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# The Preparatory 3D Graphic Simulation on the RSR Dismantling Process of the KRR-1&2

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## Abstract

A three dimensional graphic simulation has been carried out for the dismantling process of the rotary specimen rack(RSR) in the Korea Research Reactor-1&2(KRR-1&2). First of all, the general steps of the graphic simulation were established and reviewed for the dismantling process of the object. Four dismantling processes, which are the removal of RSR, reactor core region, beam tube, and thermal column and activated concrete, were selected for the graphic simulation on the virtual space by the consideration of the activation, worker training, work difficulty and so on. In the present study, the dismantling procedure of the RSR was divided into several steps and its visualized simulation was performed by the 3D graphic software. Finally, the simulation result was converted to moving file with extension of AVI so that easy approach can be made on window OS system.

## I. Introduction

Commercial nuclear power plants, research reactors and related facilities are generally decommissioned due to the end of their useful lives, political/economical reason or safety problems. At the present time, over 80 nuclear plants and over 350 research reactors have been decommissioned or are under decommissioning in different stages [1, 2]. In Korea, KRR-1&2 have been operated with a significant contribution to nuclear activities since 1962 and 1972, respectively. Now, because of the end of their useful lives and normal operation of a new research reactor, HANARO (High-flux Advanced Neutron Application Reactor), the decontamination and decommissioning is being carried out for the KRR-1&2, which were shutdown in 1995, from 1997 [3].

Nowadays, computer graphic simulation is extensively employed before practical activity is

carried out for construction and manufacturing. Especially, in the area of radioactivity-concerning facilities, in-advance virtual simulation in the computer graphic space is very efficient and essential in terms of record-keeping, finance, workers' safety and training and so on.

Therefore, in the present study, the processes to be simulated are determined and the fundamental graphic simulation is carried out for the dismantling of the RSR in the KRR-1&2 which is one of the chosen processes.

## II. The Concept of the 3D Graphic Simulation for the KRR-1&2 Dismantling Process

The graphic simulation is to mirror the real movement and environment into a virtual computer space[4, 5]. Therefore, the corresponding scenario is essentially required on the working process with cutting, transportation, placement and so on.

When the scenario has been given, what should be modeled three dimensionally should be determined. Further inspection on modeling gives classifying the dismantling object, equipments, and working environment into the minimum unit of modeling. That is, "Element" is defined and created in that basic modeling.

A part modeling is carried out with the elements and a device is established by the consideration of the mechanical or kinematical mechanism. That detailed modeling includes kinematics and assignment of the motion for the real embodiment of the process.

All the 3D objects made in that way, which are not parts but devices, are arranged in the virtual working environment. That is, the layout is a build-up for the simulation.

The sequence is composed based on the scenario and the devices are assembled. After all, the simulation programming is carried out and the simulation of the dismantling process is completed eventually.

The performed simulation result can be converted to the common movie file with the type of AVI or MPEG for the purpose of the easy approach. Practically, the concerned users including the work manager or worker are able to get a visual investigation or training for the optimization of the dismantling work.

In Figure 1, the general flow for the graphic simulation of the KRR-1&2 dismantling process is shown.

