United States Patent	12393188
Kind Code	B2
Date of Patent	August 19, 2025
Inventor(s)	Adisaw; Rini et al.

Device for assisting equipment restoration work and method for generating equipment restoration work assist information

Abstract

A restoration work information storage unit stores a work item for restoration that is set for each location at which an abnormality is expected to occur in equipment to be managed, and priority information indicating a priority of execution for each of the work items. Upon detecting that an abnormality has occurred in the equipment and an operation of the equipment has been stopped, a restoration assist information generation unit generates restoration assist information, in which the work items for restoring the equipment are arranged in the order of execution according to the priority information, based on information of a location at which the abnormality has occurred. Upon detecting that a state of any location in the equipment has changed before a restoration work based on the restoration assist information is completed, a restoration assist information update unit updates the restoration assist information.

Inventors: **Adisaw; Rini (Kanagawa, JP), Watanabe; Katsumi (Kanagawa, JP)**

Applicant: **AMADA CO., LTD.** (Kanagawa, JP)

Family ID: **1000008765945**

Assignee: **AMADA CO., LTD. (Kanagawa, JP)**

Appl. No.: **18/013122**

Filed (or PCT Filed): **July 05, 2021**

PCT No.: **PCT/JP2021/025300**

PCT Pub. No.: **WO2022/009832**

PCT Pub. Date: January 13, 2022

Prior Publication Data

Document Identifier	Publication Date
US 20230244222 A1	Aug. 03, 2023

Foreign Application Priority Data

JP	2020-116799	Jul. 07, 2020

Publication Classification

Int. Cl.: **G05B23/02** (20060101)

U.S. Cl.:

CPC **G05B23/0289** (20130101); G05B2223/02 (20180801)

Field of Classification Search

CPC: G05B (23/0289); G05B (2223/02); G05B (23/0286); G06Q (10/06312); G06Q (10/20); G06Q (10/06311)

References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
2010/0299172	12/2009	Nottoli	705/29	G06F 3/0483
2014/0198630	12/2013	Nof	370/216	H04L 45/28
2014/0297354	12/2013	Kogiso	705/7.26	G06F 9/46
2016/0133070	12/2015	Ikeda	701/31.4	G07C 5/0808
2016/0334800	12/2015	Han	N/A	G05D 1/0274
2019/0235502	12/2018	Lindsey	N/A	G05D 1/46
2019/0367190	12/2018	Bewlay	N/A	B64F 5/60
2020/0151676	12/2019	Mitchell	N/A	H04W 4/029

FOREIGN PATENT DOCUMENTS

Patent No.	Application Date	Country	CPC
10-097317	12/1997	JP	N/A
2002-224762	12/2001	JP	N/A
2011104658	12/2010	JP	N/A
2012164120	12/2011	JP	N/A
2017175611	12/2016	JP	N/A
2019-28556	12/2018	JP	N/A
2020-102221	12/2019	JP	N/A

OTHER PUBLICATIONS

Extended European Search Report for corresponding EP Application No. 21838283.6 dated Nov. 22, 2023. cited by applicant

International Search Report for corresponding Application No. PCT/JP2021/025300, mailed Sep.

14, 2021. cited by applicant
Written Opinion for corresponding Application No. PCT/JP2021/025300, mailed Sep. 14, 2021. cited by applicant

Primary Examiner: Poudel; Santosh R

Attorney, Agent or Firm: Renner, Otto, Boisselle & Sklar, LLP

Background/Summary

(1) This application is a national phase of International Application No. PCT/JP2021/025300 filed Jul. 5, 2021, which claims priority to Japan Application No. 2020-116799 filed Jul. 7, 2020, each of which is hereby incorporated herein by reference in its entirety.

TECHNICAL FIELD

(2) The present disclosure relates to a device for assisting equipment restoration work and a method for generating equipment restoration work assist information.

BACKGROUND ART

(3) When an abnormality occurs in automatically operated equipment and the operation thereof is stopped, a restoration work is necessary to restore the state to an operable state again. Work items and work procedures necessary for the restoration work differ depending on the equipment and the occurrence situation of the abnormality. Therefore, a worker determines the work items and work procedures necessary for the restoration based on his/her knowledge and experience to perform the corresponding work.

