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How to Prevent Cords and Cables from Getting Entangled: A Study of Systematic Classification of Various Solutions

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Abstract

Cords and cables often cause troubles by getting complex and entangled, around appliances at home, around PCs at offices, around equipments in labs, etc. The present study started to think of methods of preventing cords and cables from getting entangled. Since the problem lasts so long and spreads so widely, there must be a lot of different solutions known and used in the world, we thought. Thus we first searched for various methods, tools, devices, equipments, etc. which are used for such a purpose, at home, at offices, at hardware stores, at PC shops, etc. Then we classified all these cases, in a bottom-up manner, into a hierarchical system of methods expressed in the functional terms.

Then we reorganized the system of solutions by introducing step-wise expanding scopes of the target system. A system of solutions has been found, namely: (A) As for a cord or cable, to adjust its length so as not to get entangled. (B) As for multiple cords or cables, to bundle them, to combine and unite them. (C) As for the connecting parts between devices and cords/cables, to standardize them for easy connection and disconnection and to use simple connection modules. (D) As for the system containing devices and cords and cables, to reorganize the devices in their functions, structures, methods, and arrangements, and to set and store cords and cables in appropriate places. Significance of this sort of study of classifying solutions is discussed.

1. Introduction

It is often seen that cords and cables get messy and entangled around PCs, TV and audio sets. To think of some methods for preventing such messy, entangled situations is the motive of the present study.

This topic was proposed by Tomoyuki Itoh in early summer in 2006 as a subject for his thesis work at Osaka Gakuin University. In Nakagawa's seminar class in the Faculty of Informatics, we choose "Thinking Methods for Creative Problem Solving" as the main, common subject and give training of TRIZ (Theory of Inventive Problem Solving) and USIT (Unified Structured Inventive Thinking). Students are advised to find some concrete problems to solve and are requested to write a thesis individually after the group work of trying the problems in the class.

On this topic, it could be an approach, of course, to try to solve the concrete case of problem, i.e. the cords and cables getting entangled around his own desktop PC at home, and to find some concrete solutions or to make new devices. But we did not choose this approach.

Since we know that the problems caused by cords and cables getting messy and entangled can be seen everywhere, we have chosen in the present study an approach to think over this universally spread problem and to try to find solutions in a much wider scope.

The problematic situations of cords and cables getting messy and entangled can be seen everywhere in the kitchen, in the offices, in the labs, in the factories, inside equipments, etc. The problem has occurred for many decades and everywhere in the world. Thus, people must have tried various methods and made quite different devices. So if we look around closely, we will be able to find a variety of solutions. Hence it must be more useful to survey in a wide scope and to think generally of the whole space of solutions than to try to find individual specific solutions.

Thus the task of the present study is to collect as many methods, devices, materials, and products as possible used in the world for the purpose of preventing cords and cables from getting messy and entangled and to organize them by category.

In which way to organize those solutions is the focus of the present study. We have decided to organize those different solutions from the viewpoint of methods, i.e. to classify them in the functional representations.

A deeper aim of the present study is to discuss what kind of knowledge we can get from such a system and what kind of suggestions for new solutions we can obtain.

Classification is a basic means for systematization. Clarifying the viewpoints of classification is a way to reveal the solution system. Viewpoints of classification need to be hierarchical and multi-dimensional, in the sense that the detailed level of classification requires another

new viewpoint. Thus the viewpoints of classification and the items obtained in the classification reveal the new viewpoints of solution methods and new further specified ideas.

We describe below that TRIZ and USIT have enabled the introduction of new viewpoints into the classification and resulted in deeper understanding of the solutions.

2. Collecting Examples of Solutions

In the present study we started to observe and collect various methods applied for the purpose of preventing the cords and cables from getting messy and entangled, and to collect their concrete items, such as devices, materials, and products.

The survey is found effective at the following places:

- at home, in the living room, study room, kitchen, etc.
- at offices
- PC rooms, laboratories,
- shops of electric and IT products,
- do-it-yourself store, hardware store,
- in the factories,
- inside the rack housing and chassis

'Cords and cables' in the present paper mostly mean some kind of wires having metal cords (inside) and transferring electricity and signals. Since the words of cords and cables are used in various items in the interchangeable way, we use them here without distinction.

As the survey went on, we understood that we should better think of the target objects wider than the original restriction of 'cords and cables'.

