MTU AERO ENGINES AG

COMPANY REPORT

AEROSPACE AND DEFENSE

4 JANUARY 2019

FRANCISCO CASTANHO, MAKSIM DEFER

francisco.castanho@novasbe.pt
maksim.defer@novasbe.pt

Full steam ahead for MTU as end-customers drive demand for engines and maintenance

- Currently trading at EUR 157.8, we value MTU shares with an **upside potential of 25.1%** until December 2019 (**EUR 197.4**) justifying our **buy recommendation; consensus TP at 190.3**
- Our bullish view is supported by a **more positive outlook on MTU's production ramp-up and commercial position** regarding the GTF. Moreover, we also see its **Polish and Chinese JVs being severely undervalued** by investors bearing a **share price upside potential of EUR 26.3**
- MTU holds a **strong Tier-1 competitive position** in both segments (OEM and MRO) with **great market prospects driven by recent and future engine programs**
- **Commercial OEM revenues** to experience a **spike in 2018F (c. 30%; organic)** resulting from a production ramp-up and **massive GTF deliveries**. Overall, **impressive competitive dynamics** thanks to **new engine programs** (mainly GTF) resulting in an estimated **topline CAGR of 6.6% until 2027F**. **Profitability expected to pick-up** after GTF ramp-up eases down and MTU enters a smooth consolidation phase with **EBIT margins up from c. 8.1% in 2019F to c. 9.6 % in 2025F**
- **MRO** continues a **success story** thanks to V2500's reign and GTF boost in years to come; top-line to see **c.16% CAGR over 2020F and c.6% over 2027F**, although with lower operating margins as a result **of the business model transition**

Company description

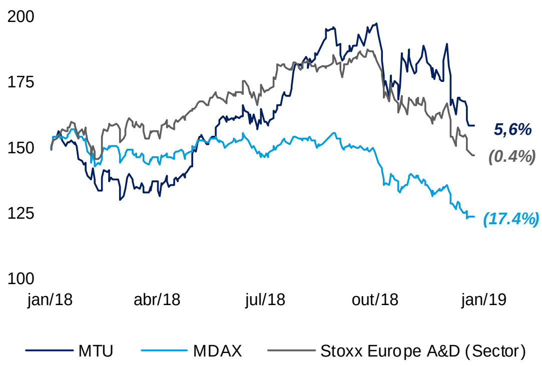
MTU Aero Engines AG is a German producer of engine parts for both civil and military aircraft. By also operating in engine MRO it covers the entire engine lifecycle. It partners with the main engine OEMs - GE, Pratt & Whitney and Rolls-Royce - producing engines for the world's largest aircraft producers (e.g. Airbus and Boeing)

Recommendation:	**BUY**
Vs Previous Recommendation	*n.a*
Price Target Dec. 2019:	**197.4 €**
Vs Previous Price Target	*n.a*
Price (as of 2 Jan 2019)	**157.8 €**

Bloomberg as of 02/01/2019

52-week range (€)	129.2-198.7
Market Cap (€m)	10,030.9
Fully diluted shares outstanding (m)	55.5

Source: MTU, Bloomberg



Source: Bloomberg; Note: Rebased as of 02/01/2018; Percentages highlight 1-year performance

(Values in € millions)	2017	2018E	2019F
Revenues	5,036	5,804	6,507
EBITDA	723	644	746
EBITDA margin	*14.4%*	*12.3%*	*11.3%*
EBIT	527	492	561
EBIT margin	*9.1%*	*10.5%*	*8.5%*
Net income	393	320	365
Net income margin	*8.8%*	*7.8%*	*5.5%*
EPS	7.4	6.2	7.1
EV/Sales	2.57x	2.29x	2.11x
EV/EBITDA	17.9x	20.6x	18.4x
EV/EBIT	24.6x	27.0x	24.5x
P/E	22.6x	27.0x	23.6x
Leverage	1.4x	1.7x	1.5x

Source: MTU, Analyst estimates

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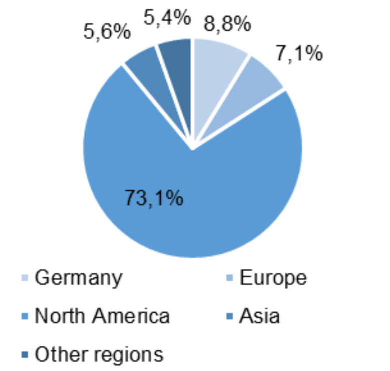
Company overview

Founded in 1934 and headquartered in Munich, Germany, MTU Aero Engines AG ("MTU" or "the Company") is a manufacturer of engine parts with worldwide presence in 12 countries. It operates in two segments (1) Original Equipment Manufacturing (OEM) for commercial and military engines (47.9% and 7.8% of 2017A Sales, respectively) and (2) maintenance, repair and overhaul (MRO) (44.3% of 2017A sales). Through associates and subsidiaries, it is also present in the engine leasing business, thereby covering the entire engine lifecycle. Main parts produced are high-pressure and low-pressure turbines as well as turbine center frames[1]. The Company partners with core engine OEM players – General Electric (GE), Pratt & Whitney (PW) and Rolls-Royce (RR) – which together generate around 64% of MTUs revenues. The majority of revenues are generated in North America, although the company operates production and maintenance facilities also across Europe and Asia. As of 2017A, it employs 8,846 people, of which 68% in OEM and the remaining in MRO.

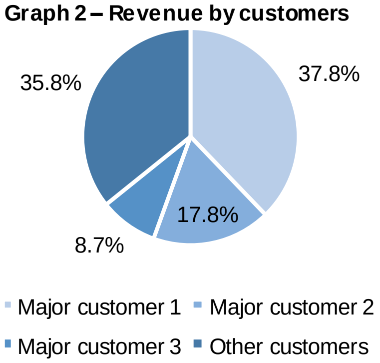
Graph 1 – Revenue by region



Source: MTU

The company went public in 2005 after having been owned by KKR & Co. for two years[2]. Since then, it has grown impressively, generating revenues of EURm 5.036 in 2017A (2006A EURm 2,416). Most recently, the company engaged in the development of an innovative engine solution in partnership with Pratt & Whitney and the Japanese Aero Engine Corporation – the geared turbo-fan engine ("GTF") – which constitutes a highly relevant part of MTUs equity story.

Graph 2 – Revenue by customers

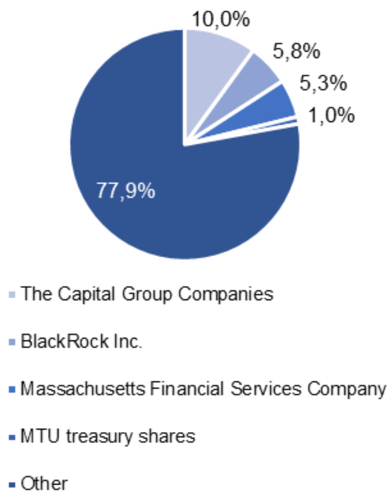


Source: MTU

Shareholder structure

As of 31 December 2017, MTU had 51,499,842 shares outstanding of which 99% were in free float. With 93%, the majority were held by institutional investors, while the rest were held by retail investors (6%) and MTU (1% treasury shares). Around 36% of shares were owned by institutional investors with more than 3% of voting rights according to German Securities Trading Act. The share of institutional investors has constantly increased over the last 8 years from 87%. Its institutional investors are strongly focused in the Anglo-Saxon regions with over 60% being based in the US (32%) and the UK (31%). The remaining ones are from Germany (13%), France (10%) and other countries (13%)[3]. The company regularly engages in buying back and issuing shares for employee and executive compensation purposes (e.g. MAP employee stock option program).

