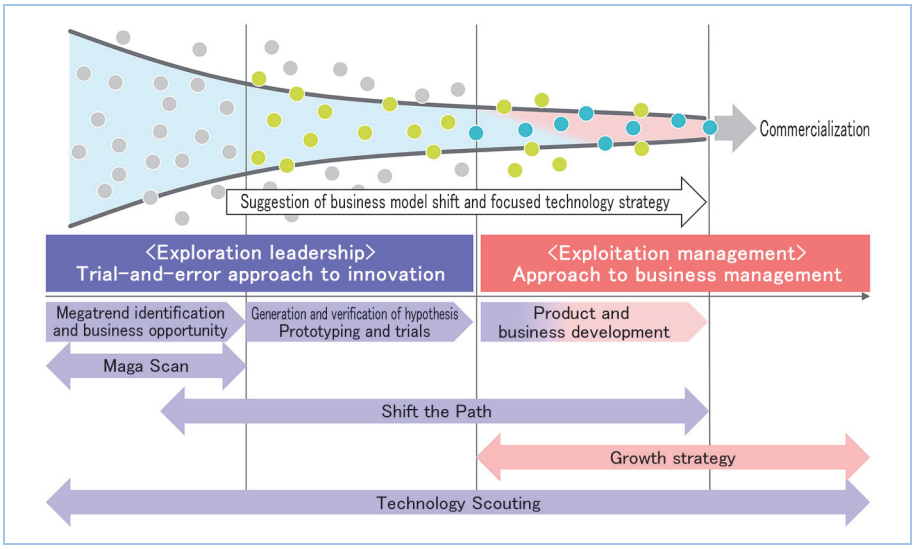

Figure 2 Development of growth strategy from business model shift/new business conception initiated by MHI FUTURE STREAM
(Blue: led by Shared Technology Function, Red: led by Business Functions)

"Technology Scouting" has two key concepts. One is finding disruptive technology seeds that may have a significant impact on the medium- to long-term insight/vision obtained in "Mega Scan". The other is to find technologies needed to realize the innovation hypotheses generated through "Shift the Path". MHI grows these technologies together with external partners.

In addition to Mega Scan and Shift the Path, this report features our project of "pivot

development" enabling the outcomes of Mega Scan/Shift the Path to be speedily implemented in society by quickly finding value on a small scale through co-creation. Lastly, as a place of co-creation, "Yokohama Hardtech Hub", in which networks are utilized advantageously, is also described.

3. Medium- to long-term changes in the business environment (Mega Scan)

Let us look back at some of the major events that occurred in recent years. In 2020, the outbreak of the coronavirus infection had a huge impact on the behavior of the global economy and people. In 2021, COP26 saw a historic agreement on climate action among countries, each of which set targets for decarbonization. In February 2022, the Russian invasion of Ukraine shook multiple aspects of our society including security and decarbonization. Further, in December 2022, the North-South divide manifested itself more explicitly than ever at COP27, which exposed the difference between the ideals and the stance of each country on the matter.

As described above, many of the recent events that happened either spontaneously or artificially are quite unexpected, if the future is predicted as an extension of the past. No one can foresee what the world will be like even in a few years from now.

Through Mega Scan, the trends in politics, economy, society and technology are broadly and comprehensively understood from a medium- to long-term perspective, making it possible to capture the basic flow of change that can be sustained even under the circumstances of VUCA.

3.1 Flow of Mega Scan

In Mega Scan, the world trends surrounding MHI Group are categorized and organized into "megatrends", "undercurrents" and "change drivers". The last category is defined as something that brings about change in megatrends and undercurrents, while being influenced by the everyday social landscape. Based on these mutually correlated factors, change in the business environment is broadly and comprehensively viewed from a medium- to long-term perspective (**Figure 3**).