For example, wires, ropes, strings, threads, tubes, hoses, and pipes have similar problems of getting complex and entangled, even though they have different features from cords and cables due to differences in materials, shapes, and sizes. Thus various practices of using these similar things are of some help for reference. For example, fishermen release the ropes of fishing nets rapidly without getting them entangled, and firefighters handle the water hoses in a compact manner.

Similarly, gardeners support the stems of flowers and also bundle many of them; the tasks they do have features common to the present one. Hence, not only the electric and communication fields which we can easily associate with cords and cables but also many other fields can provide us examples of solution ideas and solution items for our problem.

For each case of examples, we have collected the real item, its photo, photos in use and recorded the observation. We tried to accumulate them in cards and in files.

Next we tried to observe each case closely and discussed: In which situation and for which target objects the method or the item is used; how the item/device/material works; what kind of structure, shape, and material does it have; what merits, restrictions, and demerits does it have; how is it improved further; etc.

3. Preliminary Consideration for the Classification and Systematization

The collection and classification of these cases of examples were carried out in the following way, where some backtracking processes are omitted.

3.1 What Is the Problem?

According to the USIT process of problem solving, we have to clarify first what is really the problem, or undesirable effects. We may list up the followings:

"Cords and cables get messy and entangled around devices"

- Difficult to recognize the connecting relationships among the devices
- Difficult to manage, maintenance, exchange, etc.
- Using unnecessarily-long cords and cables
- Causing leakage of electricity, and burning
- Taking space unnecessarily and wastefully
- Looking messy, untidy, unclean

The problem situation may be sketched as illustrated in Fig. 1.

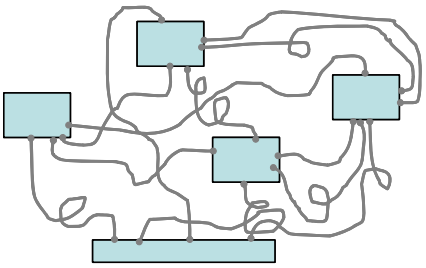

Fig. 1. Problem situation of entangled cords and cables

Thus the task we need to solve is represented in general terms as 'to prevent cords and cables getting messy and entangled around devices', and it contains a number of sub-tasks as mentioned above.

3.2 What Are the Causes of the Problem?

The causes of the problem described above are multi-folded in the following way:

- There are many devices involved.
- They need to be connected with many cords and cables.
- It is necessary to remove, add, and replace the devices from time to time.
- It is necessary to move the devices from time to time.
- There are a variety of devices and different sorts of cords and cables.

- It is necessary to be prepared for the future change in the system.
- Cords and cables must not be disconnected or unlinked.
- Cords and cables are longer than they are needed.
- Cords and cables gather at some places.
- Cords and cables get entangled in a complex way.

3.3 Organizing Various Solution Methods in a Bottom-up Manner

Obtaining a number of cases of solutions, we first tried to organize them in a bottom-up manner with the functional expression of Action-Object. At the stage of the thesis written by Tomoyuki Itoh [1], the solutions at the first hierarchical level were:

- Eliminate the property of cords and cables getting entangled easily.
- Make the length of cords and cables adjustable.
- Wind up the cords and cables.
- Fold up the cords and cables.
- Bundle several cords and cables together.
- Unite several cords and cables together.
- Set and fix the cords and cables after setting positions of the devices.
- Rearrange the cords and cables.
- Connect the devices and cords/cables in modules.
- Hide the cords and cables from sight.
- Remove the cords and cables.
- Use different shapes.

Below these first-level categories, we have many lower-level categories.

Since these are categorized empirically in the bottom-up manner, the classified system has as many as 12 items at the first level of hierarchy and leaves some doubts in their quality of systematic and comprehensive coverage of solutions.

3.4 Introduction of Basic Viewpoints by Simplifying the System

Thus, for making the results more persuasive, we have found the need of introducing some basic viewpoints in the classification of solutions. So we introduced the system thinking, i.e. to build up the system with simple base elements. We have introduced the four-stage scopes to understand the system, in the following way.

Scope A. A single cord or cable (connecting two devices)

Scope B. Multiple cords or cables (connecting several devices)

Scope C. Connection parts between devices and cords or cables (in the system of multiple devices and multiple cords and cables)

Scope D. A system of multiple devices connected with multiple cords and cables.

