

# ASSESSING RISK FOR STRATEGY FORMULATION IN STEEL INDUSTRY THROUGH REAL OPTION ANALYSIS

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## ABSTRACT

*While the efficiency of financial systems rests primarily on proper risk assessment and management, real option valuation (ROV) grounds strategic thinking and decision making analysis. Starting with the adoption of ROV in capital budgeting process, risk is assessed in a way so that it can be prevented or exploited or both, creating future options that incorporate uncertainty and provide flexibility. Taking both statements into concrete consideration, this paper analyses the risk faced by SMEs in the steel industry, aiming to exploit it in a different perspective. Despite the fact that the participation of SMEs in this industry is growing, many of them are still facing problems in allocating limited resources, assessing risk and strategic planning - financially or non-financially. ROV is capable to provide solutions to deal with the lack of SMEs strategic management practices by providing general application guidelines on risk assessment for the purpose of strategic planning.*

**KEYWORDS:** Real Options, Strategic Formulation, Risk Assessment, SMEs

## INTRODUCTION

Risk is defined by Collins Concise Dictionary & Thesaurus (2006) as “*the possibility of bringing about misfortune or loss*” which also bear the same meaning as “*danger, hazard, pitfall, peril and uncertainty*”. Taking this definition into economic perspective, risk is future uncertainty which needs to be managed in order to avoid variety of consequences ranging from negative surprises to permanent loss (Triantis, 2000).

It is important to emphasize risk assessment in managerial activities. Firms manage risks for various reasons. For example, in current conditions where input suppliers hold their reserves to enjoy profits on surging market and higher prices, there is a need to enter into a contract with better terms thus agreed upon a specific price (Triantis, 2000); or face the risk of incurring higher input cost for production in the future. Firms should plan to maintain a steady cash flow so that the risk of falling short of earnings is avoidable (Triantis, 2000). Maintaining a “proper” flow of revenue is also part of tax strategy to avoid the risk of paying higher tax (Chapman, 2006). Reducing variability and volatility of cash flow lead to higher after tax profits. In undertaking new investments, proper risk management will reduce the incidents of decreasing value of investment decisions and reduce the probability of costly external financing on firms’ value (Triantis, 2000; Chapman 2006). Early recognition of possible risk facilitates the achievement of optimal investment. Chapman (2006) adds that risk management gives the opportunity to “copy” industry peers to avoid underperforming benchmark and increase firms’ value that result in increment of firms’ value thus lower the probability of bankruptcy, lead to better access to capital markets and increase debt capacity.

With the various advantages profited from managing risk, apart from being illustrated above, limited number of businesses especially small and medium enterprises (SMEs) are putting serious effort into this activity (Wang, Walker & Redmond, 2007). Risk management is seen as a sophisticated activity that belongs only to big corporations.

With the emergence of SMEs as a new economic driver for many countries, SMEs’ natures of business are not limited to simple and traditional activities anymore. Higher participation of SMEs in many complex activities such as steel industry is noted in Belgium, Indonesia, China and India (Culkin & Smith, 2000; Sato, 2000; 2009). It flags that SMEs are in great need to practice a proper way of managing risk. Furthermore, with the support of governments’ policies in many economic agendas (Abdullah & Bakar, 2000), SMEs should exploit the opportunity to grow and prosper. Yet, there are questions arise when it comes to managerial approach of risk assessment:

- a. How SMEs are able to approach risk from an economic perspectives?
- b. How risks observed are integrated into strategic management practices?

Proposing to include additional step of real option valuation (ROV) into risk assessment process, this paper aims to answer to above questions. By performing a case study based on stylized facts in first stage steel processing, it hopes to contribute to enrich the literature towards the usage and application of ROV (Trigeorgis, 1993b). The results also propose solutions to SMEs on how risks should be exploited and turned into opportunities, thus able to be incorporated into their strategic practices.

This paper is structured as follows. The next section, Section 2 summarizes the development of risk management in capital budgeting and risk management without the attachment onto any financial derivatives. With the introduction of ROV into the assessment process, risks especially those related to operational uncertainties are assessed before being incorporated into the evaluation. Section 3 illustrates the framework of study before analyses of risk management process is conducted in Section 4. The results are discussed and concluded in section 5.