CITATION LIST

Patent Literature

(4) Patent Literature 1: Japanese Patent Application Laid-Open Publication No. 2002-224762

SUMMARY

(5) However, when a worker who has little experience in equipment management performs the restoration work, it may be difficult to properly determine the necessary work items and work procedures. Particularly, if the state of any location of the equipment has changed during the restoration work, e.g. if a new abnormality has occurred, it is necessary to grasp an item for which the work has already been completed, an item for which the work has not been completed, and a location at which the abnormality has occurred, and then to rearrange the work items and work procedures to be executed thereafter. Therefore, there is a problem that the processing becomes complicated.

(6) An object of one or more embodiments is to provide a device for assisting equipment restoration work that generate information for assisting a restoration work performed by a worker when an abnormality occurs in automatically operated equipment and the equipment is stopped, and a method for generating equipment restoration work assist information.

(7) According to a first aspect of the one or more embodiments, a device for assisting equipment restoration work is provided, which includes a restoration work information storage unit configured to store a work item for restoration and priority information, the work item being set in advance for each location at which an abnormality is expected to occur in equipment to be managed, the priority information indicating a priority of execution for each of the work items, a state information acquisition unit configured to acquire state information of a predetermined location of the equipment, a restoration assist information generation unit configured to generate, when it is detected that an abnormality has occurred in the equipment and an operation of the equipment has been stopped, restoration assist information, in which the work items for restoring the equipment

are arranged in the order of execution according to the priority information, based on information of a location at which the abnormality has occurred and the information stored in the restoration work information storage unit, and a restoration assist information update unit configured to update, when it is detected that a state of any location in the equipment has changed based on the information acquired by the state information acquisition unit before a restoration work based on the restoration assist information is completed, the generated restoration assist information based on information of the location at which the change has occurred.

(8) According to a second aspect of the one or more embodiments, a method for generating equipment restoration work assist information is provided, which includes storing, by a storage unit, a work item for restoration and priority information, the work item being set in advance for each location at which an abnormality is expected to occur in equipment to be managed, the priority information indicating a priority of execution for each of the work items, acquiring state information of a predetermined location of the equipment, generating, when it is detected that an abnormality has occurred in the equipment and an operation of the equipment has been stopped, restoration assist information, in which the work items for restoring the equipment are arranged in the order of execution according to the priority information, based on information of a location at which the abnormality has occurred and the information stored in the storage unit, and updating, when it is detected that a state of any location in the equipment has changed before a restoration work based on the restoration assist information is completed, the generated restoration assist information based on information of the location at which the change has occurred.

(9) According to the device for assisting equipment restoration work and the method for generating equipment restoration work assist information of the one or more embodiments, it is possible to generate information for assisting a restoration work performed by a worker when an abnormality has occurred in automatically operated equipment.

Description

BRIEF DESCRIPTION OF DRAWINGS

(1) FIG. **1** is a front view showing configurations of a tool changer and a bending machine equipped with a restoration work assist device of one or more embodiments.

(2) FIG. **2** is a block diagram showing a configuration of the restoration work assist device of the one or more embodiments.

(3) FIG. **3** is a flowchart showing processing executed by the restoration work assist device of the one or more embodiments.

(4) FIG. **4** is a diagram showing an example of restoration assist information that is generated or updated by the restoration work assist device of the one or more embodiments.

DESCRIPTION OF EMBODIMENT

(5) As one or more embodiments, a description will be given of a device for assisting equipment restoration work (hereinafter referred to as a “restoration work assist device”) that is connected to a tool changer (ATC) for automatically changing a tool used in a sheet metal bending machine (a press brake) and generates information for assisting a restoration work of the tool changer.

(6) <Configuration of Tool Changer Using Restoration Work Assist Device According to One or More Embodiments>

(7) In FIG. **1**, a tool changer **1** is installed close to a press brake **2** and is communicably connected to an NC device **3** that controls the tool changer **1** and the press brake **2**.

(8) The press brake **2** is a device that bends a workpiece to be processed at a predetermined position, to which an upper table **21** and a lower table **22** that are long in the left-right direction are provided so as to correspond vertically. A punch **23** is attached to the upper table **21**, and a die **24** is attached to the lower table **22**. A processing station **25** is constructed by attaching the punch **23** and

