IRRADIATION METHOD IN THE PROTECTION OF CULTURAL HERITAGE OBJECTS ENDANGERED BY MASSIVE BIODEGRADATION

Branka Katušin-Ražem, Branka Mihaljević
Radiation chemistry and dosimetry laboratory
Ruđer Bošković Institute

Mario Braun,
Croatian Conservation Institute
Cultural heritage artefacts made of organic materials are susceptible to deterioration caused by insects, moulds, fungi and bacteria.

Biodeterioration is a widely present natural process which is causing unwanted changes in cultural heritage objects: alteration of appearance, loss of strength, partial degradation, which eventually lead to complete disintegration.

In fulfilment of the task of safeguarding of our cultural heritage all necessary actions must be exercised: preventive measures, as well as all actions aimed at suppression, eradication and control of biodegradation agents.

Nevertheless, serious infestations occur in store rooms of museums, collections and sacral places\textsuperscript{1-3}, which is an acute problem worldwide.

\begin{enumerate}
  \item International Centre for the Study of the Preservation and Restoration of Cultural Property, ICCROM (http://www.iccrom.org.info/en) - “an estimated 60% of the world’s collections in storage are inaccessible and deteriorating rapidly.”
\end{enumerate}
Biodeterioration, a permanent problem of safekeeping of cultural heritage objects in museums and church premises

The situation in Croatia is similar to conditions elsewhere in the world: deterioration in store rooms is to a great extent caused by insects and moulds.

Intensive biodegradation of CH objects is provoked by abrupt changes of their stable and optimum keeping conditions caused by:
- natural catastrophes (floods, earthquakes, etc.)
- man-inflicted activities and conflicts (wars, riots, etc.)

The necessary repositioning of a large number of objects in the course of a rescue operation is bringing infested and uninfested materials in contact, which leads to an abrupt development of pests and endangerment of whole collections.
Methods suitable for rescuing large quantities of heritage material endangered by biodeterioration

The methods suitable for the suppression of massive biocontamination of CH objects by fast processing large quantity of materials are:

treatment with poisonous gasses and treatment with ionising radiation

The use of ethylene oxide is severely restricted nowadays.

Irradiation has been proven an effective method of preservation of perishable cultural heritage objects; the principle was described in the previous lecture:

Irina Pucić, Katja Kavkler, Branka Mihaljević:
*MATERIAL RESPONSE AS A CRITERION FOR THE APPROACH TO RADIATION TREATMENT OF CULTURAL HERITAGE OBJECTS*

Present lecture will focus on the efficacy of irradiation method for rescuing large numbers of CH objects endangered by massive biocontamination and successful examples will be given.

Special emphasis will be given to successful cases of rescuing of art objects during the war in Croatia (1991-1995) from the aspect of emergency treatment.

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Radiation desinsection, an especially suitable curative treatment of entire infested museum collections

Radiation method is most often applied for desinsection, i.e. insect eradication in wooden CH objects (about 90% of all treatments). Radiation desinsection in mass treatment of entire museum collections during regular and urgent clean-up and renewal actions, represents an example of especially successful application of radiation method.

**France:**
The entire collection of the museum (Historical Museum of Lyon), about 200 m³ mostly wooden objects, was treated for desinsection by irradiation at ARC-NucléArt in Grenoble in the process of rearrangement, cleaning up of the museum and repositioning of the objects.

Radiation desinfection in rescuing of entire collections heavily endangered by moulds

Professional literature presents some especially successful cases of radiation decontamination of heavily infested large collections:

**Romania:**
(2001) film archive, tens of boxes of film rolls (300 rolls), heavily infested by moulds, were successfully treated with 25 kGy.¹

**Poland:**
(2001) 60,000 pieces of prisoners’ shoes, exhibits from the Majdanek Nazi Camp Museum, were irradiated with 19 kGy.

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The Netherlands:

(2006) A famous collection of books in international law and archives of the Peace Palace Library, The Hague, had to be moved to a new place. Prior to transportation, archival and library materials had to be cleaned, dusted and subjected to urgent mould and insects eradication. Radiation disinfection with 10 kGy was applied, followed by vacuum cleaning.

Clean treated materials are kept in new storage under controlled conditions.