Graph 3 – Shareholder structure



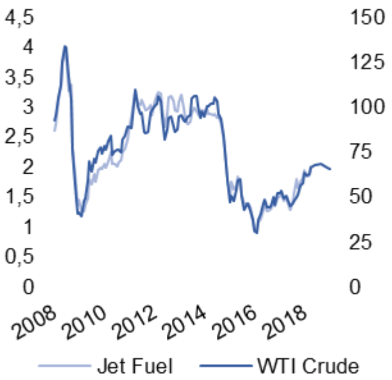
Source: MTU

[1] Additionally, the Company operates in marine and industrial gas turbines and corresponding maintenance. We consider this and the engine leasing businesses to be non-core due to MTUs low strategic focus as well as immaterial revenue and profit contributions
[2] The company had previously been sold by DaimlerChrysler to KKR in late 2003 for an undisclosed amount
[3] MTU annual report 2017. Approximation based on top 50 largest shareholder

Graph 4 – World RPK historical development

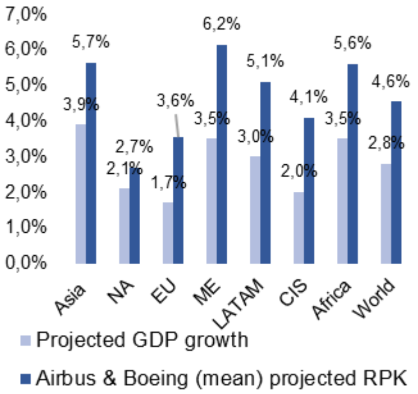
Source: IATA, IMF

Graph 5 – WTI crude oil (USD/bl) and jet fuel price development



Source: EIA
Note: See footnote no.5

Graph 6 – GDP and RPK CAGR 2016A-2036F



Source: Airbus, Boeing, IATA, IMF

MTU and the broad airline industry

MTU's underlying business performance and future development are strongly tied to the wider aviation industry. Specifically, future demand for new aircraft and maintenance of new and existing engines, as well as spare parts these activities generate.

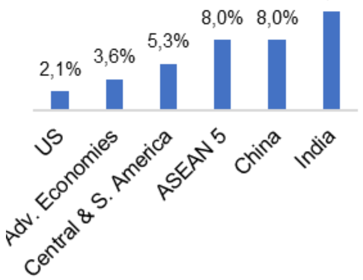
Typically, air traffic demand growth had closely been tied to global GDP growth; however, in the recent past (since 2014) there has been a slight mismatch between both, in which demand for air travel measured by revenue passenger per kilometer (RPK[4]) is outgrowing GDP growth. Key drivers for this decoupling effect have been depressed oil and jet fuel prices together with rising disposable income, expanding middle classes, increased tourism and travel propensity as well as historically low interest rate levels. Excluding the latter, these effects have been more significant in developing markets in Asia (particularly China and India) and Latin America – and they are widely expected to continue in the future, further driving air travel demand rather independently from worldwide GDP growth.

Jet fuel (or oil, more broadly) usually constitutes the largest cost driver for airlines, and it has been at extremely low levels in the last three years; the lower cost structure has allowed for decreasing air fares, thereby driving air travel demand up and pushing up airlines' revenue and operating margins as well as increasing available seats per mile (ASM). Forecasts suggest price levels of USD 65.5/bl by Q1 2019[5], which is still 40% below the USD/bl 109.5 peak in 2011. Even though lower oil prices help fostering demand via lower fares, we expect aircraft demand to reach record growth rates despite oil price developments. The main reason lies in the fact that the new aircraft engine programs already in market (and especially the ones under development) are much more fuel-efficient, aircrafts are lighter and more optimized towards seat/capacity efficiency, driven by increasingly modern technology and design, which can observed in recent aircraft & engine pieces.

As important, tourism has become more prevalent across the globe: disposable income in developing markets has been growing massively, with an increasing share of spending in tourism and travel. These markets are poised to represent the lion's share of growth, with China and India growing this metric at a CAGR of 8% and 11%, respectively, compared with 2.1% and 3.6% in the US and other

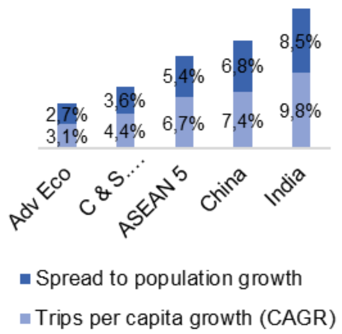
[4] Traditional metric to measure demand for air traffic. RPK measures the number of kilometers (or miles - RPM) travelled by passengers. Airlines typically track RPK in conjunction with ASK (available seats per kilometer) metric, providing them an overview of demand and supply market dynamics
[5] Median analyst price forecasts compiled by Bloomberg as of May 2018. Naturally, these forecasts change frequently, especially in the recent past given constant news and developments emerging about current and future price levels

Graph 7 - Growth p.a. in number of trips 2017A-2018F



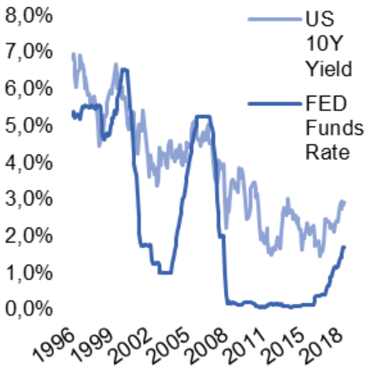
Source: Airbus, IHS, Sabre

Graph 8 – Spread to population growth and trips per capita



Source: Airbus, IHS, Sabre; Note: CAGR 2017A – 2022F

Graph 9– US 10Y T-Bond yield and FED funds rate 1996-2018



Source: FRED

advanced economies, respectively. Forecasts point to persistent growth in worldwide travel demand, with the total number of trips to increase significantly. Again, recent and future key growth comes from emerging markets, especially China and India, where the spread between growth in trips per capita and population growth is much higher compared to advanced economies.

Moreover, low-cost carriers (LCC)[6] have additionally contributed to increased air travel and aircraft demand; the surge in number of low-cost carriers led to the creation of additional routes and intensified competition, driving fares down and creating a cyclical effect resulting in increased travel demand. Over the last 10 years, seat capacity of LCCs has increased by 130% from 0.66bn to 1.52bn, which represents an LCC market share increase of c. 50% from 19.2% to 28.7%. The trend is expected to further continue - again, the Asian region will see strong growth, while Europe and North America are expected to experience a rather moderate expansion.

Record-low interest rates in the recent years have also contributed to passenger and cargo air traffic through higher business and consumer spending as well as cheap financing for airlines and leasing companies.

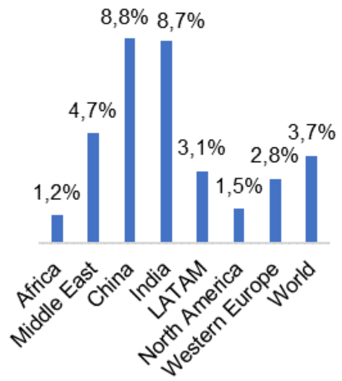
As a result, we expect demand for aircraft and after-market services[7] to increase substantially. The impact on MTU is clear: both the OEM and MRO businesses stand to benefit from an uptick in aircraft, engine and maintenance needs.