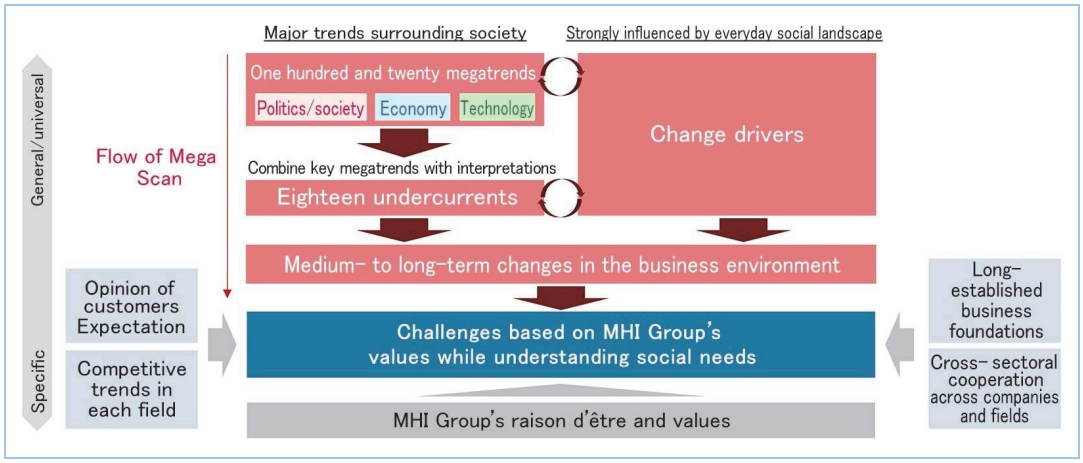

Figure 3 Flow of Mega Scan

3.2 Megatrends and Undercurrents

The macro social trends, which shall not be within the limits of our own businesses, are sorted into "120 megatrends" (**Figure 4**). Furthermore, by combining them and adding our own interpretation, we have organized them into "18 undercurrents".

Although the list of megatrends was made in 2018, the items on the list still remain the same even after all sorts of events have happened in global society. A certain item may be markedly accelerated by the resulting effects of various phenomena occurring daily. Coupled with such acceleration, some of the undercurrents may also be accelerated, thereby increasing their importance (**Figure 5**).