## LITERATURE REVIEW

Risk management started to gain attention when Bowman (1980) identifies the “risk-return paradox”. According to the paradox which based on investors’ viewpoint, stocks with greater risk need to offer higher return so that it attracts risk-averse investors’ interest. Yet, Bowman’s finding shows totally opposite result. He finds that firms with greater return have actually lower level of risk. This is due to strategic practices which adapt skilful, rigorous and continuous activities of risk management (Bettis, 1983). Since then many development of risk management approaches, processes and tools emerged.

One of the developments includes real options theory which emanates from the seminal article of Black-Scholes and Merton on European and American options in 1973. The key element argued by this theory is the failure of Net Present Value (NPV) to include uncertainty and provide flexibility in pricing up investment. This weakness leads to undervaluation (Trigeorgis, 1993a), difficulties in incorporating investment decision into strategic planning (Bierman, 1988) and very rigid for firms to react to continuously changing environment (Luerhman, 1998; Pogue, 2004). Ross (1995:101) insisted that *“For most investments, the usefulness of the NPV rule is severely limited”*.

Real options adapt financial options parameters which based on operational activities (Kogut, 1991). Real options are relevant to strategists as all decisions are made based on the ability of firms to allocate resources that fit into strategic mission (Bowman & Hurry, 1993). Options also grant the “preferential access to future opportunity” (Bowman & Hurry, 1993: 762). Furthermore, the beauty of real options is it includes both the options of undertaking activities or acquiring resources (Sanchez, 1993). These advantages are quantified, providing quantitative intuition for decision making process (Luerhman, 1998).

With uncertainty and flexibility being incorporated into investment evaluation and strategic planning, managers hold the ability to select an outcome only if it is favourable (McGrath, 1997). It is seen as a risk management tool because of the ability to limit negatives outcomes (Bookstaber, 1981; Bowman & Hurry, 1993; Sanchez, 1993) which are consistent with the aim of risk management (Triantis, 2000; Chapman, 2006).

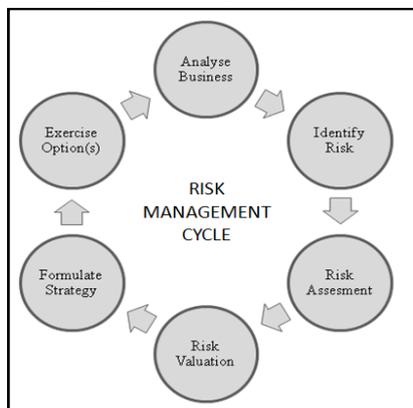
Real options allow a subtle different understanding between corporate investments and risk (Bowman & Hurry, 1993; Sanchez, 1993; Trigeorgis, 1993; McGrath, 1999). The method of application varies, to highlight some of it: from quantitative approaches applied in capital budgeting (Brennan & Schwartz, 1985; Trigeorgis, 1993a,b; Kellogg & Charnes, 2000) to more qualitative approaches such as in measuring value creation and strategic planning (Luerhman, 1998; Amram & Kulatilaka, 2000; Smit & Trigeorgis, 2006), evaluating corporate social responsibility (Kanter, 1999), risk management (Bowman and Hurry, 1993; Miller and Reuer, 1996) including the preparation of contingency plan (Rogers, Gupta and Maranas, 2003).

## METHODOLOGY

The research conducted in this study follows a stylized fact case study approach, similar to other studies in the field of real options, such as Brennan and Schwartz (1985), Dixit & Pindyck (1994) and Trigeorgis (1996), in the case of natural resource activities. This approach requires of the construction of a base case with various sources of information representative in a worldwide scenario. The analysis adapts the general risk management process by Chapman (2006). The original steps of this process begin with analysing business and its environment. Next, risks are identified and assessed before formulating strategies. According to Total Model Value by Boer (2002:76), risks affect economic and strategic capital. So, it is suggested that apart from Chapman’s process, another step of valuation

should be included to provide more quantitative intuition in risk management. As a result, a comprehensive risk management process is derived (refer to Figure 1).