Original Equipment Manufacturing (OEM) segment

The market for aircraft structures and engines is mostly organized under "risk-revenue sharing" agreements in which several partners along the value chain combine knowledge, technology and capacity to design parts and components used in the final product, much like the automotive industry. Overall, MTU's supply chain – constituted by the key aircraft and engine OEMs as well as Tier 1-3 suppliers – can be summarized in the figure below:

[6] While there has been an emerging distinction between low cost carrier and ultra-low-cost carrier, we define both in one category "low cost carrier "
[7] Includes maintenance, repair and overhaul as well as spare parts sales

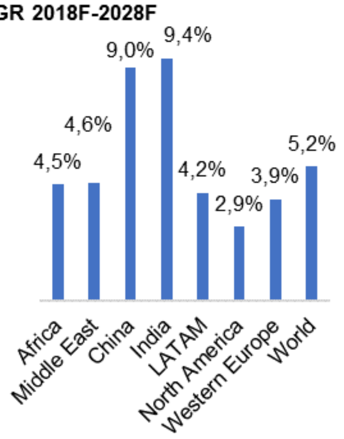
Graph 10 – Fleet size growth by region 2018F-2028F



Source: Oliver Wyman

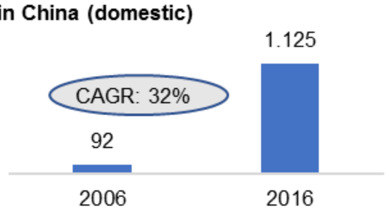
Faced with unseen demand levels, Airbus and Boeing's production sites have never been this busy

Graph 11 – Narrow-body fleet size CAGR 2018F-2028F



Source: Oliver Wyman

Graph 12 – Number of regional routes in China (domestic)



Source: Oliver Wyman

Market dynamics and revenue forecast

Facing increased traffic demand, airlines can react either by increasing load factors[8] or by increasing capacity; however, they have been increasing the former to previously unseen levels: today, fleets are operated at load factors of around 80% on average, compared to 65% just 15 years ago[9]. Hence, it will be highly challenging to increase or sustain these levels further to accommodate expected demand. On the other hand, to increase capacity, airlines can improve asset utilization – flying more hours or delaying retirements – which might be feasible in the short but not in the long-term. Hence, their most realistic option is to increase their fleet size; therefore, industry experts and executives expect the size of the current world fleet to significantly expand by c.3.7% (YoY) until 2028[10], whereby the most significant growth will come from China and India[11]. Mature markets such as North America and Europe are expected to grow at lower digits.

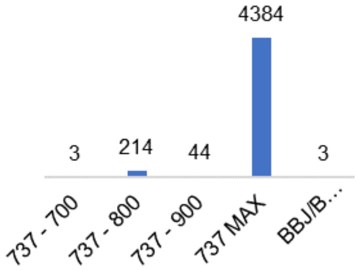
Narrow bodies are expected to continue dominating air travel

The world's narrow body fleet is expected to increase by 5.2% YoY until 2028F, representing the strongest growth compared to all other aircraft types. Over this period, their share will rise from currently 56% to 66%, of which the A320neo and B737 MAX are expected to represent c. 75%, both relevant for MTU.

Nowadays, short-haul routes dominate air travel, and they are widely expected to maintain their relevance going forward. Europe and North America in general have had a higher demand for narrow body jets (27% and 24% respectively) given shorter distances to fly as well as hub-and-spoke routes (particularly in the US). These regions will experience mainly replacement orders from legacy carriers and slight fleet increases as well as larger orders from LCCs in the short term, hence experiencing rather low but stable growth rates compared to developing markets. More significant demand for short-haul aircraft will come from emerging markets, especially within Asia-Pacific, and in particular China and India. These regions have been undergoing strong regional development driven by economic growth and liberalization, which we are confident will remain a strong trend going forward. Traffic between tier-2 and tier-3 airports[12] has in many of these regions been underserved and is expected to grow significantly; the historical development of regional routes in China provides a good example and holds true for other

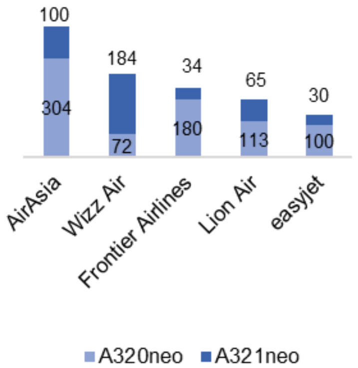
[8] Load factor refers to the ratio of RPK (revenues-passenger per kilometer) to ASK (available seats per kilometer) measuring aircraft capacity utilization, a core operating metric monitored in the industry
[9] Reflects improved scheduling, efficient passenger yield management and technology improvements both in airframe, engine architecture and engineering (IATA 2017)
[10] "Global fleet & MRO market forecast commentary 2018-2028", Oliver Wyman, May 2018
[11] Countries refer to the geographic location where airlines or lessors of aircrafts are based
[12] Tier 1: >15m passengers per year; tier 2: 1m - 15m passengers per year; tier 3: <1m passengers per year

Graph 13 – Total unfulfilled narrow-body orders - Boeing



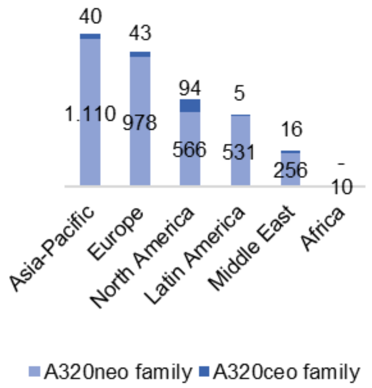
Source: Boeing

Graph 14 – Largest orders for Airbus narrow-bodies



Source: Airbus

Graph 15 – Total unfulfilled narrow body orders - Airbus



Source: Airbus O&D (as of May 2018)

emerging economies such as ASEAN countries, Latin America and India as well. On such routes, mainly smaller to mid-sized narrow-body and regional jets are required to operate at high utilization and fuel efficiency. All in all, developing economies are poised to represent the largest share in fleet growth, with China and India the key growth markets, as well as Middle East and LATAM.

Even though LCCs have started to enter the long-haul market (e.g. Norwegian, AirAsia and WOW Air), they are expected to continue predominantly operating short-haul routes with narrow-body aircraft[13]. Modern, medium-sized models such as the A320neo and B737 MAX present the largest operating performance improvements, providing higher capacity utilization and fuel efficiency. Hence, LCCs are expected to remain key demand drivers for narrow-bodies: of the major outstanding orders for the A320ceo and A320neo families which account for c.80% of total Airbus (unfilled) orders, around 79% are from LCCs[14]. Moreover, Boeing estimates that LCCs will increase their fleet share exponentially over the next 20 years, from roughly 1/4 to about 1/3 of the world's total.