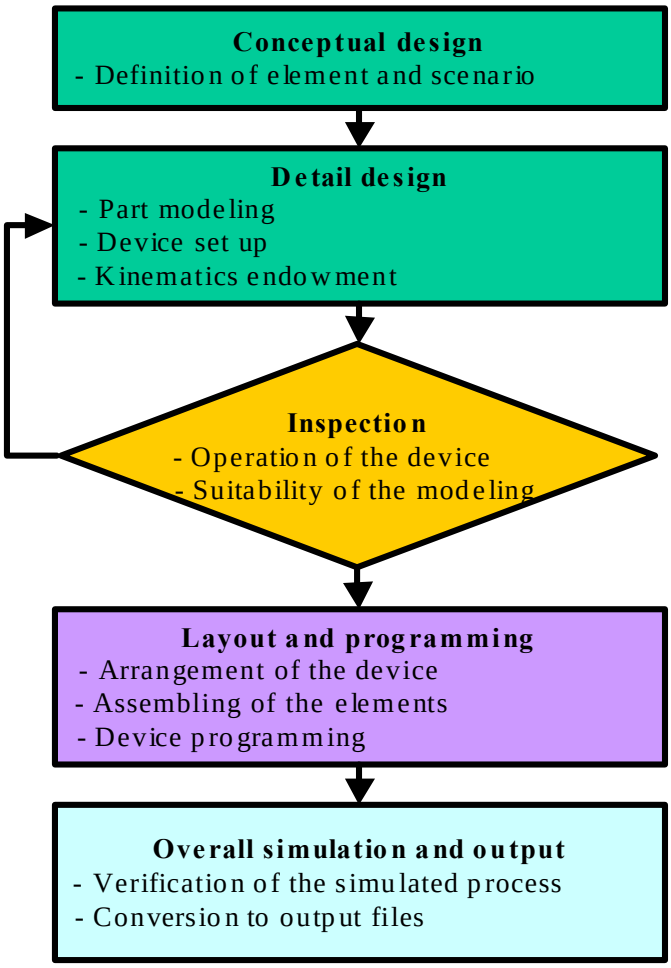


Fig. 1 General flow for the graphic simulation of the KRR-1&2 dismantling process

## III. The Selection of the Dismantling Process to be Graphically Simulated

Now, all the facilities of the KRR-2 is being dismantled from the non-radioactive area while the KRR-1 is expected to be a memorial museum. In Figure 2 and Figure 3, the horizontal and vertical view of the KRR-2 are shown.

As seen in Figure 2 and Figure 3, the KRR-2 has a reactor pool with a movable core, the RSR, and other components. It has also the radial beam ports from the core, the through beam ports, and a thermal column. Beyond this, it includes many components for the nuclear concerning experiments[3].

Due to the operation and experiment over a few decades, most components of the reactor and thermal column and beam ports will be activated. Therefore, the dismantling should be carried out carefully for the worker's safety and other things.

First of all, the dismantling procedure of the KRR-2 reactor is expected as in Figure 4[6].