In the above descriptions of A to C, it is important that we do not pay attention to the items written in ( ). Namely, in the Scope A, we consider only a single cord or cable and try to find some solutions on it, for the purpose of preventing the cords and cables from getting messy and entangled in complex systems.

Let us demonstrate the step-wise thinking in the followings:

Scope A. A single cord or cable

Figure 2 illustrates the Scope A, the first stage, of the problem situation and schematically shows the directions of solutions. The devices are shown with broken lines because we pay no attention to them.

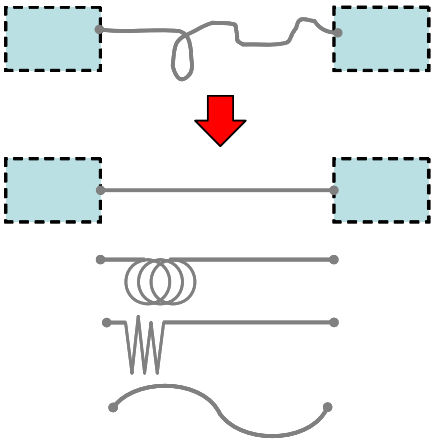

Fig. 2. Scope A: A single cord or cable, together with directions of solutions

The solution directions on a single cord or cable are to make it adjustable in the length, eliminate its extraneous part, and prevent it from getting entangled. For achieving the goal, we may make the cord/cable expandable and shrinkable, wind it up, and fold it up, etc. It is another solution to eliminate the property of easily getting entangled. There is still another solution to replace a long cord/cable with a shorter one; however, this solution implies the easy connection/disconnection of cord/cable with the devices, and hence is considered in the Scope C.

Scope B: Multiple cords and cables

The second scope regards multiple cords and cables as the target objects in the system containing multiple devices. The problem situation and the solution directions in the scope are illustrated in Fig. 3.

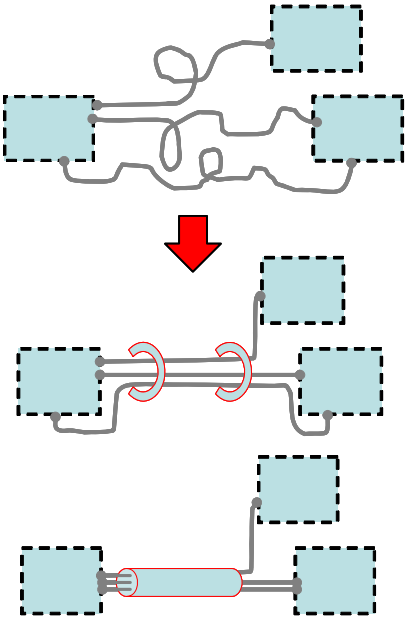

Fig. 3. Scope B: Multiple cords and cables, together with solution directions

The main solution direction in Scope B is to bundle multiple cords and cables running near and in parallel (or anti-parallel). This basic solution is applicable at a place, at multiple places of the cords/cables, and for a certain distance along the cords/cables, and further in the form of combining multiple cords and cables into a multiplex cord/cable.

Here we may also have other solutions, such as to fix the bundled cords/cables at a place, and to rearrange the positions of cords and cables. These solutions, however, are categorized in Scope D, because rearranging the positions of all the devices and cords/cables in the system is the scope more appropriate for it.

Scope C. Connection parts between devices and cords/cables

The third scope is focused at the connection parts between a device and a cord/cable. By achieving the easiness of connection and disconnection in these parts, we may try to solve the problems. Figure 4 illustrates the scope and the corresponding solution directions.

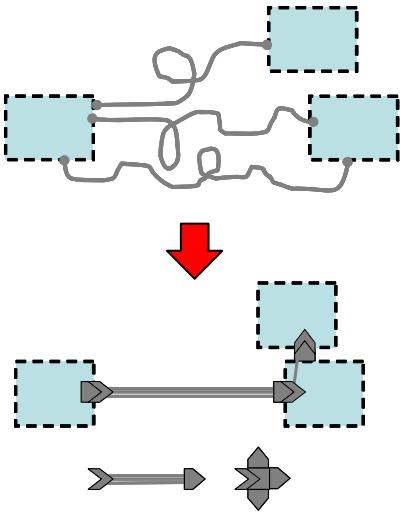

Fig. 4. Scope C: Connection parts between devices and cords/cables, together with the solution directions

The basic solution concept in this scope is to make the connection parts between devices and cords/cables standardized, easy to connect and disconnect, and easy to replace the devices and cords/cables on any request. The connection parts are commonly known as connectors, and have been standardized and improved for many years. It is a general solution direction to compose the system in a modular manner by using such standardized connectors so as to make the system flexible and extensible. In this scheme, it is also widely known to use small devices specialized for connecting functions and supplemented with some additional functions such as switching and multi-branching.