In order to pick up with rising demand for short-haul air travel and to improve operating margins, airlines are increasingly replacing older, less fuel-efficient fleet by new models. Additionally, various routes worldwide which have been served by regional jets increasingly require higher seat capacity. All in all, the most prominent narrow body aircraft platforms – A320neo and Boeing 737MAX – will together account for around 92% of deliveries; indeed, both Airbus and Boeing are facing unseen production rates, expecting to stabilize A320neo / B737 MAX production between 60 and 70 a month in the next year, up from between 40 and 50 during 2017.

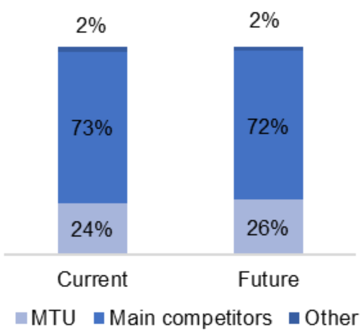
Significant upside potential in the narrow body segment for MTU – GTF vs LEAP

As of today, the most significant narrow body platforms for MTU are the A320ceo families and the Boeing MD-90 range, powered by the V2500 which is being phased-out and currently generates significant aftermarket[15][16] sales. Additionally, the Boeing MD-80 range, powered by the JT8D-20 – also designed by Pratt & Whitney (PW) and MTU – is 2 years away from full market phase-out and is still generating significant aftermarket sales.

[13] Given that establishing the LCC model for long-haul is highly complex – capital, operating, legal and regulatory requirements are much higher. Carriers are usually required to invest in new fuel-efficient aircrafts (e.g. B787) in order to operate profitably
[14] As of 31. May 2018
[15] Aftermarket services includes both maintenance and spare-parts sales
[16] The last engine sale is expected in 2019. In 2018, MTU expects to produce 200-250 engines

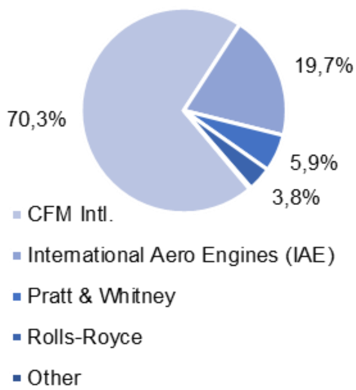
In the long-term MTU expects the GTF to account for c. 50% in A320neo market share

Graph 16 – Current and future market share within the narrow body segment



Source: FlightGlobal as of May 2017

Graph 17 – Commercial narrow-body aircraft: 2016 engine market share

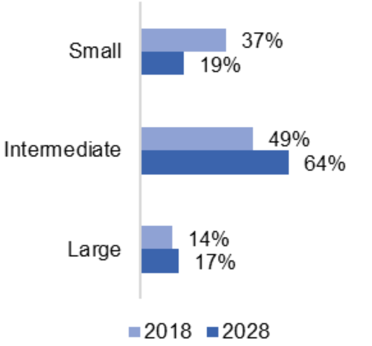


Source: FlightGlobal

Looking forward, the most substantial market share potential for MTU within the narrow body segment lies on the A320neo, which constitutes a significant part of MTU's equity story and growth potential. Given the strong growth of LCCs and the currently largest aircraft orders outstanding, LCCs will be a significant contributor to MTUs revenues in the near future with even more potential in the future. However, the PW1100G[17] engine, one of two engine options for the A320neo, is heavily competing with CFM's (GE and Safran) LEAP engine. Since its release, the PW1100G has been drawing negative attention due to technical issues leading to delivery halts from Airbus and unplanned groundings of operating aircraft. This has led to the LEAP taking on some market share from the PW1100G. However, the LEAP has also faced certain issues[18]. Nonetheless, the GTF has caused more severe delays but it is also worth mentioning that none of them were related to MTU's parts. So far, PW has been able to secure contracts for only 44% of the A320neo family engines while CFM accounts for the rest. As PW has been able to fix the issues earlier this year[19] and a great majority of airplane orders are still unfilled – with many engine choices still to be made[20] – there is still significant upside potential for the PW1100G. Today's customers can be less worried about any minor early stage issues with the engine, as orders placed today will be fulfilled not earlier than 2020, until when they can certainly be fixed. Given the significant future demand for the A320neo, the success of the PW1100G has a crucial effect on PW's and MTU's top line, and not so much for Safran and GE, as their LEAP engine is the sole option for the direct competitor of A320neo, the B737 MAX. Industry experts argue that the GTF family is a novelty, perhaps too much of it - indeed, its underlying technology and design is completely different to what airlines across the world have been used to. This naturally leads them to rely on the LEAP, which is architecturally similar to its predecessor (CFM56). Additionally, the choice between engines may be influenced by the fleet airlines already operate. Given the fact that CFM is the sole engine supplier for the current and future Boeing 737 models, airlines might tend towards CFM engines for new A320neo family orders: equipment alignment with existing fleets tends to generate cost synergies as it allows for faster and thus cheaper training of staff in maintenance, for example. These factors might constitute significant pressure on MTU's PW1100G market share potential. As an example, this year Lion Air ordered 380 LEAP engines following their historical usage of the CFM56 in all their existing fleet. Indeed, CFM has historically

[17] Developed by Pratt & Whitney (a United Technology subsidiary), MTU and Japanese Aero Engines Corporation (JAEC), which powers the A320neo whereas the overall engine family is referred as "PW1000G" or "GTF" (Geared Turbo Fan)
[18] In January 2018, Reuters reported CFM had quality issues with around 70 LEAP-1A engines (A320neo) which had to be overhauled leading to delayed plane deliveries for about a month
[19] MTU additionally confirmed this in its H2 earnings call
[20] As of May 2018, c. 30% of A320neo customers have not decided on the engine choice

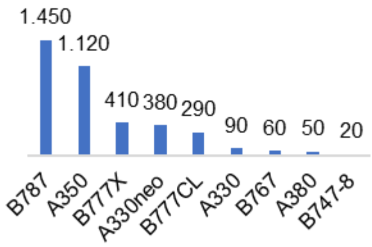
Graph 18 – Wide-body market share by size category 2018F-2028F



Source: Oliver Wyman

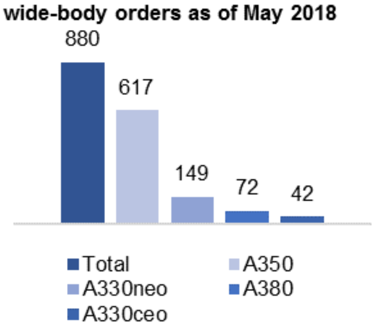
Large-size widebody aircraft accounted for 32% of the active fleet in 1996. In 2017, that number declined to around 11%

Graph 19 – Wide-body deliveries 2018F-2028F



Source: Oliver Wyman

Graph 20 – Airbus total unfulfilled wide-body orders as of May 2018



Source: Airbus as of May 2018

dominated the narrow body engine market with around 70% market share vs. IAE's[21] 20% (key products for both are the CFM56 and V2500, respectively). Finally, some topline potential over the next 10 years will come from around 800 total orders[22] of the MC-21 and C-Series (A220[23]), for which MTU is the exclusive engine supplier (GTF).