**Figure 1: Risk Management Cycle (Source: Own design)**



The process is a cyclical process as to suit constantly changing environment. It starts with analysing the business characteristics: strength, weaknesses, opportunity and threats (SWOT) – the mostly applied strategic assessment tool. Next, relevant risk exposures are identified. Each risk is assessed individually and collectively before been measured and valued according to ROV method. The valuation process applied in this study follows a methodology of log-transformed binomial lattice approach developed by Trigeorgis (1991). Calculations are performed using *DerivaGem* (Hull, 2010). The values are later added to traditional NPV for more meaningful value. The result, term as Enlarged Net Present Value, incorporates uncertainties i.e. in this case – risks; and provide flexibility (Trigeorgis, 1993a) as per equation 1.

$$\text{Enlarged (or Strategic) NPV or ENPV} = [\text{NPV} + \text{Real Option(s)}] \quad [1]$$

Later, strategy is formulated to suit firms’ interest and mission. When uncertainty becomes plain into view and options are approaching its expiry, firms will choose the best options to be exercised. The cycle will restart after this and constantly proceeds to react to the continuously changing environment.

## ANALYSES

Based on the framework drawn in Section 3, this section analyses the process of risk management from *Step 1: Analysing Business Characteristics* of the new investment in mini-mill first stage steel processing, until *Step 4: Risk Valuation*. This section aims to demonstrate how ROV is feasible and practicable to manage risk, taking an example of SMEs’ activity in mini-mill smelting project in first stage processing of steel.

Mini-mill approach required low specific investment that attracts new comers (Bonmo, 1998), which supports the recent growth of SMEs’ participation in steel industry (Culkin & Smith, 2000). Production system of mini mill is able to reduce man hours per tonne by minimum 60%, giving greater flexibility on the process and has lower impact on the environment. As the plant is small in scale, it has the possibility to be located near steel users’ plant. Many technical advantages of this approach such as replacing the use of coke ovens with COREX process from VAI, thin slab technology for hot strip production including continuous linking of downstream pickling and cold rolling makes mini-mills more preferable among investors.

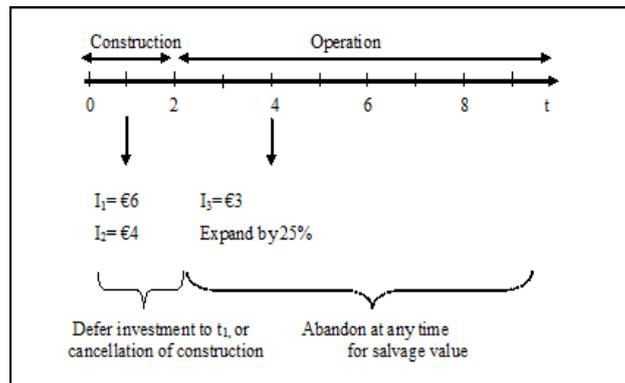
## Business Analysis and Case Background

Let say, there is a new proposal of building up an iron smelting plan based on new process innovation, mini-mill iron smelting. The investment requires €10 million, €6 million in  $t_0$  and €4 in  $t_1$ , i.e. €9.81 million discounted at 5%. By investing this amount, the firm will have a mini-mill plant with capacity of producing 182000 tons per year. However, due to Kyoto Protocol, the plant is allowed to produce only up to 75% of its capacity in order to maintain emission and effluent at minimum level. If the levels of emission and effluent exceed the allowable levels, the firm will be penalized.

**Table 2: Net cash flow calculation during operation period (€ in millions)**

Year	Production Rate (%)	Gross Revenue	Fixed Cost	Variable Cost	Net Cash flows ( $k = 12\%$ )
2	14.8	8.19	2	6.825	(0.635)
3	45	24.57	2	20.475	2.095
4	75	40.95	4	34.125	2.825
5	75	40.95	4	34.125	2.825
6	75	40.95	4	34.125	2.825
7	75	40.95	4	34.125	2.825
8	75	40.95	4	34.125	2.825
9	75	40.95	4	34.125	2.825
<i>V</i>					<b>9.25</b>

**Figure 2: Investment project with expected option of deferring investment, cancellation during construction, expansion and abandonment**  
(Source: Own design)



Net cash flows are calculated by extracting all fixed costs and variable costs from gross revenue. For production rate below 50%, fixed cost is €2 million, and for above 50% it becomes €4 million. Table 2 shows the detailed calculations to reach the net cash flows of *V*. The risk-free interest rate is 5% (continuously compounded 4.879016%) and the average adjusted-risk rate is 12%. Average volatility of output prices is 30%. The expected project life is estimated to be 10 years, including two years of construction period. The project is summarized in Figure 2.