Radiation desinfection in rescuing of entire collections heavily endangered by moulds

**USA:**

(1982) abandoned artefacts of the Alan Mason Chesney Medical Archives, Johns Hopkins Medical Institutions, Boston, MA

295 packages of heavily infested archival and paper materials were irradiated with 4.5 kGy. Monitoring of treated artefacts over 8 years revealed no apparent changes: “the project has to be considered a success”

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Library collection at Colorado State University suffered the largest water-related library disaster in the USA. After a rapid outbreak of mould infection, 425 000 soaked books were freeze dried and successfully treated with 15 to 25 kGy

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1. Gamma radiation, Abbey Newsletter, Volume 8, Number 2, Apr 1984
   http://cool.conservation-us.org/byorg/abbey/an/an08/an08-2/an08-201.html (1.05..2014.)
2. R. Silverman. The Day the University Changed
   http://cool.conservation-us.org/byauth/silverman/day/index.html (1.05..2014.)
Croatia: Irradiation facility at the Ruđer Bošković institute (RBI), Zagreb

Panoramic batch-type dry storage $^{60}$Co irradiator (constructed 1963.)

Pilot plant level: in 1983: 50 kCi; presently:~ 26 kCi

Irradiation chamber:
- rectangular room: 4.9 m × 3.9 m × 3.5 m
- capacity 4 - 6 m$^3$ of material

Applications:
- services: desinsection, desinfection and sterilization of pharmaceutical, medical, cosmetic and food materials$^1$
- 30 years application of radiation method for treatment of CH objects (wood, textile, paper, leather and other)
- about 20 m$^3$/year, mainly wooden objects

Recommended doses:
insect eradication 0.5 - 2 kGy
fungi control 5 - 10 kGy
decontamination 10 - 25 kGy

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Radiation treatment of cultural heritage objects in the RBI facility

In collaboration with Croatian Conservation Institute and all interested parties

Treated by irradiation over 25 years:

More than 8,000 wooden sculptures, parts of altars, furniture pieces, tools, musical instruments, other wooden, paper, leather, textile, straw items, etc.

Atelier Kožarić contains more than 6,000 exhibits: sculptures, reliefs, assemblages, objects, installations, paintings, prints, drawings, sketches, ready-mades, and many everyday items.

http://www.msu.hr/#/en/93/
Selected case of massive radiation desinsection I: Contemporary art objects

Museum of Contemporary Art, Zagreb (MSU), purchased the entire inventory of Atelier Kožarić in 2007 for future permanent exhibition, management and maintenance. Before moving into the Museum building a large number of objects were treated with 2 kGy for preventive and curative purposes.

The Altar of Our Lady of Loretto, Plešivica, from 1757, was damaged by pest attack provoked by exposure to humidity caused by bad roof - for conservation within CrCI-RBI cooperation, the altar was dismantled, taken apart to 147 pieces, wrapped and transported to the RBI irradiator. As the first step of conservation the altar was desinsected by irradiation treatment with 2 kGy.

Project leader: K. Škarić, Croatian Conservation Institute

Radiation method in rescuing of cultural heritage objects during the war in Croatia

The war against Croatia 1991-1995, which followed the breakdown of Yugoslavia put many cultural objects on the Croatian soil to serious jeopardy.

During the autumn of 1991, in anticipation of war, the Institute for the Protection of Cultural Monuments of the Croatian Ministry of Education, Culture and Sports initiated a massive action of withdrawing CH objects from immediate war zone together with local (then) Conservation Restauration Institutes. The collections of museums and galleries, churches, libraries and archives were moved into previously determined, sometimes improvised, storage spaces\(^1,2\).

On the territory of northern Croatia there were 15 pre-selected secret depots outside the areas affected by war operations. In joint actions of conservators and restorers, church authorities and other involved groups and individuals, with wholehearted cooperation and support by the (then) Croatian National Guard, later to become Croatian Army, about 5,000 objects, mostly polychromic sculptures, altar parts and other wooden objects, comprising about 3,000 complete altars, were evacuated to safer places\(^1,2\).

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1. Ž. Laszlo, Zaštita i obnova pokretnih spomenika kulture u ratu, Informatica Museologica br. 1/4 1992..
2. Ž. Laszlo, private communication to B. Katušin-Ražem
Radiation method in rescuing of cultural heritage objects during the war in Croatia

As there is no ideal plan for rescuing, especially under war conditions, it is conceivable that a significant fraction of cultural heritage objects was lost or damaged during the war.

About 40% of the Croatian architectural heritage was damaged or destroyed.

The list of lost, destroyed or damaged objects from 162 churches, monasteries and other sacral buildings comprises 3098 paintings, sculptures and church furniture pieces¹

The losses of museums and galleries recorded by the Museum Documentation Center (MDC) comprise: 3178 destroyed and 2283 damaged objects²

2. Muzejski dokumentacijski centar http://www.mdc.hr/RatneStete/hr/ (1.5..2014.).

St. Dorothea, Logorište near Karlovac.
Radiation method in rescuing of cultural heritage objects during the war in Croatia

Cooperation of Croatian conservation Institute (CrCI) and RBI: Specially successful case of protection of art objects in Croatia

Inadequate safeguarding and keeping, repositioning, inadequate temporary shelters and other adversities of war caused serious deterioration of CH objects susceptible to biodegradation. To mitigate the problem of massive biodeterioration it was decided to irradiate endangered CH objects by $^{60}$Co gamma rays in the Radiation Chemistry and Dosimetry Laboratory of the RBI as an interventive and/or preventive treatment. Supervised by the CrCI, more than one third of CH objects evacuated from northern Croatia, mostly polychromic sculptures, parts of altars and other wooden pieces, comprising about 1500 complete altars, were transported to the RBI for radiation desinsection or, if necessary, desinfection. Irradiation treatment enabled their safe storage in designated depots jointly with many other such objects prior to their conservation and restoration, without the risk of cross-contamination. Significant number of objects were stored in the CrCI depot in the Batthany castle, Ludbreg.