Slow and steady growth in the widebody segment

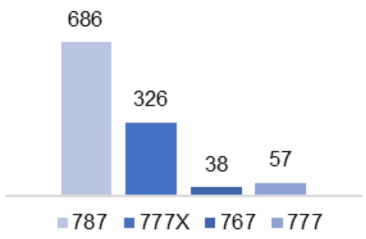
The increased flexibility and efficiency in itineraries demanded by customers across the world has led airlines to focus on adding more frequencies to their route offering, while increasing non-stop flights within their networks. Hence, and in-line with our estimates for narrow bodies, we expect the widebody segment to experience a turnaround with demand for mid-sized widebodies to rise significantly, increasing its market share from 49% to 64% in the next 10 years. This development will take off a large part of market share from small widebodies, which today account for 37% (2028F: 19%). Hence, we see increased demand for the Boeing 787 and Airbus A350-900 which fall in the intermediate size within wide-bodies – substantially more modernized, fuel-efficient and tech-driven than its larger counterparts (e.g. B747-8 and A380)[24].

Despite the overall unattractiveness of large widebodies for most legacy carriers, they are expected to increase slightly from currently 14% in market share to 17%. There are routes under which they can regularly be filled (e.g. London – Los Angeles) and be operated economically. Here we see demand for future replacement and new orders for the 777X and A350-1000. Moreover, Middle East carriers such as Emirates heavily rely on larger widebodies; given their young fleet age, we may see some small additions or replacements in the short-term, but stronger demand over the long-term. Finally, in the (very) long term, there may be positive demand dynamics for larger widebodies given strained airport capacity and saturation of airlines slots, especially as air traffic increases significantly[25]. This might overturn the present "hype" around intermediate/large narrow bodies, that could lead to overpopulation of air-related infrastructures.

[21] IAE (International Aero Engines) is the joint venture between PW, MTU and JAEC together producing the V2500
[22] Oliver Wyman 2018-2028 fleet and MRO forecast
[23] Renamed as A220 by Airbus as it took control over the aircraft program (previously coined "Bombardier C-Series") – presented at Farnborough June 2018 concentration
[24] Newer large widebody aircrafts operate with just two engines whereas the older ones operate with four engines. Hence, the latter are comparatively less fuel efficient because high load factors are often difficult to sustain over the year on super-large widebodies (except in certain regions such as the Middle East), making them overall less efficient and thus unattractive to the majority of legacy carriers
[25] There are certainly physical limits to airport and air space capacity and hence a limit to the total number of aircraft in the year. We believe that the currently observed (and expected) demand - especially for narrow bodies – is not sustainable in the long-term. Therefore, to relieve airports and air space, there is likely to be some shift towards more wide bodies in the (very) long term.

Strong positioning in engines for popular wide bodies

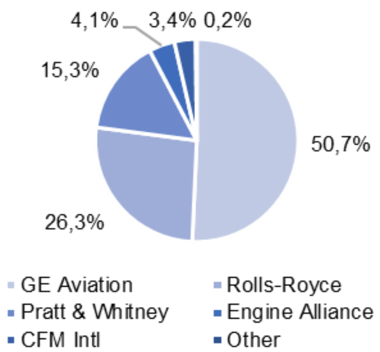
Graph 21 – Boeing total unfulfilled wide-body orders



Source: Boeing

The wide body engine market is more diversified compared to the narrow body, with airlines usually having up to three engine choices from (mostly) GE, PW and RR. MTU's growth story in the widebody segment lies significantly within the B787 and B777X, with some residual orders and expected deliveries for the B777 Classic. MTU is strongly positioned as a partner with GE involved in the development of the GE9X engine – to exclusively power the B777X – as well as the GEnx, which powers the B787 and currently has a 60% market share vs. Trent 1000 (Rolls-Royce). Indeed, GE Aviation is a long-standing market leader within the wide body segment, with c.51% market share in 2016[26].

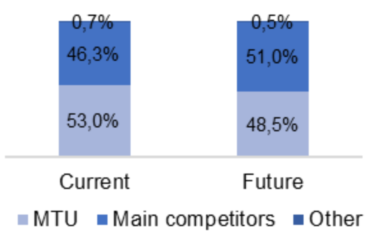
Graph 22 – Commercial wide-body aircraft market 2016



Source: FlightGlobal

With around 1,450 expected deliveries over the next 10 years and currently 686 (unfilled) orders, the B787 is expected to be the dominant widebody. The GEnx has been the preferable choice for most airlines and leasing companies[27] compared to the Rolls-Royce Trent 1000, which has generated a series of recurring problems, with its CEO Warren East accounting for USDm 800 in costs for replacing faulty turbine blades on B787 engines[28]. On the B777X – for which production will start in 2020 – the exclusive engine is the GE9X in which MTU is participating with a 4% program share. As of today, 326 planes have been ordered and in total around 410 planes are expected to be delivered over the next 10 years. Though there are still some orders outstanding for the B777 Classic as of today (57[29]), with the introduction of the B777X, the PW4000 engine which is only used on the 777 Classic will contribute to MTU's revenue through only a few new sales but mainly through higher-margin aftermarket activity. The CF6 used on the current A330 family and B767 is currently at the end of the series production and will mainly contribute through aftermarket sales. A few new sales will come from a forecasted demand of around 60 new 767 as well as currently 62 outstanding freighter orders. Finally, there will be some very low future demand from new A380 orders which are forecasted to amount for around 50 over the next 10 years; on this aircraft, the GP7000 engine (in which MTU participates) is competing with RR's Trent 900.

Graph 23 – Current and future market shares within the widebody segment

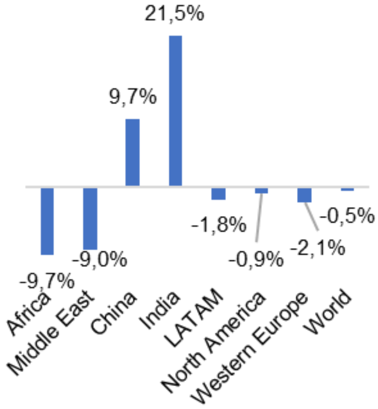


Source: FlightGlobal

Overall, the widebody fleet is expected to grow at a 4.1% CAGR over the next five years, and at 2.8% over the following five-year period[30]. We expect MTU to capture significant growth due to its presence with the GEnx and GE9x which will

[26] FlightGlobal, 2016
[27] Industry experts consider the GEnx to be the best-performing wide-body engine. See "What to consider when choosing engines", AirFinance Journal Issue May 2018
[28] "The world's three biggest engine-makers hit a snag", The Economist, 23 June 2018
[29] Other (additional) 35 orders are for the 777 freighter version
[30] Oliver Wyman 2018-2028 fleet and MRO forecast

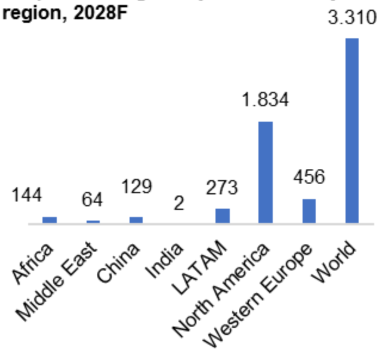
Graph 24 – Regional jet fleet growth p.a 2018F-2028F



Source: Oliver Wyman

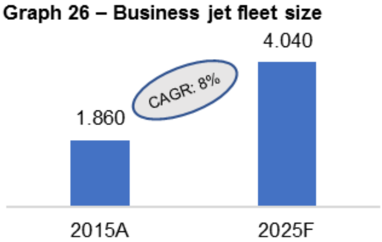
The soon-amendable scope-clauses in the US may bring another strong push for the GTF engine in the regional and business jet segments

Graph 25 – Regional jet fleet size by region, 2028F



Source: Oliver Wyman

Graph 26 – Business jet fleet size



Source: Bombardier

power the most demanded aircraft in the segment, hence, we end up incorporating growth forecasts in-line with the market's expected development.

