ANNEX E

ROI ANALYSIS OF BIM IMPLEMENTATION

Adopting BIM in an AEC industry firm can be analysed as any other investment we can think of businesswise. In this section the **Return on Investment** (ROI) of the initial investment for BIM adoption will be analysed based on a white paper released by Autodesk [1], with several variations to accommodate relevant variables. As described in the previous section, the BIM implementation process goes beyond this initial investment in both complexity and cost. Nevertheless, this analysis is only offered to give a general view on what has to be considered and what can be expected in early stages of adoption.

Return on Investment is defined as the earnings derived from an investment divided by the cost of the investment.

$$ROI = \frac{Earnings}{Investment}$$

The variables considered for this analysis will be the following:

A0 = Initial investment (€): It considers investment on hardware upgrade, BIM software licensing and personnel training.

A1 = Implementation process investment (€): It considers the budget assigned to a BIM implementation plan, with included costs of consultants and assigned managers.

B = Labour cost (€/month): It represents resources spent on staff and destined to productivity.

C0 = Recovery time (months): Personnel performance drops to rise again during training. When training is over, productivity level is expected to be higher than before. Recovery time represents the time needed to recover the initial pre-BIM productivity, and does not make reference to the length of the training process.

C1 = Training process time (months): During the training process productivity grows until it reaches a higher level of productivity. At that moment training process time (C1) is considered finished.

C2 = Resource recovery time (months): This parameter defines the period of time needed to earn net benefits from the achieved productivity increase.

D = Productivity loss (%): When first adopting BIM productivity drops below normal performance. Loss is expressed with respect to pre-BIM productivity.

E0 = Productivity gain (%): Once training is over productivity has increased. It represents performance increase with respect to pre-BIM status.

E1 = BIM engagement productivity gain (%): As BIM implementation progresses towards IPD, advantages that favour performance become more evident. It represents the increase of productivity achieved in IPD with respect to pre-BIM status.

To carry out this simplistic ROI analysis, some basic considerations have been made. Usually, when adopting BIM, staff productivity drops at the start. As training is imparted, performance starts to increase until it reaches an initial productivity gain, which is higher than before. To model performance, a bisymmetric sigmoid learning curve has been chosen. Net benefits appear once performance gain has compensated the lost resources during the recovery period. The resource recovery time (C2) is obtained as follows:

$$C_2 = \frac{C_1 \cdot (E + D)}{2 \cdot E}$$

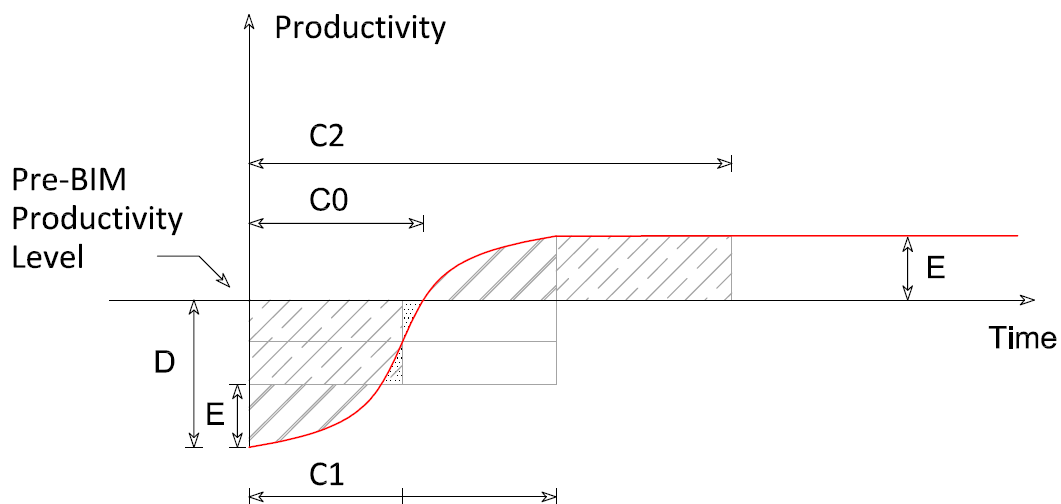*Figure 1* shows graphically how the resource recovery time (C2) is obtained.

Figure 1: *Productivity curve at initial stages of BIM adoption*

Earnings will be quantified by the part of the resources that are destined to an increased productivity. As mentioned, benefits start to appear at the resource recovery time (C2), when training has finished and a certain period of time has passed. For the scope of this work, BIM engagement productivity gain (E1) will not be used, as little information has been yet surveyed on how IPD is achieved time-wise and the performance gain it represents. Nevertheless, it is a valuable parameter to keep track of the BIM implementation process. According to BIM users surveyed, a close relationship between BIM engagement levels and ROI perception exists [1] [2].