Cooperation RBI-CrCl: Rescuing of CH objects in war Radiation treated polychromic sculptures

After adaptation of the Batthany castle, CrCl Ludbreg, accomplished by Croatian experts, assisted by Bavarian conservators and supported by the Bavarian Government, a significant number of irradiated objects were stored there.

The recovery from war damages, conservation and restoration activities started immediately in the newly constructed restoration workshop and are on-going till the present day¹.

Selected example I: *Rescuing of CH objects in war*

The Church of Blessed Virgin Mary of the Snow in Kamensko

Pauline monastery Kamensko near Karlovac was occupied in 1991 and destroyed by the Yugoslav Army during the war in Croatia.

Only one day before the occupation a few members of the Croatian Conservation Institute removed 29 sculptures, but main constructions of the altars remained.
Selected example I: Rescuing of CH objects in war
The Holy Cross Altar from the Church of Blessed Virgin Mary of the Snow in Kamensko

The remaining Holy Cross Altar (from 1685) was burnt during intense devastation of the church. Four years later, the remaining unburnt parts of the altar were found choked with microflora.

Project leader: Romana Jagić, Croatian Conservation Institute
Selected example I: 
Rescuing of CH objects in war

The Holy Cross Altar from the Church of Blessed Virgin Mary of the Snow in Kamensko

The remains of the altar were collected, dried, wrapped in foil, packed in boxes and desinfested by irradiation with 5 kGy at the RBI irradiation facility. Strongly infested remains recovered from the crypt were irradiated to 20 kGy. Irradiated parts have been under restauration in the CrCI atelier in Ludbreg for several years.

http://www.h-r-z.hr/index.php/djelatnosti/struni-skupovi/318-radiacijske-metode-u-zatiti-kulturne-batine (1.05.2014.)
Selected example I: Rescuing of CH objects in war
The Holy Cross Altar from the Church of Blessed Virgin Mary of the Snow in Kamensko

Found elements of all ornaments enabled complete reconstruction. After drying, stabilization, conservation and restoration the altar was re-erected.

The altar was returned into the repaired church in 2008.
Selected example II: The church of the Assumption of Blessed Virgin Mary in Gora near Petrinja (12th or 13th c.)
Polychromic sculptures from the church inventory were buried in the crypt of the church destroyed at the beginning of the war. After 6 years, in 1997, seven of them were found in very bad state, soaked and covered with dirt and mud.
Selected example II: 
*Rescuing of CH objects in war*

**Polychromic sculptures, St. Mary, Gora, Petrinja**

Sculptures were processed by cleaning, drying, irradiation with 20 kGy for decontamination, and with 5 kGy after recontamination appeared. After conservation & stabilisation the sculptures were stored at the depot Ludbreg.
Selected example III: 
*Rescuing of CH objects in war*

**St. Dorothea Church, Logorište, 17th c.**

The altar was evacuated shortly before the church was damaged in 1991. In the process of rescuing it was irradiated at the RBI with 2 kGy for desinsection and stored in the CrCI depot in Ludbreg. Conservation and restoration were completed in 1995. St. Dorothea was the first church restored after the war.

Project leader: Romana Jagić, Croatian Conservation Institute
For more than 25 years Croatia has been following leading trends in conservation and has been able to contribute to successful application of radiation treatment for the prevention of CH biodegradation in Europe. The international community recognized the use of irradiation desinsection and disinfection for the preservation CH objects against massive biodeterioration during the war in Croatia (1991 - 1995) as an especially successful application.

(http://www.iiconservation.org/publications/nic/nic.php)

News in Conservation, August 2007

As a result of more decades of worldwide experience and on the basis of collected knowledge it is safe to say:

- Desinsection by irradiation has proved a suitable method in situations demanding a large number of objects to be treated in a short period of time, such as arise during renovation of buildings or repositioning of entire numerous and voluminous collections attacked by insects.

- In addition to that, disinfection by irradiation has proved to be the method of choice in cases of massive jeopardy by fungi and moulds arising in consequence of elevated humidity caused by inclement weather.
Thank you!