the die **24** so as to form a pair.
(9) At each processing station **25**, when the upper table **21** is lowered while the workpiece is positioned on the die **24**, the workpiece is sandwiched between the punch **23** and the die **24** and bent.
(10) The tool changer **1** includes a punch side finger **11**, a punch side finger sensor **12**, a punch rack **13**, a punch stocker **14**, a die side finger **15**, a die side finger sensor **16**, a die rack **17**, and a die stocker **18**. A restoration work assist device **30** that manages the tool changer **1** is connected to the tool changer **1** via the NC device **3**.
(11) The punch side finger **11** is configured to be movable to and from the press brake **2**, and grips the punch **23** that has been used by the press brake **2** and transports the punch **23** into the tool changer **1**. Further, the punch side finger **11** grips the punch **23** to be newly used and transports the punch **23** to the press brake **2**. The punch side finger sensor **12** detects the operation state of the punch side finger **11**, whether or not there is the punch **23** being gripped, the installation state, and the like.
(12) The punch rack **13** includes a space for storing a plurality of the punches **23**. The punch stocker **14** stores the punch **23**, which is transported from the press brake **2** by the punch side finger **11**, at a predetermined position of the punch rack **13**. Further, the punch stocker **14** takes out the punch **23**, which is to be transported to the press brake **2**, from the punch rack **13** and moves the punch **23** to the punch side finger **11**.
(13) In the same manner, the die side finger **15** is configured to be movable to and from the press brake **2**, and grips the die **24** that has been used by the press brake **2** and transports the die **24** into the tool changer **1**. Further, the die side finger **15** grips the die **24** to be newly used and transports the die **24** to the press brake **2**. The die side finger sensor **16** detects the operation state of the die side finger **15**, whether or not there is the die **24** being gripped, the installation state, and the like.
(14) The die rack **17** stores a plurality of the dies **24**. The die stocker **18** stores the die **24**, which is transported from the press brake **2** by the die side finger **15**, in the die rack **17**. Further, the die stocker **18** takes out the die **24**, which is to be transported to the press brake **2**, from the die rack **17** and moves the die **24** to the die side finger **15**.
(15) As shown in FIG. **2**, the restoration work assist device **30** includes a restoration work information storage unit **31**, a display unit **32** as an output unit, and a CPU **33**. The restoration work information storage unit **31** stores a work item for restoration, which is set in advance for each location at which an abnormality is expected to occur in the tool changer **1**, and priority information indicating a priority of execution for each of the work items. Note that the priority of execution for each of the work items is set in consideration of the work order from the perspective of the structure of the machine. The display unit **32** includes a display screen.
(16) The CPU **33** includes a state information acquisition unit **331**, a restoration assist information generation unit **332**, a display control unit **333**, a work execution status information acquisition unit **334**, and a restoration assist information update unit **335**. The state information acquisition unit **331** acquires operation state information and the like detected by the punch side finger sensor **12** and the die side finger sensor **16** as state information of a predetermined location in the tool changer **1**.
(17) Upon detecting that an abnormality has occurred in the tool changer **1** and the operation has been stopped, the restoration assist information generation unit **332** generates restoration assist information based on information of a location at which the abnormality has occurred and the information stored in the restoration work information storage unit **31**. The restoration assist information includes information in which the work items for restoring the equipment are arranged in the order of execution according to the priority. The display control unit **333** causes the display unit **32** to display the restoration assist information generated by the restoration assist information generation unit **332**.
(18) The work execution status information acquisition unit **334** acquires information indicating an execution status of a restoration work by a worker. Upon detecting that a state of any location in the

tool changer **1** has changed during the restoration work, the restoration assist information update unit **335** updates the restoration assist information, which is generated by the restoration assist information generation unit **332**, based on information of the location at which the change has occurred and the information acquired by the work execution status information acquisition unit **334**.

(19) <Operation of Tool Changer **1** According to One or More Embodiments>

(20) As an operation of the tool changer **1** according to the one or more embodiments, a method for generating equipment restoration work assist information, which is executed by the restoration work assist device **30** when the abnormality occurs in the tool changer **1**, will be described with reference to a flowchart in FIG. **3**.

(21) When the timing of changing the tool of the press brake **2** arrives ("YES" in S**1**), the tool changer **1** executes a tool change process (S**2**). In the tool change process, the punch side finger **11** removes and grips the punch **23** attached to the processing station **25** of the press brake **2**, and transports the punch **23** into the tool changer **1**. Then, the punch stocker **14** stores the punch **23**, which is transported by the punch side finger **11**, in the punch rack **13**.

(22) Further, the punch stocker **14** takes out the punch **23** to be used next from the punch rack **13**, grips the punch **23**, and moves the punch **23** to the punch side finger **11**. The punch side finger **11** changes the punch **23** by transporting the punch **23** to the press brake **2** and attaching the punch **23** to the processing station **25**. In the same manner, the die **24** to be installed to the press brake **2** is also changed.

