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Using 3D scanning in the protection of industrial heritage- the example of Queen Luise Adit

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I INTRODUCTION

A few years ago, 3D scanning was still very expensive. In the past, the purchase of specialized equipment was unaffordable for cultural institutions but today it is changing.
Now, museums can buy professional 3D scanning equipment which guarantees very precise measurements. 3D scanning produces high-precision digital references and more professional documentations of artefacts. However, 3D digitalization is a big challenge for many museums and institutions that protect heritage. This paper presents an example of the protection of industrial heritage in Silesia, a region with a strong industrial identity. The Queen Luise Adit is part of the Coal Mining complex and the revitalization of this attraction was a long-term process. It is also a very good example how to use 3D scanning to protect big post-industrial areas.

II A SHORT HISTORY ABOUT ADIT

Upper Silesian heritage comprises mainly of industry and technology. Most of the Polish historic industrial structures are located here. They constitute an integral part of the cultural heritage of the region as well as determine its character. The majority of the sites are connected with the tradition of mining, iron and steel industry, power industry, railways, communication and water production. Today the Queen Luise Adit is a part of the Coal Mining Museum in Zabrze, but it once was The Queen Luise Mine; the first Prussian state coal mine in Upper Silesia and was opened in 1791. The construction of the drift began in 1799 and lasted until 1863, taking as much as 64 years to be completed. At that time, the adit was the longest construction of its kind in Europe, with a total length of 14,250 m. The main purpose of the adit was to drain the Queen Luise Mine. Water is a major threat to miners' safety. Over the years, the tunnel was also used to transport coal, saving time compared with the traditional way of transporting coal - the strength of human muscles or horses.

Taken 15 years to complete, the post mining infrastructure has been restored and adapted to new functions. The goal of the restoration was to make the infrastructure safe for tourists and cultural activities, and to conserve of over 5 kilometres of interconnecting underground corridors[1].

III PRACTICAL METHODS OF INVENTORY AND PROTECTION OF MINING HERITAGE

There are many reasons why we need to protect industrial heritage from oblivion:

1. Preserve history and tradition
2. Support the people (workers)
3. Educate tourists and visitors[2]

But it is not easy to manage large mining areas with extensive underground corridors; even if you have clear ideas, the question is how to inventory everything?

Queen Luise Adit is a wonderful place to see and touch history but it also has areas which we have not yet seen, and are still not uncovered. For example, in 2019 a big chamber was uncovered:

there for the first time and we had to be prepared for

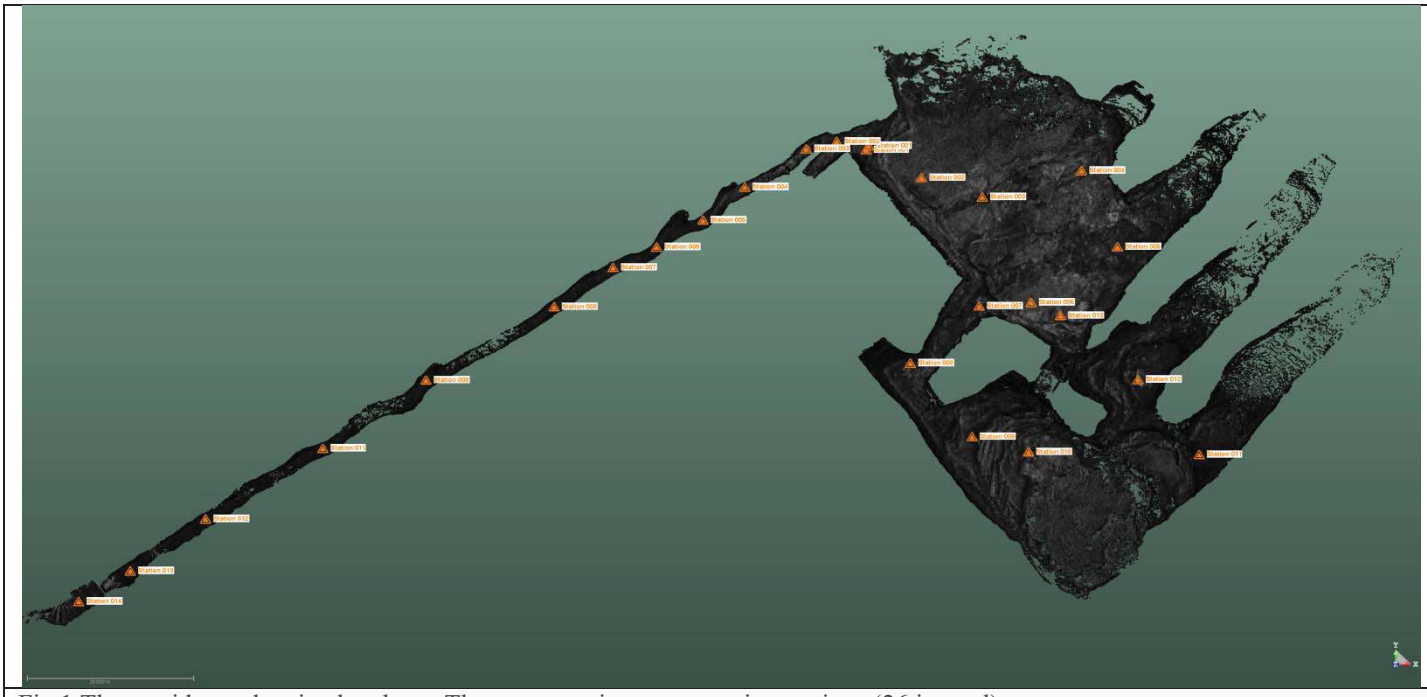

Fig.1.The corridor and main chamber – The orange points are scanning stations (26 in total).

In this situation, we decided that the best choice for the chamber's documentation would be the use of a 3D scanner. In order to get there, we had to cross a 105-meter corridor, whose height in the most difficult places, was about 100 cm. The road to the chamber was difficult and took about 20 minutes; the narrow corridor did not help in transporting the scanner and special equipment needed to breathe.

Before we started the scan, we had to choose where to start. We decided to go to the chamber first and scan the corridor during the return. This task required special preparation from us – we needed equipment for breathing in difficult conditions and equipment for measuring the concentration of carbon dioxide. We went everything.

We expected mud, water and darkness, but we still did not know how big the chamber was and how the 3D scanner would handle it. Time constrained us, because we could not be in such a place for too long because of the amount of carbon dioxide.

We started scanning from the main chamber, we chose level 3 of the scan - 500,000 points per second. The whole scan took us about seven hours (26 scanning stations). The essential problem was good scanner stabilization. We used a Trimble TX8 scanner, which needs only one perfect levelling check. Wrong levelling can cause significant errors of point clouds, and give unsatisfying results.

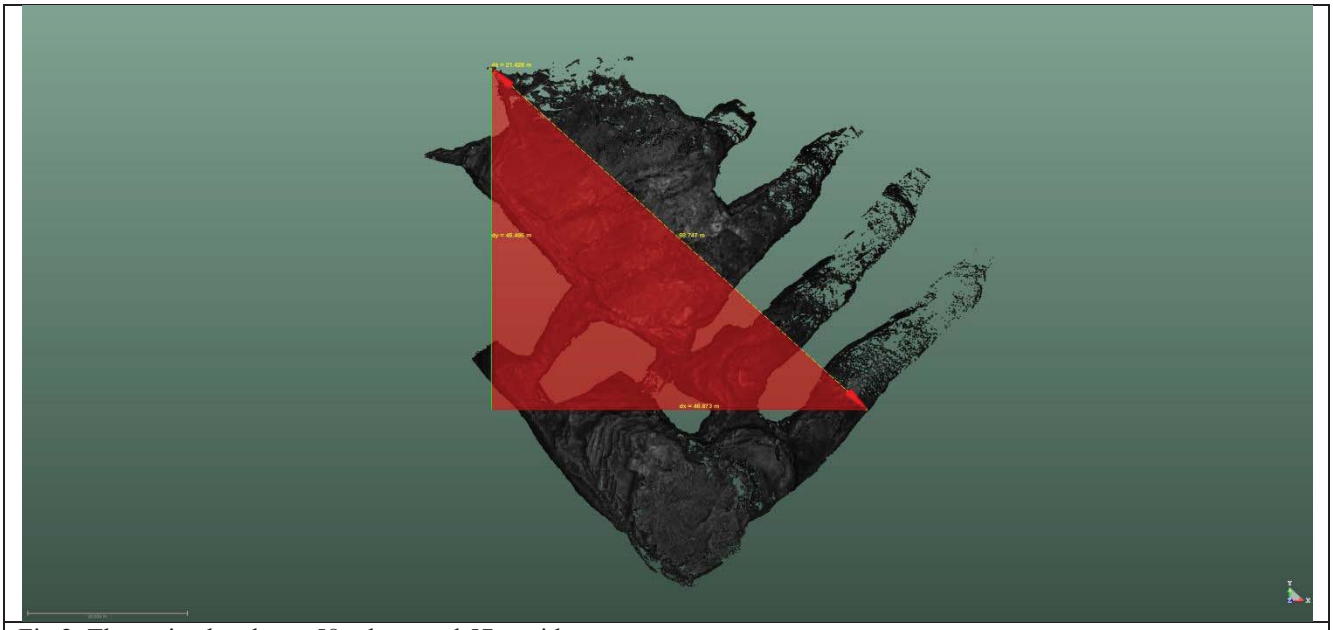

Fig.2. The main chamber – 58m long and 57m wide.