Cost of investment will be characterized by the investments needed (A0, A1), and part of the resources that have not been destined to productivity with respect to normal performance levels. This makes reference to the decrease in productivity during training (D). As mentioned before, the learning curve considered is bisymmetric, and therefore productivity is under normal levels during the recovery period (C0). For simplicity, and to stay in the conservative side of the analysis, a constant productivity decrease (D) will be considered during this interval.

The analysed ROI is suited for post resource recovery time (C2). Time (T) is defined in months. The considered formula is as follows:

$$ROI\ (T) = \frac{B \cdot \left(\frac{E}{1+E}\right) \cdot (T - C_2)}{A_0 + A_1 + (B \cdot D \cdot C_0)}$$
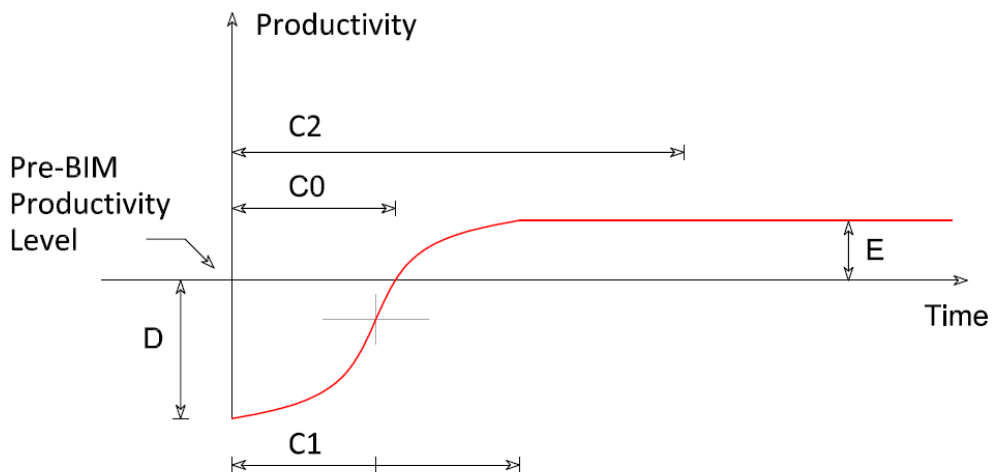
Figure 2: Productivity curve at initial stages of BIM adoption

The provided formula for ROI analysis has various limitations. Although it is appropriate for initial analysis, more complex processes have to be quantified and estimated. Implementation costs go beyond initial investment, and consultancy and assistance costs have to be considered as well. Furthermore, earnings can see unexpected increases as the adopting firm becomes more engaged with BIM use. These earnings can come from marketing new businesses to clients, improved project quality that facilitates repeat assigned jobs, linking BIM to analysis tools that improve productivity and so forth [1].

To give a brief view on what ROI can be expected to be on the first year of BIM adoption, an example will be developed. If we consider a medium sized architectural or structural design firm of fifteen employees for instance, we can now proceed to estimate the ROI variables. For these estimations, the next parameters are considered:

- 15 employees.
- 1300€/month · employee.
- 15 desktop computers.
- 100€/GDRR5 2GB Nvidia GEFORCE GTX 650 graphic cards (These are basic hardware upgrades).
- 5500€/year Autodesk Building Design Suite Licencing.
- 570€/ A3D BIM Consulting Autodesk Revit Courses lasting 5 months.
- 2000€/month during 6 months A3D BIM consultant.
- 3 months productivity recovery time, 50% productivity loss and 25% productivity increase based on surveys made by Autodesk[1] and exposed in their "BIM's Return on Investment" whitepaper [1].

Following, the variables for the ROI analysis are shown:

- **A0: Initial investment = 5500+1500+8550 = 15550€**
- **A1: Implementation process investment = 12000€**
- **B: Labour cost = 19500€**
- **C0: Recovery time = 3 months**
- **C1: Training process time = 5 months**
- **C2: Resource recovery time = 7.5 months**
- **D: Productivity loss = 50%**
- **E0: Productivity gain = 25%**

Therefore, the ROI for a medium sized design firm in the first year of adoption is:

$$ROI\ (12) = \frac{B \cdot \left(\frac{E}{1+E}\right) \cdot (12 - C_2)}{A_0 + A_1 + (B \cdot D \cdot C_0)} = \ 31\%$$

A ROI of approximately 30% for the first year of adoption can usually justify the implementation of BIM in AEC industry firms. Nevertheless this particular example only illustrates one estimated case. There are many types of firms that vary in size and work procedures. Therefore it is prudent to acknowledge that every firm has to develop their own ROI study. If they do implement BIM, then it is highly recommendable to follow track of ROI in order to contrast implementation achievements.

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[1] Autodesk commissioned an online survey of users of their Revit® Architecture software in December 2003. Approximately 100 users provided responses to the survey.

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