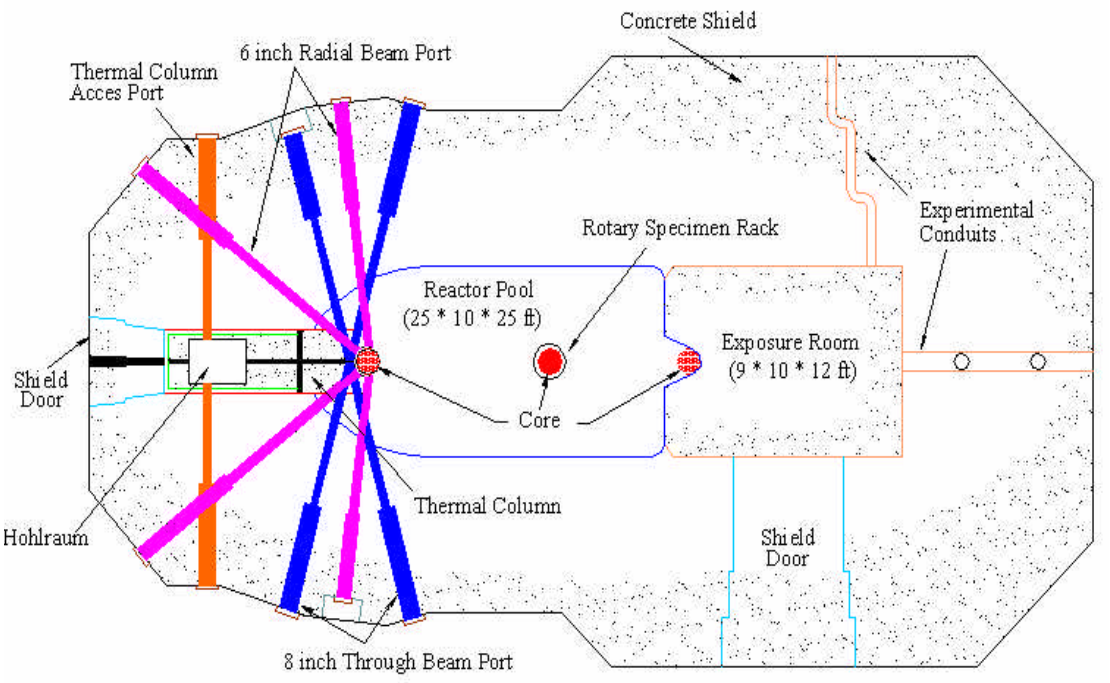


Fig. 2 Horizontal Crossection of the KRR-2

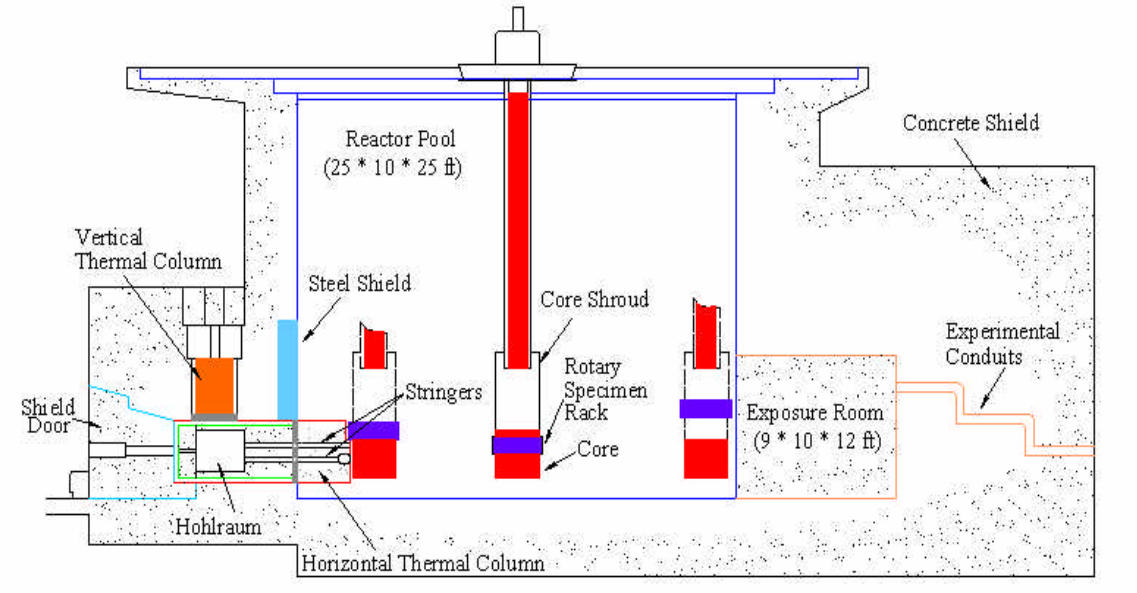


Fig. 3 Vertical Crossection of the KRR-2

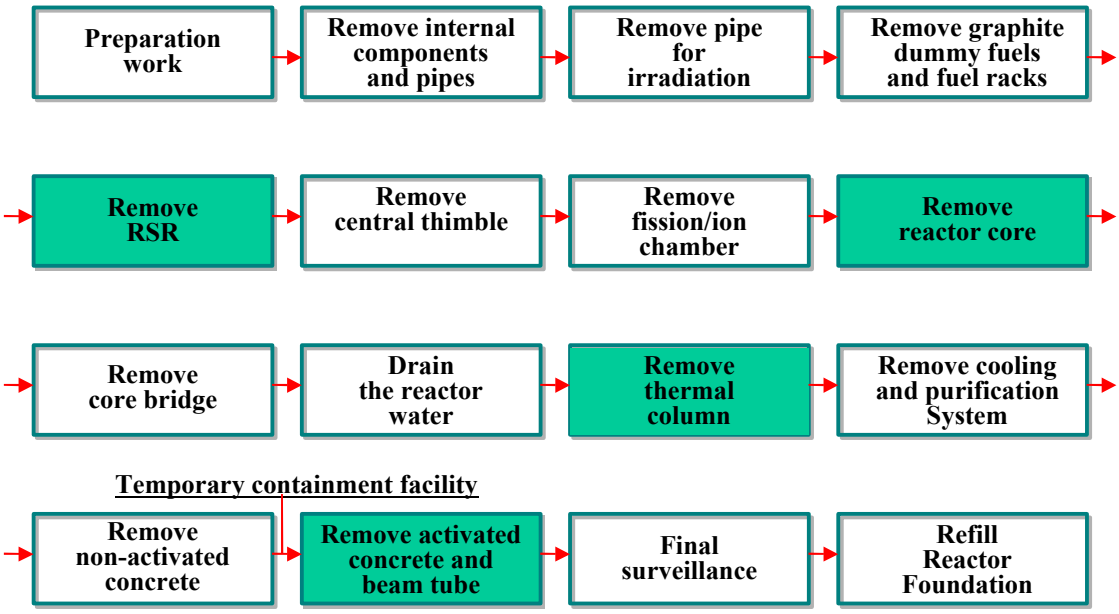


Fig. 4 The Procedure of Dismantling KRR-2

Also, all the works will be performed according to the suitable work statement and procedure. But, for the present, every working process will not be simulated and instead, some selected processes according to the criteria will be simulated 3D-graphically. In this study, the selection was carried out by the consideration of the work with a relatively high radioactivity, the working difficulty and other factors which are to be thought important.

The summary of the criteria gives these;

- ☐ Work with the treatment of high radioactivity material
- ☐ Work with the difficult approach or access
- ☐ Work with the relatively large expectation dose on workers
- ☐ Work with the possibility of risk in terms of the safety
- ☐ Work with the working difficulty due to under-water and remote control
- ☐ Work with the requirement of the precise and detail work procedure
- ☐ Work with the requirement of special training

Taking account of those criteria, four dismantling processes were chosen to simulate in the virtual space. Figure 5 shows the selected processes according to the criteria.

| Selection Criteria / Dismantling Process | Expected Dose (man-mSv) | Risk | Difficulty of work | Requirement on detail procedure | Special training |
|---|---|---|---|---|---|
| Remove internal components and pipes | 1.56 | M | L | X | X |
| ⇨ **Remove RSR** | **3.84** | **H** | **H** | **O** | **O** |
| ⇨ **Remove reactor core and so on** | **718.00** | **H** | **H** | **O** | **O** |
| Drain the reactor water | 0.08 | L | L | X | X |