Scope D: A system composed of multiple devices and multiple cords/cables

So far we have focused our attention to a single or multiple cords/cables and to the connection parts; they are parts of a system. The fourth scope handles the whole system of the problem. The problem situation and the solution directions in this scope are illustrated in Fig. 5.

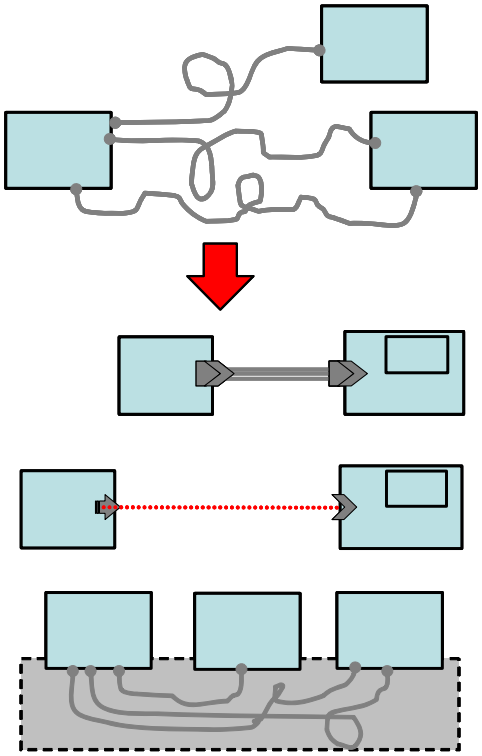

Fig. 5. Scope D: A system with multiple devices and multiple cords/cables, together with the solution directions

Either after trying to solve the problem in the scopes A to C or prior to but assuming the afterward trials of problem solving in the scopes A to C, we try to solve the problem in this scope D by examining the devices in their functions, structures, spatial arrangements, etc. and accordingly by deciding/modifying the overall arrangements of cords and cables.

The general solution direction in this scope is first to reexamine the devices of the system in the problem from the aspects of their functions, structures, and spatial arrangements, etc. Sometimes it is recommended to merge or unite a device with another, and some other times to divide a device into multiple ones and to take out a part of a device. There are other cases that the whole system of multiple devices is reorganized and recomposed into a new one and that the whole system is made into a movable unit.

Another important viewpoint in this scope is to change the scheme of connection with cords and cables. A focus in the current technology is the wireless connection using radio waves, infrared rays, etc. and thus eliminating the objects in the form of cords and cables. Eliminating power cables by use of batteries may be a case of merging devices.

Another typical solution direction is to set and fix the indispensable and complex cords and cables at appropriate places inside or around the system, especially at the places besides/outside the human activities, in such a way that they are non-disturbing, hidden, unseen, and hence as if absent of existence. This solution principle is widely used by setting the cords/cables inside the devices, under or back of the desks, under the floor, over the ceiling, inside the cable/pipe ducts, etc.

4. A System of Solutions for Preventing the Cords and Cables from Getting Entangled

On the basis of the discussion in the previous section, we have reorganized the cases collected so far and added newly and have built a system of solutions for preventing the cords and cables from getting entangled. The result is shown in Table 1, at the end of this paper.

As the results of the step-wise consideration of the scope of the problem, the solution system shown in the table has much clear positioning of various solution ideas and is more systematic and comprehensive than the previous bottom-up study. Even though all these solution directions are already known and widely used, the present study has its significance in the understanding of such solutions in the general scheme of preventing the cords and cables from getting entangled. We will point out a number of significant solution directions in the followings.

(A) A single cord or cable: To adjust the length and prevent from getting entangled

'To expand and shrink' (A1) is realized in the form of spiral telephone code, imitating the rubber structure in a macro scale, but with not so large expansion ratio. To use longer and shorter cords/cables in the interchangeable way is categorized in (C1), because the solution assumes smooth connection and disconnection with standardized connectors.