Regional and business jets[31]

Currently, over half of regional jets are operated in North America. Given the need to connect many dispersed smaller airports all over the U.S. and Canada as well as predominant hub-to-spoke points, the continent will experience a constant but low demand for regional jets in the near future. Demand will come mainly from replacement orders and a small number of new orders given increasing air traffic. The main barriers for future growth in the U.S. are scope clauses under which the largest U.S. airlines operate. These restrict fleet sizes, seat number per plane and weight, with airlines either already operating at limit or close to it. The soon to be introduced next generation 76-seaters MRJ90 and E175E2 – for MTU highly relevant models – will likely exceed the maximum take-off weight (MWTO) for most US airlines. Artificially reducing MWTO by lowering fuel levels will reduce flying range significantly, making the new jets too "expensive turbo-prop jets" and therefore not interesting for US airlines. These clauses become amendable soon in 2019 (Delta and United) and 2020 (American Airlines). So far, it is difficult to form a well-grounded opinion on the outcome as well as its impact on future regional jet fleet sizes. However, further developments might surface in the coming months allowing for updated model assumptions and forecasts.

Relevant foreseeable demand for regional jets will therefore come from other markets – once again emerging economies in Asia. As is the case with narrow body demand, regional jets are attractive to airlines on hub-to-spoke routes as well as traffic to and between tier-2 and tier-3 airports, particularly with less than 100 passengers per day. In China, for example, more than 50% of intra-regional routes have less than 100 passengers; in Latin America, 90% of intra-regional routes are below 1,000 miles making regional jets attractive. This demand is expected to sustain over the long-term; depending on the outcome of negotiations in the U.S., additional and maybe significant demand may surge.

Regarding the business aircraft segment, the worst performing platform with the fleet growing at a CAGR of 2.7% in the past four years, vis-à-vis a CAGR of between 5% and 6% for the two decades before 2010[32], it is expected to see

[31] We separated narrow bodies from regional aircraft: the new models (Embraer E2 and Bombardier's C-Series – renamed A220 after Airbus acquired the program) often lie in between the two categories, both due to thrust power and seat capacity range they offer. Hence, many analysts and experts refer to them as crossover narrow bodies" – with flexibility to serve many different types of carrier business models. We previously included Bombardier's C-Series within the narrow body segment given its larger thrust power and seat capacity, and now we include Embraer's E2 jets within the regional aircraft segment which entails comparatively lower levels on the mentioned features

[32] Bombardier Business Aircraft Market Forecast 2016 – 2025

The core players in the business jet segment are releasing new models in the next five years, with MTU engines being the exclusive option for:

- **2018: Gulfstream's G500; Bombardier Global7000**
- **2019: Gulfstream's G600**
- **2022: Dassault Falcon 8X**

some growth especially coming from the large business jet segment in which new aircraft is expected to be deployed over the next years, culminating in an 8% CAGR between 2015A and 2025F[33]. The key drivers behind this expected uptick in demand rely essentially on improved economic growth, increased penetration within emerging markets[34] (largely underserved), as well as intrinsic replacement demand from the current fleet. However, the business jet segment is – in our view - the most sensitive one to economic growth, business cycles and confidence, and MTU's positioning is not material. Hence the top-line head and tailwinds are relatively insignificant. Overall, we expect low stable growth looking forward.

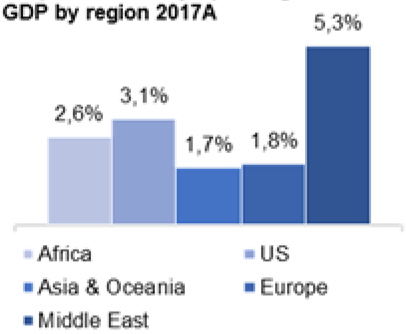
"(…) The main driver [of demand for business jets] is business confidence and the underlying business environment (…)"

Scott Donnelly, Chairman and CEO of Textron, CNBC, 15 October 2018

Massive potential in the regional jet engine market for MTU

With 91% market share in the regional segment, CFM's CF34 engine dominates the regional jet market, while MTU offers only MRO services for this powerplant. In the future, with the introductions of the MRJ in 2020 as well as three versions of the E-Jet E2 in 2018, 2019 and 2020, MTU will be able to capture c.90%[35] of the regional jet market as new deliveries of all these aircraft platforms will be almost exclusively powered by the GTF engine family[36]. In the business jet segment, we are confident on MTU being able to capture the growth potential coming from the large segment via its positioning with the PW800 (in development, yet already fully certified and waiting for EIS, expected by Q4 2018) – the exclusive engine option for the new G500, G600 and Dassault's F8X, in early development phase. Moreover, MTU's participation in the PW300/500's positions are able to capture some limited growth from light and medium segments.

Graph 27 – Military spending as % of GDP by region 2017A



Source: SIPRI military expenditure database 2018

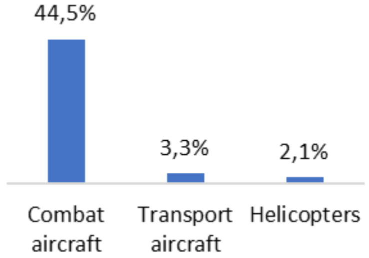
The United States and Middle East are the most representative countries in military spending as % of GDP. With approx. USDbn 619 in 2017, the United States accounted for over 1/3 of worldwide military spending

MTU's current military presence to stagnate; export potential presents only slight growth opportunities

Overall, military expenditure increased across the board to a new peak in 2017 – 2.2% of world GDP (USDbn 1,739). Key regional drivers over the recent past have been the US, China, India, Russia and the Middle East[37]. These levels are in line with historical ones, providing no signs of contraction. Looking forward, military spending is expected to rise at a very decent pace, although mostly driven by capital deployment into cybersecurity, intelligence, reconnaissance and unmanned aircraft. Thus, we see limited upside potential for MTU as a provider of engine

[33] According to Bombardier's projections
[34] Greater China alone is expected to generate a CAGR of 10% in fleet size growth between 2015 and 2025, increasing from 405 to 1095, with 700 new deliveries and only 10 replacements
[35] MTU company presentation 2018
[36] Mitsubishi's MRJ: PW1200G / Embraer's E2-Jet Family: PW1700&1900G (all part of the GTF family)
[37] SPIRI Fact Sheet, May 2018: "Trends in world military expenditure 2017"

Graph 28 – Market share of MTU engines per aircraft type 2017A

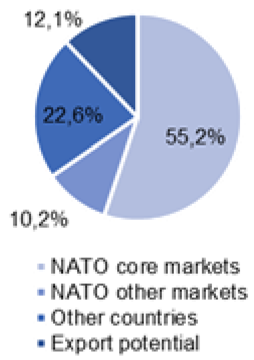


Source: Adapted from FlightGlobal

Core and other NATO countries will contribute with some low stable growth through fleet additions and replacements. Especially the U.S. and Eurofighter countries such as Germany are important top-line drivers in our valuation

Most recently, MTU engaged in a new partnership with GE for the development of T408 engines for the new CH-54K military pieces

Graph 29 – Active MTU engine fleet by region 2017A



Source: Adapted from FlightGlobal

components and aftermarket services for military aircraft, at least for its current client base.