| ⇨ **Remove thermal column** | **4.80** | **H** | **H** | **O** | **O** |
| Remove cooling and purification system | 0.50 | L | M | O | X |
| Remove pipe for irradiation, core bridge | 0.86 | M | M | X | X |
| ⇨ **Remove activated concrete and beam tube** | **105.83** | **H** | **H** | **O** | **O** |
| D&D of the pit and distilled water tank | 2.51 | M | H | O | X |
| Decontamination of the wall and floor of the reactor room | 3.02 | L | M | X | X |

* Arrows means for the selection.

Fig. 5 The Selection of the Process for the Graphic Simulation

## IV. The Preparatory 3D Graphic Simulation on the RSR Dismantling Process

The simulation on dismantling of the RSR, which was considered a low and intermediate radioactive level, has been illustratively carried out in four processes. The RSR is composed of stainless steel of the sprocket, chain and bearings with the intermediate level and of aluminum of the body, sample tube and others with the low level in Figure 6 and Figure 7. Therefore, the separate treatment on the stainless steel part is needed for the reduction of the waste volume and so on.

In the present study, the dismantling procedure of the RSR was considered to follow several steps in spite of the possibility of the further change[7]. First of all, the drive shaft and sample tube, which are hung from the core bridge, are cut appropriately. The floating tank is removed and The inner and outer periphery of the upper part of the housing is cut by a suitable cutter. And then, if necessary, the drive shaft and tube can be cut again close to the upper part of the housing. When the removal of the upper part of the housing is completed, the drive shaft, sprocket, supporter and other elements are removed. Next, the chain for revolving the sample holders is removed and the sample holders are gotten rid of.