One of the goals of verification by using a 3D scanner was the possibility for measuring in not yet uncovered places in old coal mining. The measurement results from laser scanning are very precise, and measurement errors are mere millimetres, depending on the scanner's position. The result of this is that now we can use a 3D scanner to define the scale of the workings of rock layers in the mine. Very important tasks can be done with this technique:

- monitoring changes and deformations, underground and outside
- monitoring the condition of closed coal mines[3].

Practical use of 3D scanning shows us that this method is cheap, because we only need one very good quality scanner and two persons to work underground, and in a laboratory after scanning. Also, this technology can find wide usage in mining – for geological purposes of course, but also for tourism. Point cloud data of a chamber is not only specialist information for researchers but can also be a very accessible method of presenting heritage[4].

The protection of post-industrial heritage is not only accomplished with knowledge and history but also with the help of modern technologies.

It should be pointed out, that the results of scanning could be easily used by third parties, on computers or via internet. We also believe that this technology will become a common technique for other institutions and museums looking for new methods to protect heritage.

As a result of the research performed using a 3D scanner, it has become possible to prepare a development study on the protection of the rock mass around the former Queen Louise Mine, with particular emphasis on the basic pavement in deck 510 and the ramp up to 80 m[5].

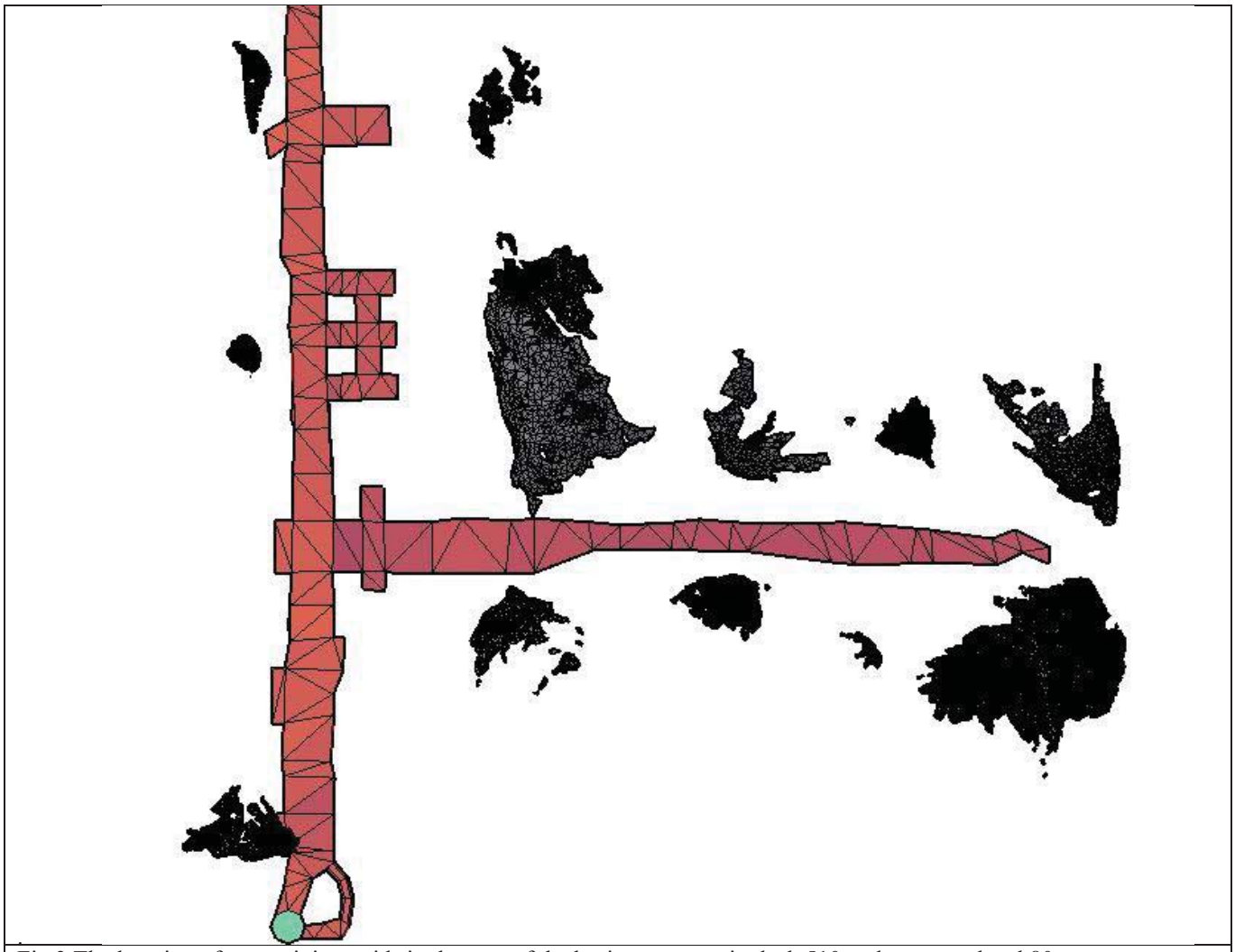

Fig.3.The location of post-mining voids in the area of the basic pavement in deck 510 and ramps to level 80 m.