With *V* of €9.25 million and *I* of €9.81 million, the *NPV* of the project following traditional approach is €-0.56 million (*negative NPV*). Later, the amount of *NPV* will be incorporated with ROV to derive at *ENPV*.

## Risk Identification

In this section, risks identified are relevant to the above investment and mostly related to operational activities. Uncertainty is hedged with options rather than using derivatives in financial markets. In short, the possibility of hedging with derivatives is totally disregarded in this study.

Steel industry is highly concerned about the risk of operational hazard like explosion, fire and radioactive contamination especially when it comes to producing as mini-mill plant (Schütz, 2003). Explosion and fire are caused by incidents in furnaces that involve oxygen and highly flammable materials used in heat production. Mishandling of ferrous scraps such as CS 137 and CO 60 may result in radioactive contamination thus incur expensive cleaning cost if happen.

The other type of steel industrial risks is less serious but more complicated to deal with – business interruption risk. The first interruption is fluctuation in price of inputs and outputs. Input prices is controlled by major producers and adapted by other small miners as benchmark (Bilous & Hon, 2004; Robertson, 2008), while outputs are traded in terminal exchange market like London Metal Exchange (LME) and Commodities Exchange New York (COMEX), resulting in little influence for steel producers to control raw material cost and revenue.

As the business is involving in hazardous activities, there is usually higher requirement to be followed and certified causing additional interruptions of legal, taxation and environmental regulation. Steel industry has to compile with many and complex environmental law imposed that nowadays become more and more critical such as awareness to Kyoto Protocol. Tax regime is also continuously changing depending on government interest and current economic situation.

Technical risk is also an interruption which due to obsolesce of technology regardless in line with process and production, hazard prevention or business management. With competition getting stiff, evolutions in technical aspects have been developed to overcome pollution, reduce production cost and improve product quality. Therefore, for a business to survive in this industry, awareness in such development is essential. Finally, the project is also exposed to financial risks when it comes to debt and borrowing cost interest rates and currency exchange risks.

## Risk Assessment

Based on the above risks identified, several precautionary steps to overcome risks have been identified and established by creating four types of real options. The options are option to defer investment, option to cancel investment, option to expand investment and option to abandon investment for salvage value.

*Option to defer* (Tourinho, 1979; McDonald & Siegal, 1986; Paddock, Siegel & Smith, 1988), is valued as an American call. Project initiation may be delayed to next year,  $t_1$ . The projected net cash flows will remain static but the cost of investment will increase by 5%.

*Option to cancel during construction* is valued as a compound option of a call on a put (Cortazar & Schwartz, 1993). With this option, construction can be cancelled at any time without any penalty. The firm might earn any invested amount, being discounted at the adjusted-risk rate of 12%. Once cancelled, the project cannot be deferred, expanded or abandoned.

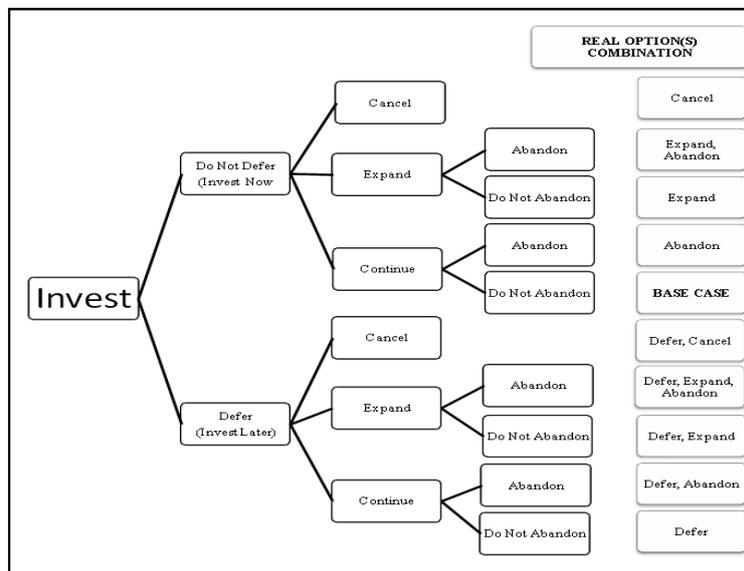
*Option to expand* (Brennan & Schwartz, 1985; McDonald & Siegal, 1985; Pindyck, 1988; Myers & Majd, 1990) is valued as a European call. At year  $t_4$  the firm has the opportunity to increase capacity by 25% without being penalized for polluting the environment according to the Kyoto protocol. The expansion activity includes improvement in process innovation, up-to-date hazard prevention equipment and upkeep with technical advancement.