(23) If an abnormality occurs in the tool changer **1** and the operation is stopped while the tool changing process is being executed in this manner ("YES" in S**3**), information of the state is acquired by the state information acquisition unit **331**. When the information is acquired by the state information acquisition unit **331**, the restoration assist information generation unit **332** specifies a location at which the abnormality has occurred based on sensor information and the like of the respective locations acquired by the state information acquisition unit **331**, and extracts a work item necessary for the restoration work from among the information stored in the restoration work information storage unit **31** (S**4**).

(24) Next, the restoration assist information generation unit **332** rearranges the work items in the order of execution according to the priority information set in the extracted work items, and generates the restoration assist information for assisting the restoration work. FIG. **4**(*a*) is an example of the restoration assist information generated by the restoration work assist device **30**. As shown in FIG. **4**(*a*), the generated restoration assist information includes six work items from a first work item to a sixth work item arranged in descending order of the priority.

(25) Here, the first work item indicates a restoration work of the punch side finger **11** that is executed by moving the punch side finger **11** to a retreated end in the tool changer **1**. The second work item indicates a restoration work of the die side finger **15** that is executed by moving the die side finger **15** to a retreated end in the tool changer **1**. The third work item indicates a work of storing the punch **23** in the punch rack **13** by the punch stocker **14**. The fourth work item indicates a work of storing the die **24** in the die rack **17** by the die stocker **18**. The fifth work item indicates a work of retracting each component to a predetermined standby position. The sixth work item indicates a work of storing the tools on the tables. Specifically, the sixth work item indicates a work in which the punch **23** on the upper table **21** is gripped by the punch side finger **11** and stored in the punch rack **13**, and the die **24** on the lower table **22** is gripped by the die side finger **15** and stored in the punch rack **13**.

(26) The generated restoration assist information is displayed on the display unit **32** by the display control unit **333** (S**5**). The worker recognizes the items of the restoration work and the execution order from the displayed restoration assist information, and starts the work from the first work item "restoration work of the punch side finger **11**".

(27) When the worker performs an operation to start the restoration work of the punch side finger

11, the information of the operation is acquired by the work execution status information acquisition unit **334** and sent to the restoration assist information generation unit **332**. Upon acquiring the information of the operation, the restoration assist information generation unit **332** determines, from the information detected by the punch side finger sensor **12**, an operation state of the punch side finger **11** and whether or not there is the punch **23** being gripped by the punch side finger **11**. Then, based on the determined information, the restoration assist information generation unit **332** specifies a location of a button or the like to be operated in order to move the punch side finger **11** to the retreated end in the tool changer **1**.

(28) The display control unit **333** causes the display unit **32** to display information indicating the specified location. When the worker visually recognizes the displayed information and executes the operation, the punch side finger **11** is moved to the retreated end in the tool changer **1** and the work execution status information acquisition unit **334** acquires execution status information of the operation. Upon acquiring the execution status information of the operation, the work execution status information acquisition unit **334** recognizes that the work related to the first work item has been completed.

(29) Next, when the worker performs an operation to start the second work item "restoration work of the die side finger **15**," the restoration assist information generation unit **332** determines an operation state of the die side finger **15** and whether or not there is the die **24** being gripped by the die side finger **15**, in the same manner as the processing described above. Then, based on the determined information, the restoration assist information generation unit **332** specifies a location of a button or the like to be operated in order to move the die side finger **15** to the retreated end in the tool changer **1**.

(30) The display control unit **333** causes the display unit **32** to display information indicating the specified location. When the worker visually recognizes the displayed information and executes the operation, the die side finger **15** is moved to the retreated end in the tool changer **1** and the work execution status information acquisition unit **334** acquires execution status information of the operation. Upon acquiring the execution status information of the operation, the work execution status information acquisition unit **334** recognizes that the work related to the second work item has been completed.

(31) Here, it is assumed that the punch side finger **11** is displaced from an installation position and a new abnormality occurs ("YES" in S**7**, FIG. **4**(*b*)) when an attempt is made to perform the work of storing the punch **23** by the punch stocker **14**, which is the third work item, until the restoration work by the worker is completed ("NO" in S**6**), for example, after the work of the second work item is completed. FIG. **4**(*b*) shows a timing at which the new abnormality has occurred during the restoration work based on the restoration assist information of FIG. **4**(*a*).

(32) When the punch side finger **11** is displaced from the installation position, the punch side finger sensor **12** detects the abnormality and the state information acquisition unit **331** acquires the detection information. When the state information acquisition unit **331** detects the abnormality of the punch side finger **11**, the restoration assist information update unit **335** determines a work item needed to be executed thereafter (S**8**).