It is more practical to store the extra portion of cord/cable in a compact manner. Winding-up (A2) and folding-up (A3) are the solutions used commonly. Since cords and cables containing thin metal wires can not be bent sharply, folding-up the cords/cables does not give a neat structure. Thus winding-up is used more often. However, when the cords/cables are coiled like a snake, they are twisted and this causes a trouble in handling long cords/cables. Thus, it is a normal method for thin cords/cables to catch one at the middle of the length and wind it up towards both ends simultaneously in a flat manner.

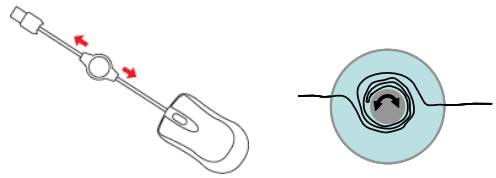

Fig. 6. Winding-up the cord/cable. An example and its inner structure

Another good method is to wind up the cord/cable in the form of character '8'. This method is used in storing the fishing-net ropes and applicable to even thick cords/cables which do not bend nor twist so much. This method is used manually, but I have not seen any compact automatic device applying this method.

(B) Multiple cords and cables: To bundle, to combine, and to unite

The most common way to handle multiple cords and cables is to bundle them and keep them together (B1). Since this method is easy and useful, various types of devices (mostly in some form of belts) are produced and used. Not only bundling the multiple cords/cables at a place or at several places, but also bundling them along a certain distance (B2) is often useful.

An interesting tool in this category is a spiral belt made of plastic with elasticity (See Fig. 7). Since the spiral is not closed, it can be installed at the middle of multiple cords/cables, and the size of the bundle and the length of bundling can be adjusted as desired.

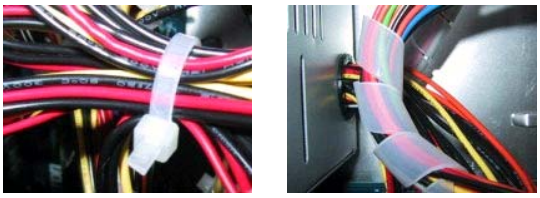

Fig. 7. Examples of bundling cords and cables

It is also important to combine multiple cords and cables into a single united cord/cable (B3). Two wires for power supply are usually attached side by side, and are handled as a single (composite) cord/cable. Several tens of signal cables are attached side by side forming a belt, which is used in the PC cabinet, etc. Furthermore, there are many cases of composite cords/cables containing a number of inner cords/cables and sometimes a number of inner layers of different functions. The case of USB cable is suggestive in the point that it contains not only signal cables but also power supply cables.

(C) Connection parts between devices and cords/cables: To use standardized connectors and connection modules

To use standardized connectors at the connecting parts between the devices and cords/cables (C1) is of course a widely used solution. To attach connectors to the devices and to the both ends of cords/cables (C2) is the solution at the next step. According to this solution, it becomes easy to replace devices and to use cords/cables of appropriate lengths so that the cords/cables can be arranged neatly.

On the basis of these connectors, different kinds of modules specialized for connecting functions and further incorporated with various additional functions (C2) have been made and used. For example, the power strips may have the functions of multi-branching, switching (On/Off), surge protection, etc.

Fig. 8. An example of multi-branching connection module

These modules should have varieties and flexibilities in their spatial arrangement of structure (C3) for their practical use.

(D) System: To reorganize the devices and to store the cords/cables in and around the system

This is the fourth step approach where we examine the whole system containing multiple devices and many cords and cables. Instead of the simple approach to preventing the cords and cables from getting entangled, one may take an approach of improving the system in its basic principle, and then the problems of cords and cables may be solved at their root causes.

The multiplexing telecommunication, where multiple channels are transmitted through a single cable, is an example of this category (D1). It is recommended to set and fix the principal devices in the system and then to optimize the arrangement of cords and cables (D2). After deciding the arrangement of cords and cables in the system, one may fix the cords and cables at some critical positions (D3).

Introducing wireless communications and eliminating the needs of cords and cables (D4) is the current trend of technological evolution.