*Option to abandon* is valued as an American dividend paying put (Myer and Majd, 1990). At any time the project can be abandoned for alternative use and enjoy a salvage value of, in principle, 50% of accumulated capital outlays net of 10% average annual depreciation, being discounted at adjusted-risk rate of 12%. Table 3 summarizes the purpose of these options.

**Table 3: Types and Purpose of Options**

Types of Option	Purpose
Deferral	<ul style="list-style-type: none"> <li>To deal with extreme fluctuation price in input and output prices and wait until uncertainty becomes plain in view.</li> <li>To hold investment so that information on latest environmental concerns/issues is evident.</li> <li>To plan for better tax planning so that able to benefit from tax incentives or to reduce tax rate imposed on heavy/hazardous activities.</li> <li>To provide an opportunity by performing stage-investment strategy.</li> </ul>
Cancellation	<ul style="list-style-type: none"> <li>To obtain financial flexibility in the case that investment cost increase higher than perceived.</li> <li>To avoid extra legal and taxation cost if hazardous accidents happen during construction.</li> <li>To avoid further losses if demand is not competitive.</li> </ul>
Expansion	<ul style="list-style-type: none"> <li>To equipped plant with better technology to prevent hazardous risk and technical risk of obsolesces, resulting in better production process and quality.</li> <li>To keep up with increase in demand without violating environmental law and avoid penalty.</li> </ul>
Abandonment	<ul style="list-style-type: none"> <li>To stop production and enjoy salvage value if output prices fall beyond profitable rate.</li> <li>To cease operation if legal suit leads to further losses or bankruptcy.</li> </ul>

**Figure 4: Combination of options for the investment according to the proposed sequence (Source: Own design)**



Besides these four individual options, there is possibility of two or more options being combined together as a portfolio. It is crucial to analyse the sequence of options in order to identify any possibility of combining several real options embedded in the nature of an investment project. Smit (1997), for example, has identified the stages in petroleum concession project before valuing it.

For example, from the base case, first, the firm has an option whether to invest now or defer investment. Later, by choosing an option to invest, it opens up to more options. After investment is taken, the firm may choose to cancel it during construction. However, by exercising this option, it closes the opportunity of incorporating other options later. If construction proceeds, investment has the options to expand and/or abandon in later time. Figure 4 shows possible option combinations for the investment according to the sequence proposed.

## Risk Valuation

The next step performed in this analysis is to value risks which have been incorporated into options using ROV and integrate it into evaluation of project investment. The options are valued individually and collectively as combinations of several options using *DerivaGem*. The results of valuation are presented in Table 4.

**Table 4: Values of options, ENPV and interactions (€ in millions)**

Item	Value of Option	ENPV	Interaction <sup>a</sup>
Individual option <sup>b</sup>			
Defer	1.48	0.92	Not Applicable
Cancel	0.17	-0.39	
Abandon	1.17	0.61	
Expand	3.22	2.66	
Value with two real options <sup>c</sup>			
Defer and cancel	0.23	-0.33	-1.42
Defer and expand	2.12	1.56	-2.58
Defer and abandon	1.63	1.07	-1.58
Expand and abandon	1.81	1.25	-2.58
Value with three real options <sup>d</sup>			
Defer, expand and abandon	2.37	1.81	-4.14
<sup>a</sup> The value of the combined options minus the sum of separate values i.e. (defer and expand) – (defer + expand). <sup>b</sup> Refer to Appendix A1 – A4 for details. <sup>c</sup> Refer to Appendix A5 – A8 for details. <sup>d</sup> Refer to Appendix A9 for details.			

## DISCUSSION AND CONCLUSION

With the capability of real options evaluating investment with incorporation of uncertainties and provision of flexibility, it is possible to integrate risk in strategic planning. Risk and flexibility are translated by providing opportunity for managers to defer, cancel, expand and abandon investment (Triantis, 2000). It is important for managers to understand that by deferring commitment under uncertainty can help firms to avoid losses and enhance firms' value.

