Research and Development (R&D)

R&D activities at Yokogawa are classified into two types. Firstly, product development and applied research activities are geared to meeting customer needs and target a relatively foreseeable future. Secondly, innovation activities are conducted from a longer-term perspective, involve greater uncertainty, and are directed toward the identification and generation of new business opportunities. Whereas business headquarters are mainly responsible for the former, the latter is primarily the task of the Innovation Center.

The mission of the Innovation Center is twofold:
1. Research and develop new technologies that complement those of each business headquarters and address customer issues, leading to expansion of the business scope.
2. Prepare for an uncertain and unpredictable future and open a path to the creation of new businesses by working with customers to uncover latent issues and find ways of addressing them.

R&D structure at Yokogawa

By engaging in innovation activities, Yokogawa not only provides systems but also creates technologies and solutions together with customers that prompt them to change their perspectives and approaches. The innovation process consists of three concentric layers as shown in the figure below. The outermost layer, consisting of information from the field and signs of change obtained by scanning the external environment, such as markets and customers, is reflected in standardization, intellectual property and open innovation, which constitute the second layer that supports innovation activities, the innermost layer. In innovation activities, we generate ideas, refine them through R&D and incubate them. Repeated execution of these three stages leads to commercialization.

1 Ideation stage
We acquire insights into the future through the use of methodologies such as scenario planning and scanning. Based on scenarios that assume shortages of food, energy, and water will occur in the near future, the Innovation Center has elected to focus on biology, energy, and materials, and is coming up with ideas for activities that can be carried out in these fields.

2 R&D stage
We identify and then refine promising research themes from the various possibilities that emerge at the ideation stage. At this stage, researchers whose duties normally focus on the R&D of new technologies also examine the feasibility of the identified research themes, analyze markets, and, if necessary, engage in cultivation of markets.

3 Incubation stage
When an R&D project reaches an advanced stage and the goal comes into sight, the incubation stage starts. At the incubation stage, researchers develop a strategy with support from sales and marketing operations for commercialization. Then, a demonstration is conducted in collaboration with the customer to ascertain whether the developed solution offers value. If it does, the project proceeds to the commercialization stage.
Yokogawa’s Solutions

Case 1
Biological Contamination Management

To ensure food safety, companies have been recommended to introduce Hazard Analysis and Critical Control Point (HACCP) systems. Although such systems are entering wide use, the number of food recalls and food poisoning cases due to foreign substances and microbial contamination remains high. A particular drawback is that it takes too long to test for microbial contamination, so feedback cannot be provided to the food manufacturing process in a timely manner. Yokogawa advocates a simple and fast genetic testing method that utilizes a highly sensitive fluorescence measurement technology and a newly developed label-free gene analysis device. This can quickly identify microbial contamination in foods, beverages, and other products. As such, Yokogawa believes it can be a great help to food manufacturers in reducing operating costs. Yokogawa is currently developing a prototype of this system that can easily detect microorganisms in food, and is conducting proof-of-concept experiments using real foods and beverages. For the core gene analysis process, the type of analysis will vary depending on the design features of the detecting probe. This technology makes it possible to instantly determine the presence of microorganisms, and it can also be applied in counter-bioterrorism applications and to prevent disease outbreaks.

Case 2
Solutions for Optimizing Operations

Cost-reduction potential

At production sites, skilled engineers are able to achieve high facility utilization rates by using their five senses to detect unusual noises, vibrations, and the like at an early stage, and thereby identify equipment maintenance issues that need to be addressed. In recent years, however, a decrease in the number of such skilled engineers has become an issue. To resolve this issue, Yokogawa has made use of machine learning to develop an algorithm that has a similar analytical capability as well as an edge computing system that is suitable for installation at production sites. By combining the results of this quantitative analysis with the maintenance and failure records for specific production sites, it is possible to grasp the condition of equipment and make intelligent predictions. To save energy and enhance efficiency in manufacturing plants, one approach has been to make design changes to equipment so that it operates more efficiently. In recent years, there has been a growing need to improve the operation of entire systems on a process, site, or regional basis. Total optimization requires the linking of equipment and plants, and the calculation of an optimal operation plan for each component of a system. As a result of advances in data processing technology and IoT systems, the foundation necessary for the effective utilization of operation data and the linkage of processes has been established; however, the process of creating the models needed for these calculations can be very time consuming and costly. To resolve this issue, Yokogawa has developed data-driven modeling and high-speed optimum scheduling technologies. By deploying these technologies to assess the potential effectiveness of solutions that improve operations and by providing consulting on the seamless implementation of the PDCA cycle covering everything up to the verification of the effectiveness of individual measures, we aim to discover problems in operations and create value.

Case 3
Use of Machine Learning and Edge Computing in Equipment Condition Analysis

To save energy and enhance efficiency in manufacturing plants, one approach has been to make design changes to equipment so that it operates more efficiently. In recent years, there has been a growing need to improve the operation of entire systems on a process, site, or regional basis. Total optimization requires the linking of equipment and plants, and the calculation of an optimal operation plan for each component of a system. As a result of advances in data processing technology and IoT systems, the foundation necessary for the effective utilization of operation data and the linkage of processes has been established; however, the process of creating the models needed for these calculations can be very time consuming and costly. To resolve this issue, Yokogawa has developed data-driven modeling and high-speed optimum scheduling technologies. By deploying these technologies to assess the potential effectiveness of solutions that improve operations and by providing consulting on the seamless implementation of the PDCA cycle covering everything up to the verification of the effectiveness of individual measures, we aim to discover problems in operations and create value.

Activities Supporting the Innovation Process

- **Standardization** Standardization has an important bearing on our global competitiveness. Yokogawa participates as a member of international standards organizations such as the International Electrotechnical Commission (IEC) and the International Organization for Standardization (ISO).

- **Open Innovation** With the aim of achieving the targets set out in the new mid-term business plan and the long-term business framework, Yokogawa is vigorously promoting collaboration with other parties that are working on promising technologies. Through the formation of strategic relationships and collaboration with partners all over the world, including universities, research institutes, and start-ups, we are working to deliver superior value to our customers.

- **Intellectual Property Strategy**: Aiming for Global Competitiveness Based on its business plans, Yokogawa is pursuing a strategy that strengthens the Company’s business foundation and improves its global competitiveness by creating intellectual property and vigorously filing patent applications, both in Japan and other countries. When required, the Company also acquires intellectual property from other parties to accelerate the pace of its development efforts and the delivery of value to customers.

<table>
<thead>
<tr>
<th>Yokogawa’s intellectual property rights (as of March 31, 2018)</th>
<th>In Japan</th>
<th>Outside Japan</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Registered</strong></td>
<td><strong>Pending</strong></td>
<td><strong>Subtotal</strong></td>
<td><strong>Registered</strong></td>
</tr>
<tr>
<td>Patents</td>
<td>1,945</td>
<td>396</td>
<td>2,341</td>
</tr>
<tr>
<td>Designs</td>
<td>115</td>
<td>3</td>
<td>118</td>
</tr>
<tr>
<td>Trademarks</td>
<td>362</td>
<td>11</td>
<td>373</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2,422</td>
<td>410</td>
<td>2,832</td>
</tr>
</tbody>
</table>