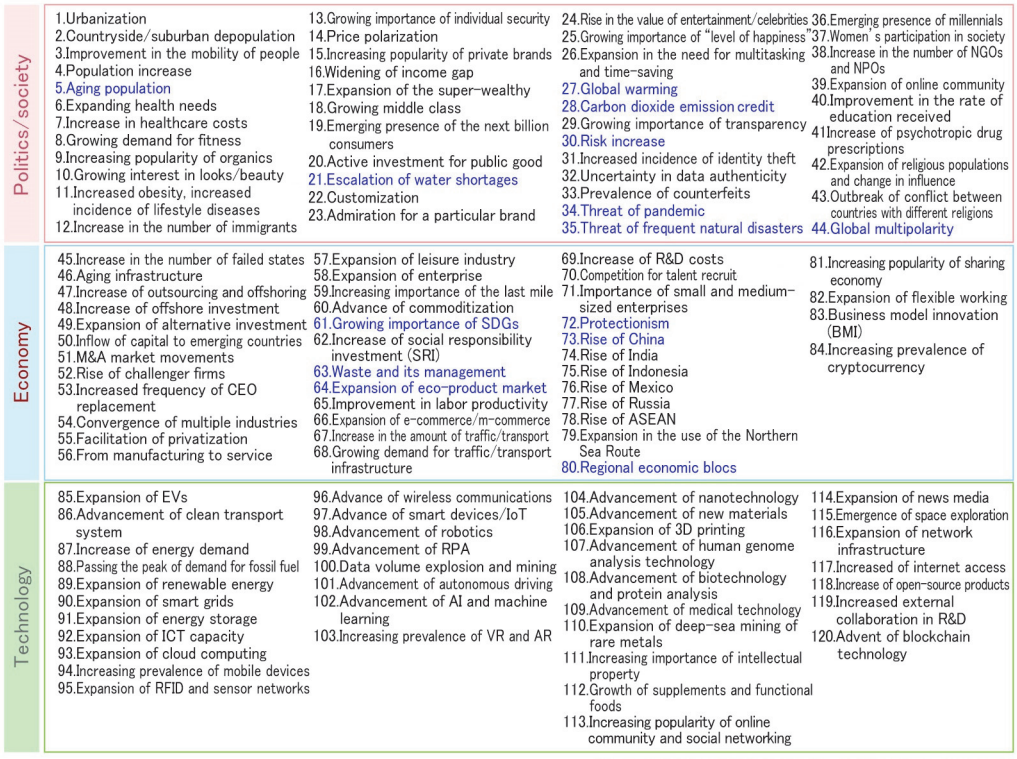

Figure 4 "120 megatrends" surrounding MHI Group

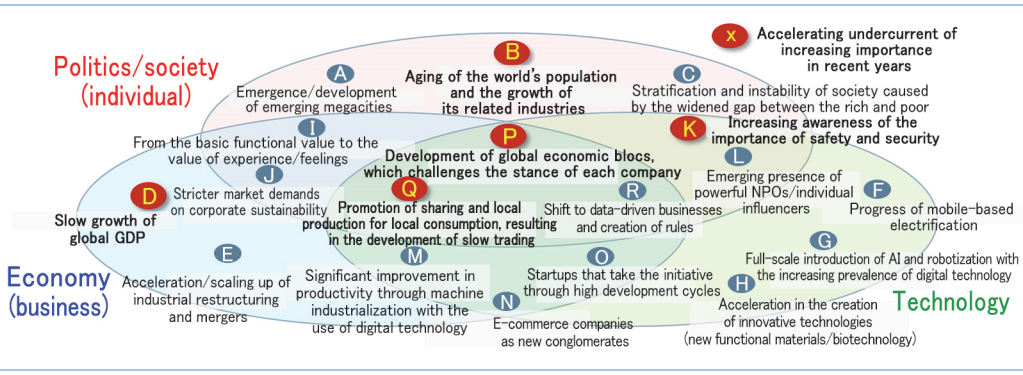

Figure 5 Eighteen undercurrents and the acceleration

3.3 Medium- to long-term changes in the business environment resulting from "change drivers"

Some of the social trends, which accelerate a particular item of the megatrends or undercurrents as described above, may directly cause change in the MHI Group's business environment. These are defined as "change drivers".

Recent "change drivers" include the occurrence of natural disasters with increasing frequency and severity, escalation of international tensions (typically as seen between the U.S. and China), and behavioral change centered around digitalization through life with coronavirus. These affect the undercurrents, which changes the environment of our business dealing with social infrastructure. In the midst of such change, MHI Group continues to support the "safety, security and comfort" of our stakeholders by making use of our long-established business foundations, enhancing the intelligence of machine systems, and creating new value by building an ecosystem in which the first two means are employed in a combined manner.

Of the medium- to long-term changes in the business environment, **Figure 6** focuses on "(a) ESG and acceleration of decarbonization," "(b) increasing awareness of the importance of national security," "(c) autonomy within a bloc and cooperation between blocs" resulting from (a) and (b), and "(d) change in the machine system value".