After applying various means described so far to solve the problem, we often meet the situations where we still

have many cords and cables arranged in a complex/confusing manner. In such situations, it a common practice to rearrange and store the cords and cables in the places such as inside the chassis/racks, under or behind the desks, under the (free-access) floor, etc., so that they are hidden without giving disturbances (D5).

5. Discussion

5.1 Significance of Systematic Classification

As we have described so far, the present study has addressed the task 'how to prevent cords and cables from getting messy and entangled' and clarified a system of solutions to the initially vague problem. We have adopted the processes, i.e., collecting various examples of solutions, classifying them in a bottom-up manner, introducing the problem-solving approach, clarifying the scopes of analysis, expanding the analysis scope step by step, and constructed a hierarchical system of solutions in the top-down manner.

One of the benefits of having built such a system of solutions is the possibility of understanding the directions of various relevant technological evolutions in a systematic way. On the basis of such understanding, when we meet new interesting products we will be able to see their essence better. And such understanding will give us strong support for us to think of new solutions to our problems.

For example, a power strip is a device for transmitting the power from a power source, e.g. on the wall, through a cable and providing multiple power sources by branching. If we used multiple cables from the original power source to individual devices, such cables could get messy and entangled. Thus we use only one cable to a common place near the devices, and then make multiple branches of cables. This is a well understood solution idea. We can now understand that the different devices shown in Fig. 9 have the same simple idea in their essence.

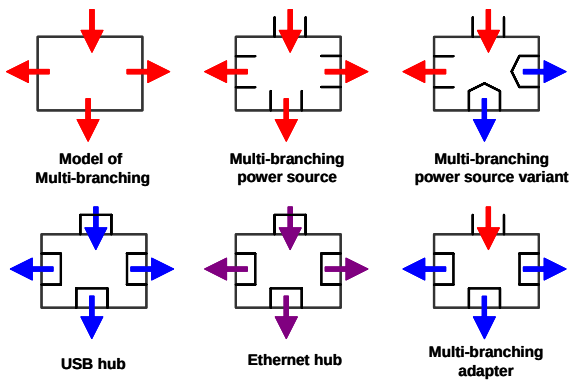

Fig. 9. A connection module with multiple branching: a model and its different examples

5.2 The Root Causes of the Problem

You may notice that various solutions listed up as 'the methods for preventing cords and cables from getting messy and entangled' in the present study are rather well known as a common sense. For example, the basic solution directions at the second level (A1, B2, etc.) in Table 1 are well known. And in the markets we can find a large number of concrete products mentioned here. Nevertheless, we see everywhere the problematic situations of cords and cables got entangled. Why not solved?

For example, one of the most basic solution directions (C1 and C2) tells us that we should better use shorter (i.e. not unnecessarily long) power cord and extend it whenever necessary by use of standardized connectors and extension cords.

On the connectors we pose many contradictory requirements: The fundamental requirement is the easy connection. Electricity or signals must be transmitted surely through the connectors and without risks of erroneous connection. However, at the same time, connectors must be easy to disconnect. Nevertheless, connectors must not get disconnected without intended operation. Connectors must be concrete products, fulfilling all these contradictory requirements in the compact body with inexpensive cost.

Connectors for ordinary power cords are designed with various considerations and improvements, and yet have some defects of not fulfilling some points of requirements. Thus it is the common sense that one should not use the connectors in the middle of cords/cables without absolute necessity.

Most of devices provide the power cords of 2 to 3 m in length. Under the situations of ordinary setting up, most of the cords have the slack of 1 to 2 m; this extraneous length is the main cause of getting entangled. To move the device for maintenance, we need the slack. To rearrange the positions of devices, we need the slack. For the cases of being far from the power source on the wall, we need the slack. Considering different situations of customers, we need the slack.

Under these considerations, the power cords of various devices are sold having the length of 2 to 3 m. We seldom see shorter cords having usually-sufficient length of 1 to 2 m. For the shorter cords, we need some extension cords from time to time; however, we cannot have any guarantee that the extension cord is available (either being provided or carrying around) whenever necessary. This causes a serious problem in such an unfortunate occasion.

After all, people have chosen to use the cords/cables somewhat longer than the usually-sufficient length, for the consideration of future, though not so large, possibility of needs. Such choices result in the extraneous lengths of

cords and cables, which provide the root causes of many cords and cables getting entangled everywhere.