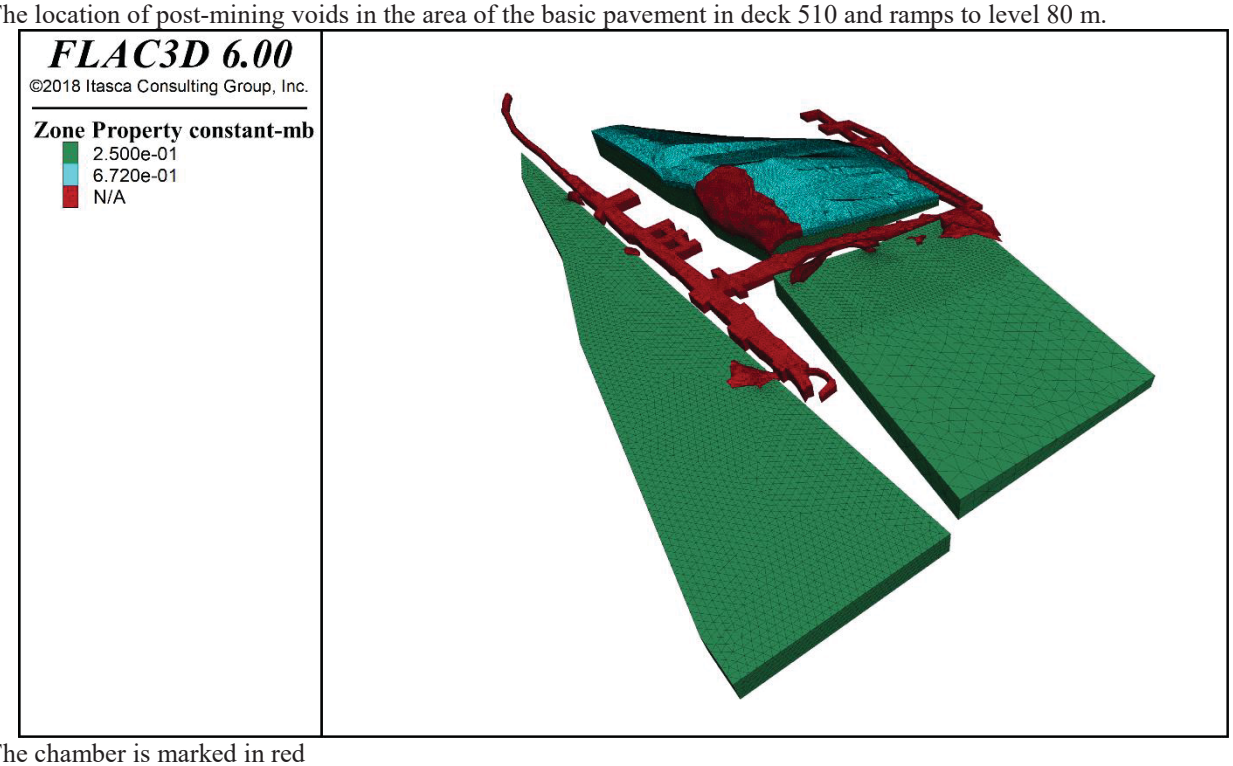

Fig.4.The chamber is marked in red

. The obtained results provide the basis for the preparation of subsequent concepts of securing unstable voids. The main task of the planned activities should be to limit any reactions in the terrain. Thanks to the use of a 3D scanner, it becomes possible to constantly monitor physical changes in the rock and monitor the terrain on the surface.

. In order to control changes in the terrain as a result of possible degradation of floor rocks, it is recommended to perform surface monitoring of the analyzed area, based on measurements performed in geodetic control networks and points located on construction works. The proposed solution of terrain surface monitoring will make it possible to determine displacements and deformations of the terrain surface, as well as their periodic increase[6].

. In the whole area that is of interest to us, protective pillars for buildings and other facilities, both surface and underground, were established and removed at various times. All these factors in connection with mining, as well as the corridor headings with unknown filling and level of degradation, and with variable hydrogeological conditions, make it difficult to accurately predict all possible threats that may appear in the analyzed area and on the surface of the area in the zone of its influence [7].

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