(33) Specifically, the restoration assist information update unit **335** determines that among the first work item and the second work item that have already been executed, the first work item "restoration work of the punch side finger **11**", which is related to the new abnormality, needs to be executed again, and the second work item "restoration work of the die side finger **15**" does not need to be executed again. Further, the restoration assist information update unit **335** determines that the third work item to the sixth work item that have not been executed need to be executed thereafter. As a result, the restoration assist information update unit **335** determines that the work items that need to be executed thereafter are the first work item, and the third work item to the sixth work item.

(34) Next, the restoration assist information update unit **335** rearranges the work items in the order

of execution according to the priority information set for the work items determined to be necessary to be executed, and updates the restoration assist information generated in step S**4**. FIG. **4**(*c*) is an example of the restoration assist information updated due to the occurrence of the new abnormality. As shown in FIG. **4**(*c*), the restoration assist information updated here includes information configured so as to firstly execute the first work item that has the highest priority, and then to execute the third work item to the sixth work item in descending order of the priority.

(35) Then, the content displayed on the display unit **32** is changed, by the display control unit **333**, to updated new restoration assist information (S**9**). The worker recognizes, from the changed restoration assist information, the content and execution order of the restoration work including a measure against the newly generated abnormality, and continues the subsequent restoration work. The work related to each item is sequentially executed by the worker, and when all the restoration work is completed ("YES" in S**6**), the processing returns to step S**1**.

(36) Further, a case will be described in which a new abnormality does not occur during the restoration work in step S**7** ("NO" in S**7**) and the restoration assist information update unit **335** detects that a state of a predetermined location in the tool changer **1** has changed. For example, it is assumed that the punch side finger **11** is stopped in the upper table **21** without gripping the punch **23** because the tool changer **1** is stopped in step S**3**. Here, if the worker visually observes this, and before starting the restoration work, manually causes the punch side finger **11** to grip the punch **23** so that the punch **23** installed in the upper table **21** is stored in the punch rack **13**, the punch side finger sensor **12** detects the gripping state.

(37) The restoration assist information update unit **335** acquires the information detected by the punch side finger sensor **12** via the state information acquisition unit **331**. The restoration assist information update unit **335** recognizes that the state of the punch **23** installed in the upper table **21** has changed to a state of being gripped by the punch side finger **11** ("YES" in S**10**).

(38) As a result, the restoration assist information update unit **335** determines that the sixth work item "work of storing the tools on the tables" is no longer necessary and will be skipped (S**11**) based on the information of the location at which the change has occurred, the information of the state after the change, and the information acquired by the work execution status information acquisition unit **334**. Then, the restoration assist information update unit **335** deletes information of the work item to be skipped in the restoration assist information generated in step S**4**, and updates the information as shown in FIG. **4**(*d*). FIG. **4**(*d*) is an example of the restoration assist information that is updated due to a change in a state of any location.

(39) Then, the display control unit **333** changes the content displayed on the display unit **32** to the updated new restoration assist information (S**9**).

(40) According to the one or more embodiments described above, it is possible to display the work items necessary for restoration and the execution order thereof as the restoration assist information when the abnormality occurs in the tool changer **1**, and when the state in the equipment during the restoration work is changed, it is also possible to update the restoration assist information as appropriate according to the change. As a result, it is possible to provide assist information so that even a worker who has little experience in managing the tool changer **1** can appropriately perform the restoration work.

(41) The present invention is not limited to the one or more embodiments described above, and various modifications can be made without departing from the summary of the present invention.

(42) The present application claims priority based on Japanese Patent Application No. 2020-116799 filed with the Japan Patent Office on Jul. 7, 2020, and all the disclosure contents thereof are incorporated herein by reference.