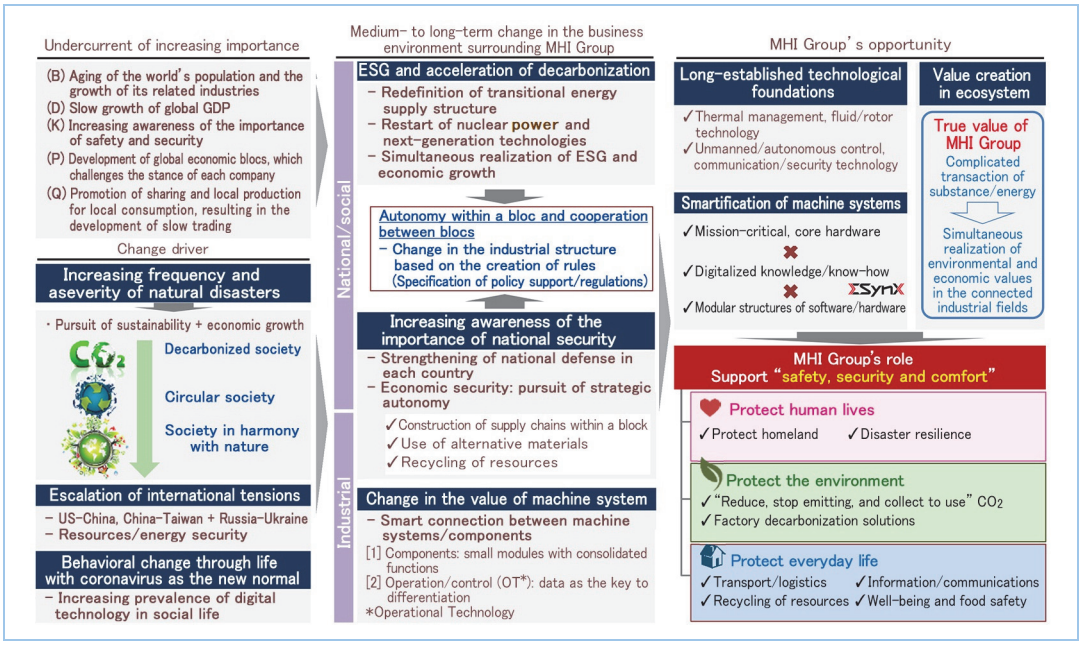

Figure 6 Undercurrents and change drivers, and their impact on the medium- to long-term business environment surrounding MHI Group

(a) ESG and acceleration of decarbonization

Although the East-West or North-South divide in the global society has been pointed out for some time, the issue has become more apparent after the Russian invasion of Ukraine and through COP27. Given such circumstances, it has also been pointed out that these divides may cause headwind to blow against climate actions. The "Global Risks Report[(1)]" , published by the World Economic Forum in January 2023, highlights "failure to respond to climate change" as one of the risks in the next 10 years. However, with climate change growing more severe, we must not stop the movement toward decarbonization in global society, and should work out a plan for transitional energy supply and demand as a realistic solution with economic growth, while considering the adversarial relations and different opinions/ideals in the international community.

Such efforts for transitional energy supply and demand are being discussed and explored by various organizations such as international organizations, countries and companies. However, it is difficult to balance S+3E (i.e., Safety, Economic efficiency, Environment and Energy security), if the supply-side and demand-side structures are separately examined despite their being essentially inseparable. It is therefore important to envision the future based on the connection between these two sides.

Having offered many products/services on both the energy supply and demand sides, MHI Group considers it necessary to make the most of the expertise gained through these businesses, create its decarbonization vision taking both supply and demand sides into account, and contribute through the products/services as a practical solution to turn the vision into reality. Under these circumstances, we are taking on various challenges toward carbon neutrality by 2040 under the banner of "MISSION NET ZERO".

(b) Increasing awareness of the importance of national security

Russia's recent invasion of Ukraine has raised the concern that everyday life can be shattered by military aggression. Although the public's interest in economic security had increased against the backdrop of US-China friction, the Russian invasion of Ukraine coupled with the deterioration of relations between China and Taiwan is placing people on higher alert regarding national security.

(c) Autonomy within a bloc and cooperation between blocs

In the midst of such developments mentioned above, the supply chains in the global economy including energy and resources, which showed a tendency to be unified into a single economic market, have exposed vulnerabilities more than ever.

As every country and company need to enhance the autonomy and indispensability of

their own economic activities, they are promptly proceeding with the rebuilding of supply chains. It is inevitable for the supply chains, which have been optimized and simplified by the global economy, to get more and more decentralized in the coming years. However, as economic activities are already firmly interconnected, they are unlikely to be completely disconnected from each other. What is expected is the interconnection between autonomous economic blocs around the world while cooperative relations are maintained[(2)].

In these circumstances, society will change as rules such as policy support schemes and regulations are created against various national backgrounds and constraints. In order to detect any such trend at an early stage and incorporate it in the strategies of one's own country or company, the availability of intelligence (information collection and analysis) will be of increasing importance.