5.3 Usage of TRIZ/USIT Way of Thinking

The present paper is not a case study of using concrete tools in TRIZ and USIT, but is a case study of using the ways of thinking in TRIZ and USIT. You may see such ways of thinking in the followings:

- Collecting a large number of examples of solutions first, extracting essence of solution ideas of them, and further systematizing the solution principles. -- This is the fundamental approach in TRIZ.
- What is the problem? and what are the root causes of it? -- These questions are the usual starting points of TRIZ and USIT.
- Various solution ideas are searched for and considered with abstract thinking with emphasis on the functions. -- This is a characteristic approach in TRIZ and USIT.
- The scope of analysis is extended step by step as: (A) a single cord/cable, (B) multiple cords/cables, (C) connection parts, and (D) a system with multiple devices and multiple cords/cables (and further the system's environment). -- This stems from the system's thinking in TRIZ and USIT.
- Various solution ideas are backed up by the Inventive Principles in TRIZ.
- At the lower hierarchical levels of the solution system, considerations on attributes of solution items, such as shapes and material properties, are fully used. -- Thinking in terms of attributes is also typical in TRIZ and USIT.

At the end of this paper, we would like to mention the insufficiency of our study in the point that we did not carry out the surveys of references, patents, and know-how even though there must be abundant knowledge in the world and some portions of them must be documented already. Not the individual solutions to the present problem but the way of revealing the solution space in a systematic way is the target of the present study.

References

[1] "A Case Study of Creative Problem-Solving Thinking: How to Prevent Cords and Cables from Getting Entangled", Tomoyuki Itoh, Thesis, Faculty of Informatics, Osaka Gakuin University, January 2007. (in Japanese)

A System of Solutions for Preventing Cords/Cables from Getting Messy and Entangled

A. A single cord or cable: To adjust the length and prevent from getting entangled

A1. To expand and to shrink for adjusting the length

like a telescope, like a rubber, like a spiral telephone cord

A2. To wind up for adjusting the length

in a spiral, in a winding-up carton, around something, in the form of character 8

A3. To fold up for adjusting the length

folding and binding, in an accordion style

A4. To eliminate the property of cord/cable being easy to get entangled

no local bending, no twisting

B. Multiple cords and cables: To bundle, to combine, and to unite,

B1. To bundle multiple cords and cables at a place

The bundle held with twisting, with tying, with hooking, with fixing in a hole, with adhesion, within a frame,
The bundle held with elastic closure, with an elastic spiral belt, with a winding tape

B2. To bundle multiple cords and cables along a certain distance

Within a fame, with an elastic spiral belt, with a winding tape

B3. To combine multiple cords and cables into a single united cord/cable

By braiding, by winding each other, by attaching side by side,

By forming a new united cord/cable, such as a composite cable, a multiplex cable

C. Connection parts between devices and cords/cables:

To use standardized connectors for easier connection/disconnection, and to use specialized connection modules

C1. To use standardized connection parts between devices and cords/cables for easier connection/disconnection

At the connection parts of the devices

At the ends of cords and cables

C2. To use modules specialized for connecting function and containing some additional functions

Additional with on/off, with root switching, with multiple branching, with an adaptor, with a filter, with twist elimination

C3. To use different shapes and spatial arrangements in the connection parts and the connection modules

With vertical or horizontal shape, with straight or bent shape, with flexible shape

D. A system of multiple devices and multiple cords/cables:

To examine the devices in their functions, structures, schemes, and to store cords/cables in or around the system

D1. To examine the functions and structures and to consider merging, uniting, dividing, taking out, etc. of the devices

Uniting the devices into a new device using fewer cords and cables (e.g. multiplex communication)

D2. To reorganize and optimize the arrangements of devices and cords/cables

D3. To reorganize the arrangements and fix the cords and cables at their places

By reorganizing according to their paths, by setting the devices and paths in the 3D space

By fixing inside the devices, in the system, in the environment (desk, floor, wall, ceiling, etc.)

D4. To eliminate the cords and cables

By embedding the cords/cables in the base, by combining multiple devices into one, by using batteries

By using wireless communication between the devices

D5. To hide the complex cords and cables at some appropriate places

Inside the chassis, in a box, under or behind the desk, over the head

Under the (free-access) floor, over the ceiling board, inside the ducts, inside the piping trench