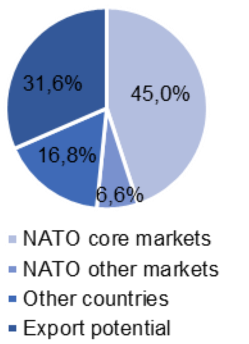
MTU participates in engine programs for combat aircraft, helicopters and transporters with focus on the following engines (and vehicles): F110 (Lockheed F-16 and Boeing F-15), EJ200 (Eurofighter), RB199 (Panavia Tornado), T408 (CH-53K) and TP400-D6 (Airbus400M). The German armed forces and other NATO members have been key customers and important revenue sources for MTU in military OEM and MRO[38], with the F-16 and the Eurofighter being the most used military aircraft among NATO members. The latter comprises 348 active units and 66 in order backlog within all NATO members in 2017.

Core and other NATO countries[39] constitute very mature and low growth markets; most of them may require only some fleet additions and replacements. Despite recent pressures by the US administration for member countries to comply with the "2.0% guideline", it is highly unlikely that NATO countries with spending in the 1-1.5% range will increase their spending to 2%, as they would need to increase their total spending by unreasonably high rates (in gross terms). The new U.S. administration increased their military budget outlays and are expected to rise even further in the near future. Therefore, within these countries, we believe mostly the U.S. can bring some upside potential in the short to mid-term, especially with the new T408 engines. Additionally, Germany and other Eurofighter countries could also only slightly improve top-line growth. Overall, implicit in our forecast, we expect core NATO countries to maintain their current expenditure levels.

On the other hand, we see increasing revenue opportunities coming from "export potential" countries, such as the Middle East, where military spending is on the rise. Recent orders from Saudi Arabia, Qatar and Kuwait constitute an actual proof of such potential. For instance, Qatar and Kuwait signed export deals for 24 and 28 Eurofighter jets, respectively[40], whereas Saudi Arabia has already received 72 Eurofighters in 2017. Hence, export potential within the Middle East is what holds our forecasts for MTU's military turnover barely positive.

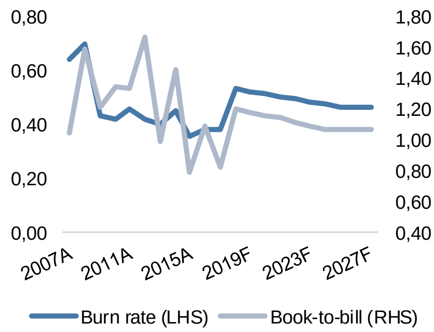
[38] Military revenue includes both OEM (engine component manufacturing and spare-parts) and MRO (maintenance)
[39] Core NATO countries: France, Germany, Italy, Spain, Turkey, United Kingdom, United States;
Other NATO countries: Austria, Belgium, Denmark, Greece, Netherlands, Norway, Poland, Portugal, Romania;
Export potential: Bahrain, Iran, Israel, Kuwait, Malaysia, Oman, Qatar, Saudi Arabia
[40] Military aircraft developed under a consortium by Airbus, BAE Systems and Leonardo; MTU participates in the engine joint-venture with GE (EJ200; program share: 30%), providing components (low and high-pressure turbines), maintenance and assembly & testing for engines destined for Germany)

Graph 30 – Orders for aircrafts equipped with MTU engines by region 2017A



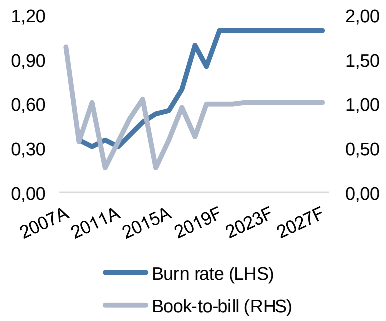
Source: Adapted from FlightGlobal

Graph 31 - BTB and Burn Rates - Commercial OEM



Source: MTU, Analyst Estimates

Graph 32 - BTB and Burn Rates - Military



Source: MTU, Analyst Estimates

Additional potential for mid-to-long-term demand will come from a Eurofighter upgrade expected around 2025, representing a replacement option for current Eurofighter countries as well as new sales potential. Moreover, Airbus revealed a concept fighter for 2030-2040 representing a successor for the Eurofighter[41]. Given MTUs extensive experience in the fighter engine market (covering c.45% of the entire current market) as well as constant R&D expenditure and synergies between commercial and military engines, we believe it is well positioned to capture future market potential. Recently, the Company announced a JV with Safran, targeting 50/50 engine participation towards this aircraft program.

However, given persisting issues with the A400M, we believe delivery delays may further occur and postpone MTU's revenue recognition. Additionally, we see a potential, though low, threat of cancelations of the current 143 outstanding orders, as occurred in the past. Thus, the export potential could be also be under threat.

The EJ200 engine for the current Eurofighter tranche 3 production is the main revenue driver. Around 130 fighters are in production which translates into 260 engines for which MTU is still to deliver components. Previous (active) tranche 2 and 1 pieces suffer recurrent maintenance needs, hence EJ200's aftermarket (parts and MRO) provides strong revenue contribution as well. Tranche 3 will last until 2021, whereas a potential update option of tranche 1 will kick in c.2025, as mentioned above, providing additional topline support. In 2020, the KC-390 and CH-53K[42] are expected to enter into service, providing additional topline support for the military segment, which is expected to suffer even more significantly in-between tranche 3 run-out and tranche 1 updates.

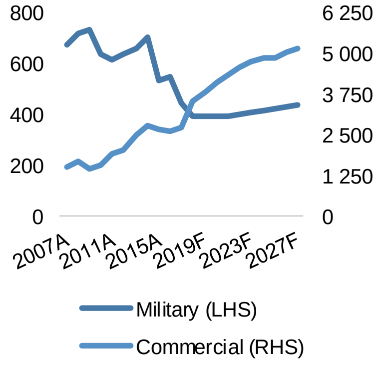
OEM top-line projections: GTF sales to push 2018F revenue up by c. 30%; military segment remains stable with some long-term potential

Overall, the GTF engine is the main revenue driver in the commercial OEM segment. We expect commercial revenues to be up c. 30% in 2018F (organic) due to MTUs largest ramp-up in its history which doubles GTF output in 2018F. As a result, we estimate a burn rate[43] of 0.53 up from 0.38 last year, which we expect to gradually decrease until 2021 and then stabilize within historical levels.