(d) Change in the value of machine system

Regarding the value shift around machine systems, which was reported in detail in a previous MHI Technical Review[(3)], unified control systems and components are becoming more valued than assembly or production.

In such advancement of machine systems, the key lies in creating new value by combining and controlling wide various types of machines, while maximizing the value of components.

Given diverse and complicated social issues such as simultaneous realization of economic and environmental values, MHI Group is developing wide-ranging solutions under the brand name of "ΣSynX" for machine intelligence. In this way, we leverage the full potential of our products and services to contribute to society.

4. Creation of new value and MHI Group's contribution (Shift the Path)

Since its foundation, MHI Group has contributed to society by delivering "safety, security and comfort" to stakeholders through the provision of machine systems. This core essence of MHI Group has stayed unchanged.

In contrast, societies and markets, which form the ground beneath our feet, so to speak, are changing rapidly. As described in the preceding section, this is caused by not only the pandemic, geopolitical upheavals, inflation and such, but also the rules that have been created in a manner related to the ideals and national interests of each country. Under these circumstances, we need to continue to propose solutions in which various issues including economic efficiency, safety, energy/resources security, and environmental conservation are dealt with in a balanced and realistic manner.

4.1 Creation of new value through the synergy of combined products/services

The future of social infrastructure, in which a number of values such as greater safety, better economic efficiency and less impact on the environment are realized in a balanced manner, would be greatly different from what it is today in terms of required functions and roles.

Toward the realization of safety, security and comfort, our challenge to create mission-critical products/services that can "protect human lives," "protect the environment" and "protect everyday life" continues. The elements that become important in this context constitute the basis of "creation of new value through the synergy of combined products/services".

For example, consider the reduction of CO_2 emissions. If various machine systems can be interconnected beyond the limitation of control optimization of each machine system to minimize energy consumption/CO_2 emissions and maximize profit, this will produce benefits more than the sum of the values brought about by the individual machine systems.

The transaction of substances (including carbon) and energy (such as electric power and heat) occurs between machine systems in a complicated manner. The maximization of environmental and economic values in the connected industrial fields takes more than knowledge about control technology using software. It is critical to truly understand the physical phenomena and mechanisms taking place within individual machine systems. MHI Group, with more than 500 products and nearly 700 technological categories, has high potential for creating new value through the synergy produced when they are combined.

While continuously improving individual products/services, we will take on the challenge to create new value that can meet the needs of customers and society in a flexible manner by "smartly connecting" these products/services. This is our proposal and ambitious undertaking in relation to our raison d'être as a conglomerate in the VUCA world.

4.2 Building an ecosystem to create environmental/economic value by connecting industrial fields

In order to connect diverse industrial fields and bring about environmental/economic value, it is required to create an "ecosystem" by networking various value chains[4]. We aim to promptly implement it in society for our wide-ranging products/services. To encourage this idea, "six keywords" have been set (**Figure 7**).

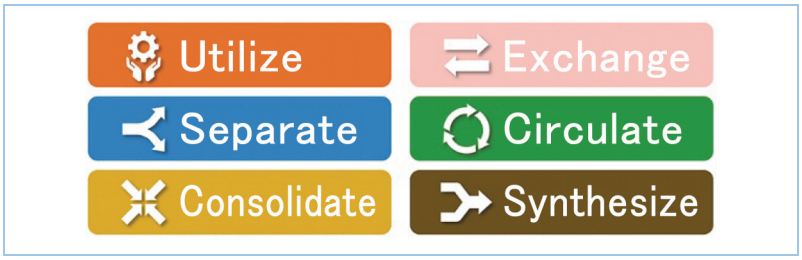

Figure 7 Six keywords for the ecosystem that MHI Group aims to realize[4]

The number of possible combinations of our products/services is countless; numerous ecosystems can be considered. For example, shown in **Figure 8** is a conceptual diagram in which a waste-to-energy boiler, CO conversion, oil/chemical synthesis, CO_2 capture, and others are incorporated. This illustrates how a large loop for carbon recycling can be created by combining our existing products and the technologies under development. Specifically, the figure includes the addition of CO conversion using carbon-neutral electricity to the waste-to-energy boiler, the production of raw materials for oil and chemical products, and the use of their final products as "sustainable aviation fuel (SAF)". In this way, the number of the value chains connected across different industrial fields will increase, which may allow environmental value to be realized while economic efficiency is also achieved with the full use of by-products.