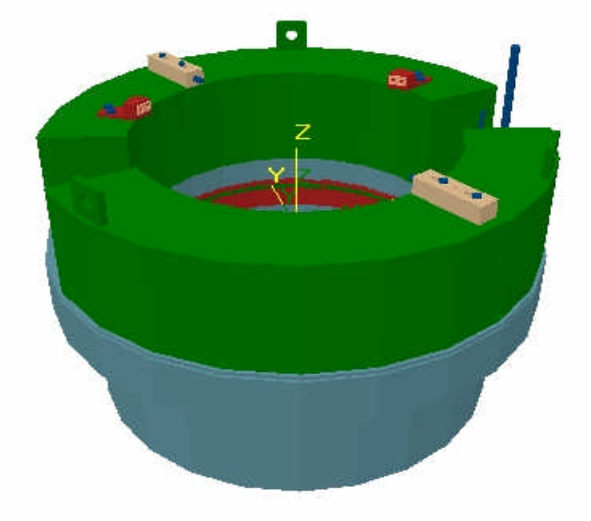


Fig. 6 The Appearance of the RSR

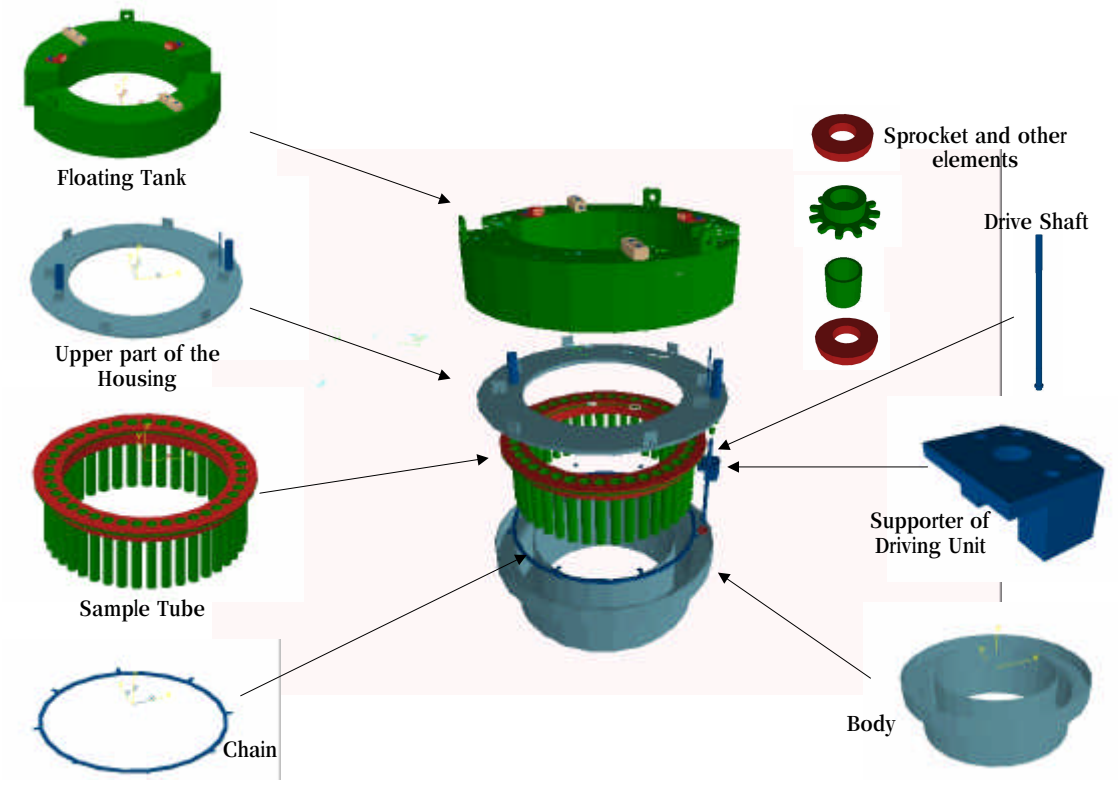


Fig. 7 The Description of the Components of the RSR

The bearing retainer is disintegrated by using a slitting wheel and some bearing sets are removed. The screws of the bearing retainer are cut after the cutting of the inner and outer periphery of the lower part of the housing. For the time being, those two steps are not simulated graphically. Finally, the body is cut into suitable pieces.

In Figure 8, the simulation procedure has been visualized with the corresponding 3D software.

## V. Conclusion and Future Plan

The basic tool for the in-advance-investigation on the work procedure of the RSR has been constructed by the fundamental 3D graphic simulation in the computer space. Moreover, the simulation result was converted to general movie file like AVI so that the concerning user can approach and inspect easily.