Claims

1. A device for assisting equipment restoration work, comprising: a restoration work information storage unit configured to store work item-items for restoration and priority information, the work item being set in advance for each location at which an abnormality is expected to occur in equipment to be managed, the priority information indicating a priority of execution for each of the work items; a state information acquisition unit configured to acquire state information of a predetermined location of the equipment, including operational status, sensor measurements, or detected abnormality data; a restoration assist information generation unit configured to generate, when it is detected that an abnormality has occurred in the equipment and an operation of the equipment has been stopped, restoration assist information, in which the work items for restoring the equipment are arranged in an order of execution according to the priority information, based on information of a location at which the abnormality has occurred and the information stored in the restoration work information storage unit, and wherein the restoration assist information further comprises associated information of each work item including at least one of work content, necessary tools, and precautionary measures; and a restoration assist information update unit configured to determine whether a work item that have already been executed needs to be executed again, and to update the restoration assist information generated by the restoration assist information generation unit to restoration assist information including the work item that have already been executed and determined to need to be executed again and the work items that have not been executed, and excluding the work item that have already been executed and determined not to need to be executed again, when it is detected that a state of any location in the equipment has changed based on the state information acquired by the state information acquisition unit during a restoration work based on the restoration assist information, wherein the update reflects a reprioritization of work items based on the changed state information.
2. The device for assisting equipment restoration work according to claim 1, further comprising a work execution status information acquisition unit configured to acquire information indicating an execution status for each of the work items included in the restoration assist information, wherein the restoration assist information update unit is configured to update, when it is detected that a new abnormality has occurred in the equipment before the work based on the restoration assist information is completed, the generated restoration assist information to new restoration assist information in which work items needed to be executed thereafter are arranged in an order of execution based on information of a location at which the new abnormality has occurred and the information acquired by the work execution status information acquisition unit.
3. The device for assisting equipment restoration work according to claim 1, wherein the restoration assist information update unit is configured to determine, when it is detected that a state of a predetermined location in the equipment has changed before the work based on the restoration assist information is completed, a work item to be skipped in the restoration assist information based on information of the location at which the state has changed, and is configured to update the generated restoration assist information to new restoration assist information in which the work item determined to be skipped is deleted.
4. A method for generating equipment restoration work assist information, comprising: storing, by a storage unit, work items for restoration and priority information, the work item being set in advance for each location at which an abnormality is expected to occur in equipment to be managed, the priority information indicating a priority of execution for each of the work items; acquiring state information of a predetermined location of the equipment; stopping an operation of the equipment in response to a detected abnormality based upon the acquired state information of the predetermined location of the equipment; generating, in response to the detected abnormality that has occurred in the equipment and the operation of the equipment has been stopped, restoration assist information, in which the work items for restoring the equipment are arranged in an order of execution according to the priority information, based on information of a location at which the

abnormality has occurred and the information stored in the storage unit; automatically moving at least one of a punch side finger, a punch stocker, a die side finger, or a die stocker of the equipment in accordance with at least one of the work items; determining whether a work item that have already been executed needs to be executed again, when it is detected that a state of any location in the equipment has changed based on the state information during a restoration work based on the restoration assist information; updating the generated restoration assist information to restoration assist information including the work item that have already been executed and determined to need to be executed again and the work items that have not been executed, and excluding the work item that have already been executed and determined not to need to be executed again; and moving the at least one of the punch side finger, the punch stocker, the die side finger, or the die stocker of the equipment to a retreated end of the equipment in accordance with a completed work item.

5. A system for assisting equipment restoration work, comprising: a sheet metal bending machine; an automatic tool changer operatively coupled to the sheet metal bending machine; an NC device communicatively coupled to the sheet metal bending machine and the automatic tool changer, the NC device configured to control operations of the sheet metal bending machine and the tool changer; and a restoration work assist device communicatively coupled to the NC device and the automatic tool changer configured to communicate restoration assist information to the NC device; wherein the restoration work assist device comprises: a restoration work information storage unit configured to store, for each of a plurality of predetermined locations in the automatic tool changer, one or more restoration work items and priority information indicating a priority of execution for each of the restoration work items, and associated information including work content, necessary tools, and precautionary measures, wherein the restoration work items include at least tool change operations performed by the automatic tool changer associated with the sheet metal bending machine; a state information acquisition unit configured to acquire state information of a predetermined location of the automatic tool changer, the state information comprising operational status, sensor measurements, detected abnormalities, or tool usage status; a restoration assist information generation unit configured to: detect an occurrence of an abnormality in the automatic tool changer and stoppage of the automatic tool changer operation based on the acquired state information, identify a location at which the abnormality has occurred, and generate restoration assist information a sequence of restoration work items corresponding to the identified location, arranged in an order of execution according to the priority information, wherein the restoration assist information includes tool change operations if required, and associated work content, necessary tools, and precautionary measures for each work item; and a restoration assist information update unit configured to: detect a change in the state information of any location in the automatic tool changer before completion of a restoration work based on the restoration assist information, and update the restoration assist information based on the changed state information, wherein the restoration assist information comprises at least one of updating tool change operations or reprioritizing restoration work items.