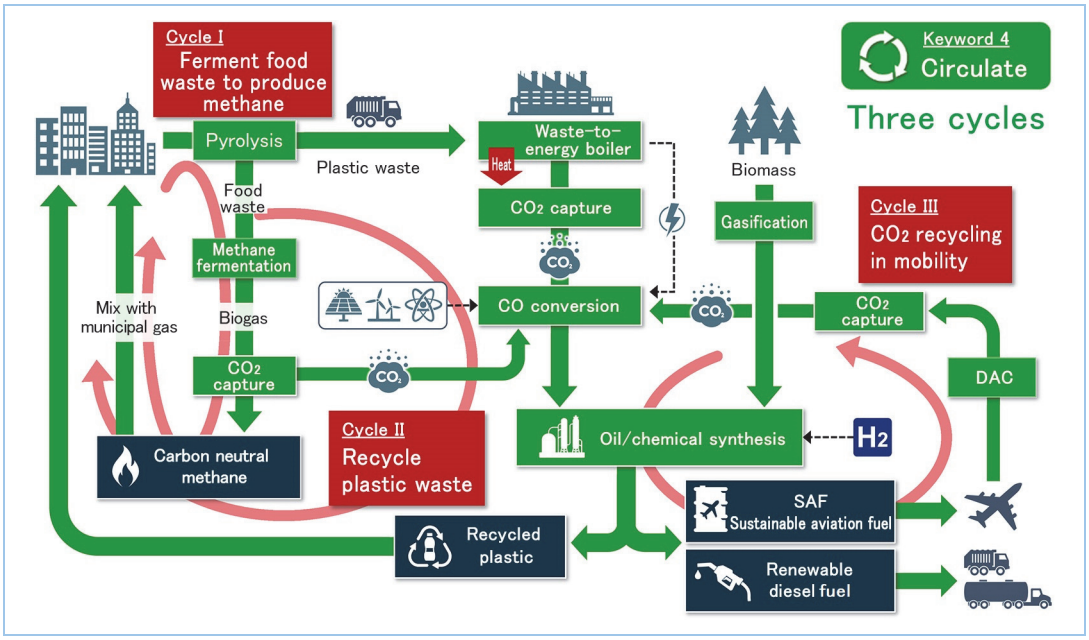

Figure 8 An example idea of an ecosystem: CO_2 circulation connecting waste incineration and mobility[4]

Turning such visions into reality requires a highly advanced level of coordination and cooperation between machines and systems, in addition to cross-sectoral collaboration involving multiple business divisions in a company, manufacturers, suppliers and customers.

MHI Group has not only hardware products, but also control technologies to operate them.

Their use for smart connection enables machines to transform into "smart machines", in which "Σ SynX" (as referred to in the preceding chapter) plays a vital role.

Having visions for decarbonization and its inextricably linked issue of resources recycling and turning them into reality will lead to economic security. Creating an image of an ecosystem from an early stage, MHI Group will continue to bring about the value necessary for the vision of the future society through cooperation with various partners including customers, and fulfill our role as a leading social infrastructure company in the VUCA world.

5. Speedy finding of value on a small scale through co-creation for social implementation - Yokohama Hardtech Hub and FUTURE STREAM CONNECT -

5.1 Our challenge of "pivot development" for speedy business creation on a small scale

Continuous delivery of new value to customers is indispensable for MHI Group's sustainable growth. However, as the creation of new value has no precedents, it will be inevitable to proceed with the materialization of products/services on a trial-and-error basis.

In so doing, it is important to repeatedly assume and test a hypothesis. A problem to be solved is fragmented into a number of the smallest hypothetical units. Any hypothesis is flexibly modified according to the test results, widening the range of new applications. In this way, new value can be implemented efficiently in society.