Managing risk using ROV as a tool starts with analysing business characteristics. Risks are identified and assessed before being valued. The results obtained from these steps are taken as a benchmark in strategy formulation. Once uncertainties are clearer and plain, managers will choose the best strategy to be exercised that suit firms' interest. After an option is exercised, the whole process has to be performed again so that additional/new risks are identified, assessed and valued before a new set of strategic planning is formulated. This process will continue along project life span over time.

The advantages of ROV are higher compared to financial hedging as real options open up more opportunity. In some cases, risk hedging is only possible with real options especially if uncertainties are related to technical aspects, competitiveness issue, legal/taxation regulations and fluctuation in demand. Projects back up with financial hedging contracts in currency exchange or interest rates would be more secure with the complementary of real options.

ROV included in risk management activities helps firm minimising risks and maximise firm value as proved against the risk paradox (Bowman, 1980). Strategic practices which adapt skilful, rigorous and continuous activities of risk management allow firms to enjoy higher profits (Bettis, 1983) and ROV is seen as a highly potential tool for this purpose. Real options is obviously capable as risk management tool. With high potential of free cost in most of the cases, or lower in any cost anticipated in application of financial derivatives for hedging, ROV promises a cheap tool that perfectly suit SMEs limited budget.

## APPENDICES

### Appendix A1. Deferral Option – Figures and Calculation

$V = €9.25$  million     $K = €10.5$  million    Option price = €1.485 million     $ENPV = €0.925$  million

### Appendix A2. Cancellation Option– Figures and Calculation

$V = €9.25$  million     $K_{CI} = 6(50\%) = €3$  million     $K_{CN} = K_{CI} + [4(50\%)]/1.12 = €4.79$  million

Option price = €0.17 million     $ENPV = €-0.56$  million + €0.17 million = €-0.39 million (negative ENPV)

### Appendix A4. Abandonment– Figures and Calculation

$V = K$  discounted at 12% = €4.435 million     $K = €5$  million    Option value = €1.17 million

$ENPV = €-0.56 + €1.17 = €0.61$  million

### Appendix A3. Expansion Option – Figures and Calculation

$V = €5.21$  million    Additional investment,  $K_A = €3$  million / (1.05) = €2.47 million

Option value = €3.22 million     $ENPV = €-0.56$  million + €3.22 million = €2.66 million

Table A3-1: Revenue ( $V$ ) of expansion option - gross and discounted (€ in millions)

Year	Additional Gross Revenue	Less: Additional Variable Cost	Additional Net Cash Flows	Additional Discounted Cash Flows
5	13.65	11.375	2.275	1.291
6	13.65	11.375	2.275	1.153
7	13.65	11.375	2.275	1.029
8	13.65	11.375	2.275	0.919
9	13.65	11.375	2.275	0.820
Total $V$				5.212

### Appendix A5. Deferral and cancellation– Figures and Calculation

$V = €9.8$  million     $K_{CI} = €2.8$  million     $K_{CN} = €4.5$  million    Option price = €0.23 million.

$ENPV = €-0.56$  million + €0.23 million = €-0.33 million (negative ENPV)

### Appendix A6. Deferral and expansion– Figures and Calculation

$V = €3.92$  million     $K = €2.4$  million    Option value = €2.12 million

$ENPV = €-0.56 + €2.12 = €1.56$  million

### Appendix A7. Deferral and abandonment– Figures and Calculation

$I = €10.5$  million     $V =$  discounted depreciation at 12% = €3.82 million

$K = 50\%$  of  $I = €5.25$  million    Option value = €1.63 million     $ENPV = €-0.56 + €1.63 = €1.07$  million

### Appendix A8. Expansion and abandonment– Figures and Calculation

$V = €5.124$  million     $K = 50\%$  of Investment = €5 million    Option value = €1.81 million

$ENPV = €-0.56 + €1.81 = €1.25$  million

### Appendix A9. Deferral, expansion and abandonment– Figures and Calculation

$V = €4.541$  million     $K = €6.825$  million    Option value = €2.37 million

$ENPV = €-0.56 + €2.37 = €1.81$  million

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