In the near future, further simulation will be created in the aspect of the kinematics on the RSR dismantling process.

## VI. Acknowledgement

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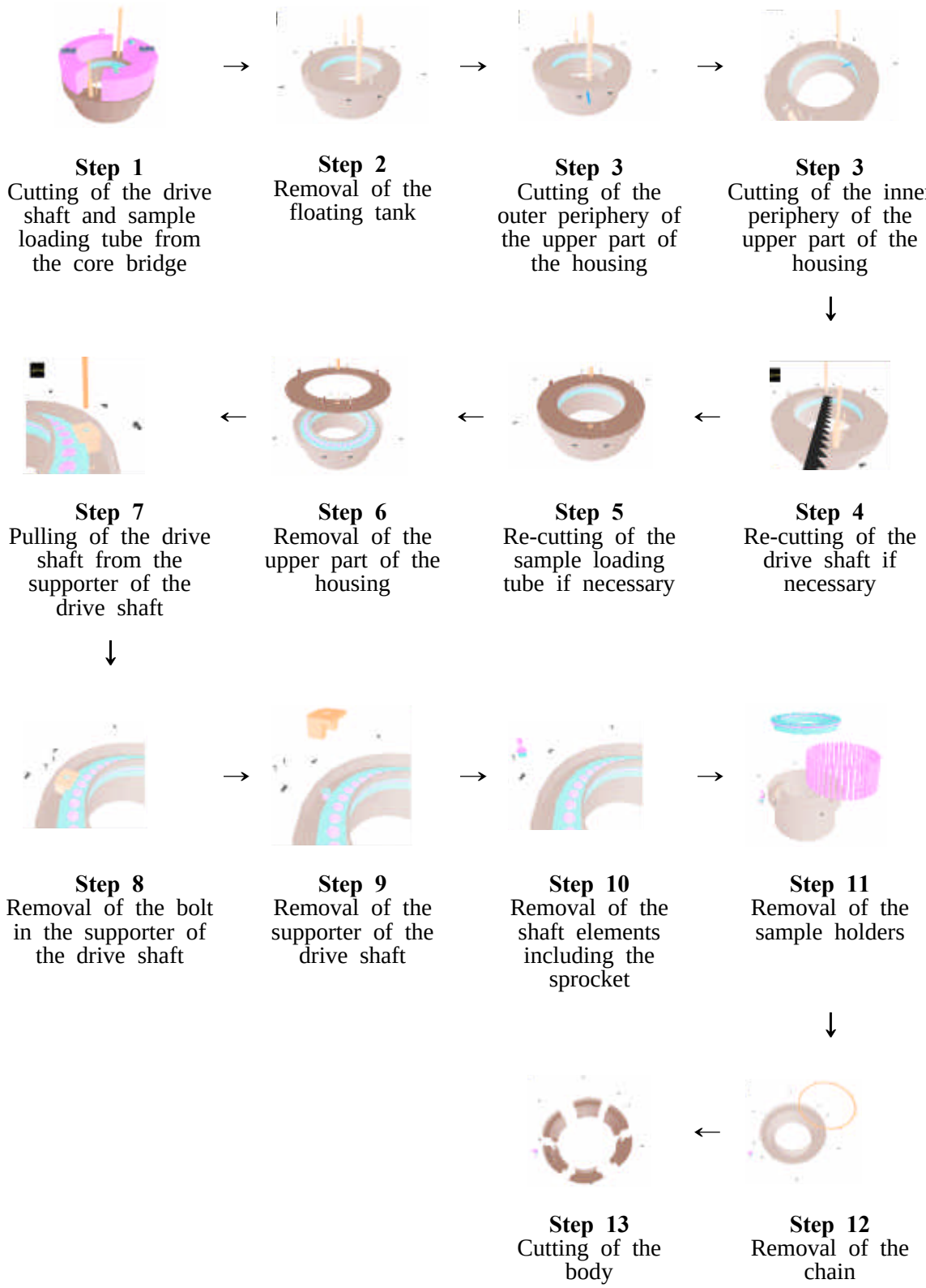


Fig. 8 The Visualized Simulation on the Dismantling of the RSR