MHI Group has introduced this process of business development under the name of "pivot development", especially in the shared technology function work.

How to deliver the value is visualized based on the initial hypothesis in the early stage of development, before being repeatedly modified while taking the customers' opinions into consideration. Moreover, we create the opportunity for customers in various fields to use or experience what we have concretized. This may enable a latent issue or an as-yet-unknown business opportunity, of which even customers themselves have been unaware, to surface. Making such pivots repeatedly makes it possible to speedily determine what product or service should be made available (**Figure 9**).

It is also possible to reach and deliver the value that is completely different from the initial hypothesis by discovering scope in a different business area or finding a possible application in an unexpected field, for example, through "the place of co-creation" in which prototyped products and services can be used or experienced by customers from various fields (as described below).

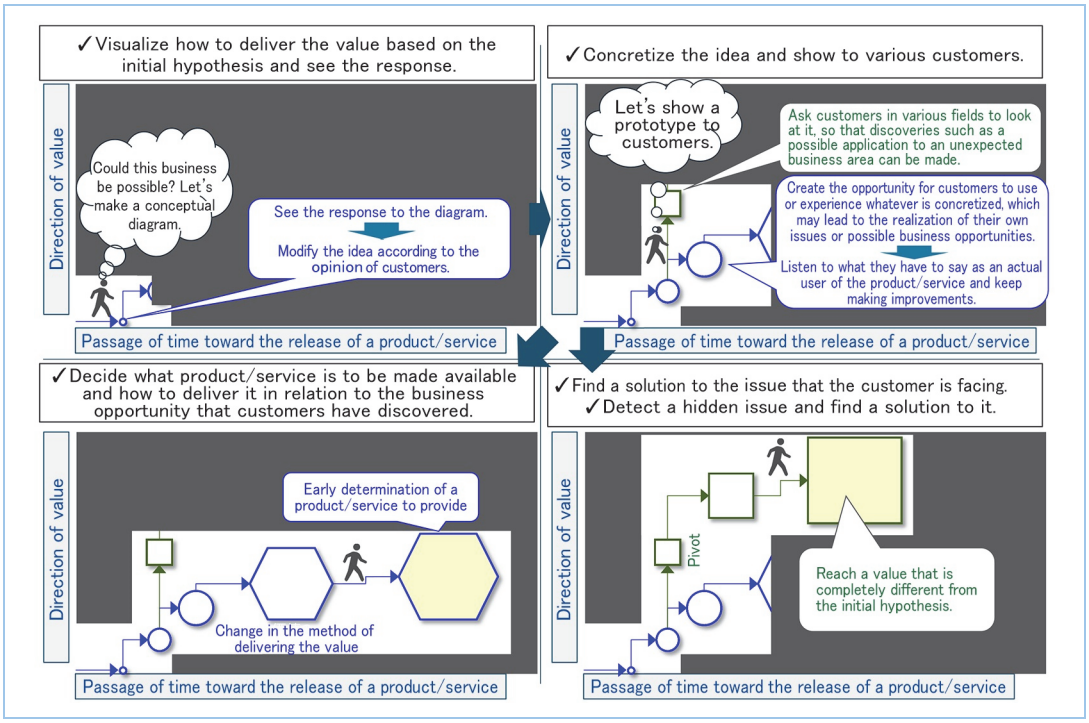

Figure 9 "Pivot development" – small and speedy development

5.2 Evolution of Yokohama Hardtech Hub: a place of high-speed creation on a small scale

Presented next is our "Yokohama Hardtech Hub (YHH)" project, in which co-creation with customers and various stakeholders becomes possible through trying out ideas for prototypes and creating opportunities for them to use the machines.

YHH serves as a platform for co-creation with various stakeholders who are engaged in manufacturing such as venture firms, local government bodies, academic institutions and manufacturers (**Figure 10**).

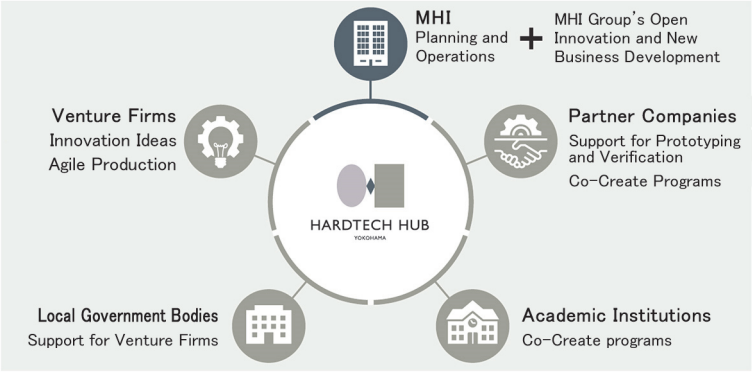

Figure 10 Conceptual image of co-creation platform that Yokohama Hardtech Hub aims for

This co-creation platform is a place that enables prototyping and testing to be conducted in a small and speedy cycle with a minimum number of reworks and misunderstandings. This is led by the companies residing in YHH's co-creation space of 20,000 m^2 working together with not only their customers but also the partners in their supply chains at this very place from the beginning of development (**Figure 11**).

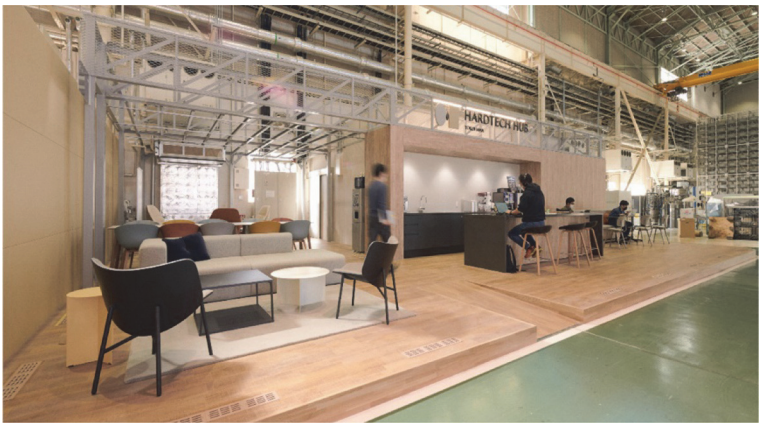

Figure 11 Co-creation space that Yokohama Hardtech Hub operates for

At YHH's space for co-creation, you can actually try out and test the idea or directly operate the prototype. The stakeholders visiting the place are diversified, including local government bodies and academic institutions. The resident companies including MHI can have the opportunity to utilize the networks of these stakeholders, which leads to the discovery of an unexpected application. With such extensive and complex networking taking place through the co-creation platform, YHH has also started to play a role as a place to accelerate the process of a new business project from PoC* until social implementation.

*PoC: Proof of Concept

6. Conclusion

This report describes the framework of MHI FUTURE STREAM with a medium- to long-term perspective to create value for future society, the direction in which MHI Group should advance in response to the medium- to long-term changes expected in the business environment,

the challenge of creating new value through combinations and ecosystem creation, and efforts to form a network of individuals with ideas and enable small-and-speedy tryouts.

In order for MHI Group to deal with the uncertainty surrounding its business environment and help society achieve sustainable growth in harmony with nature, the importance of MHI FUTURE STREAM activity will increase. Without confining ourselves to conventional business domains, we will make use of internal/external networks in various business areas to work toward co-creation and exploration and continue to transform ourselves for the better.

References

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(2) The biggest industry in 2050 will be Cultivation of Human Resources, Japanese business biweekly, ZAIKAI Co., Ltd., (2021/9)
(3) MHI FUTURE STREAM "MHI FUTURE STREAM" – Creating Group's Future, Mitsubishi Heavy Industries Technical Review, Vol57 No.1 (2020)
(4) Carbon Neutrality Briefing, Mitsubishi Heavy Industries, Ltd., (2022)