After 2019, the last sale of the V2500 will free up some production capacity (c. 200 units in 2018F). This will come at a good time with the start of serial production of

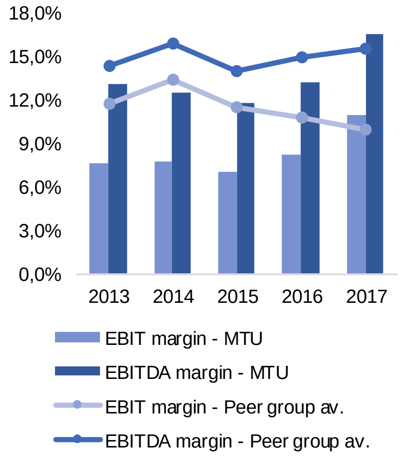
[41] https://www.aerosociety.com/news/airbus-reveals-tornado-successor-concept-for-2040s/
[42] Embraer's newest transporter jet, powered by IAE's (MTU program share 16%) V2500; CH-53K: heavy-lift cargo helicopter developed by Sykorsky for the USA, powered by the T408 (GE and MTU partnership; MTU provides the power turbines, program share: 18.4%)
[43] **BTB = (Backlog (t) – Backlog (t-1)) / Revenue (t); Burn Rate = Revenue (t) / Backlog (t-1)**, where BTB reflects demand dynamics; Burn Rate reflects delivery capacity

Graph 33 - Organic revenue growth (OEM)



Source: MTU, Analyst Estimates

Graph 34 - EBIT and EBITDA margins MTU *vs.* Peers



Source: MTU, Companies' information

While in 2017 MTU and PW delivered 374 GTF engines, the ramp-up will almost double the output for 2018 in which the company expects to deliver around 700 engines. In 2019, 1,000 deliveries are expected. After 2020, a stable production rate of roughly 1,100 engines is expected

the GE9X supporting revenues, after the main outstanding GTF orders as of today[44] are produced and the V2500 is discontinued. Additionally, the GEnx is produced at a level of 200-250 units per year providing stable revenues.

Regarding military OEM, we expect 2018F to see revenues down significantly by c. 12% on the back of a depressed order backlog. Between 2019 and 2021, we expect close to no expansion in revenues, until 2021-2025 when new opportunities may arise, with the first contributions from the new Eurofighter program. Given the low output in this segment and MTU's high production capacity, we believe there is room for higher output, explaining stable burn rates of 1,1 in the explicit and perpetuity periods.

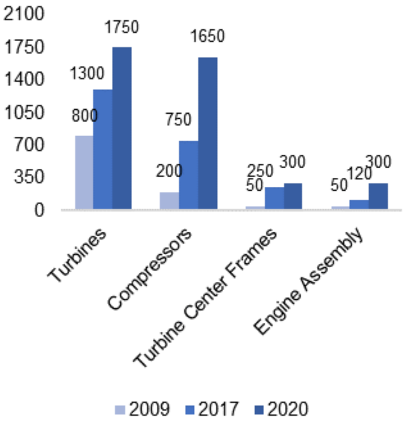
The cost side in OEM

MTU has substantially underperformed the considered peer group in terms of operating efficiency, albeit having started to catch up since 2015 and converging towards the group's average EBIT margin as of 2017 – which has been sequentially decreasing: a trend remarkably led by Rolls Royce, GKN and IHI Corporation, whereas Safran and GE Aviation have performed very well[45]. MTU has employed an ambitious strategy to tackle the bottom-line, with its own supply chain organized to maximize cost optimization while assuring high quality standards. Its high-tech facility in Munich is focused in sophisticated parts and production processes and constitutes the knowledge/know-how "HQ"; in Reszów, MTU holds a "mid-tech" facility which adopts more standardized production lines and parts manufacturing, while sourcing raw materials and some finished parts from external suppliers, predominantly from best-cost countries. However, to cope with the strong GTF-related demand and deliveries, MTU is ramping-up its production heavily between 2018 and 2020. In 2018 alone, an internal capacity increase of 20% will be achieved; as observed historically in this industry, every ramp-up comes with its problems. Management has also warned about potential issues during last year's investor presentation. We are aware of it, especially considering the new technology and newly introduced production processes, hence we incorporate a significant (negative) effect on the EBIT in our valuation until 2020, but especially for 2018. We may see lower than expected revenues not fully compensating for increased COGS (fixed part) if expected output is not met. On the other hand, economies of scale are very likely to kick in the next few years.

[44] Orders placed today are expected to be produced in 2020F or later. Until then, production capacity is fully required to fulfil existing GTF backlog

[45] OEM peer group includes: GE Aviation, GKN Aerospace, IHI Corp., Pratt & Whitney (unit of United Technologies), Rolls-Royce (Civil Aerospace division), Safran (Aerospace Propulsion segment). Due to the more diversified product portfolios of competitors and the different production cycles, it is not possible to further separate competitor's costs and clearly compare them with MTU's ones. Therefore, our cost comparison constitutes only an approximation to MTUs closest competitors

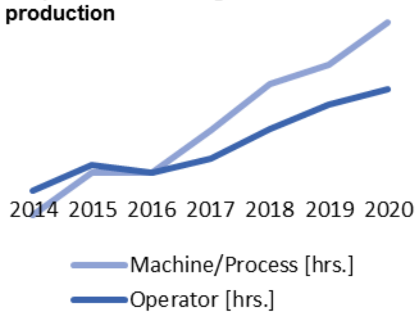
Graph 35 – Change in unit productions by type of engine part



Source: Adapted from MTU

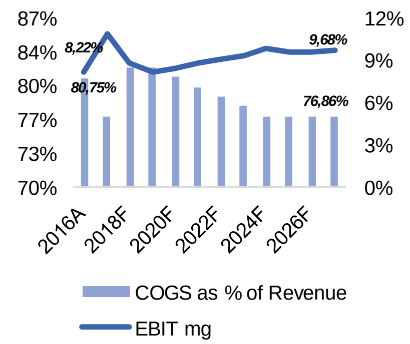
On the GTF, MTU completed its learning curve after only 250 engines, which are now produced at high automation levels – therefore limited further cost improvements

Graph 36 – Increasing automation in production



Source: Adapted from MTU

Graph 37 - OEM COGS & EBIT margins



Source: MTU, Analyst Estimates

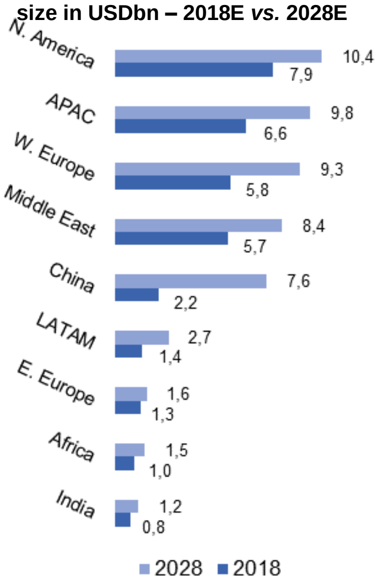
We expect unit costs on the COGS level to start decreasing already in 2018F, in accordance with MTUs guidance. Given utilization rates which are currently slightly lower on the GTF compared to the LEAP, PW may need to further increase discounts on new GTF sales to curb demand. This, however, will have an even further negative impact in MTU's EBIT. As of today, we don't expect significant impacts, but keep a close eye on it. Additionally, the takeover of Bombardier's C-Series by Airbus (A220) may result in some pressure on suppliers, including MTU.

In the mid-to-long-term we see favorable developments in cost reductions. As mentioned above, in its Munich facility, MTU is strongly increasing production automation. What is more, the company's additive manufacturing capabilities have reached a state in which it is able to implement it in series production[46]. Nonetheless, it is still in very early stages such that only non-critical parts such as eyepieces used in MRO can be produced in series. Nonetheless, we expect some cost gains mainly via material savings given less material consumption. However, complex parts such as airfoils and blades are only expected to be produced under this technology in the long-term (i.e.: after 2030) - hence not incorporated given the degree of uncertainty in terms of materiality and timing. Moreover, even though commodity prices are highly relevant for MTU, with the current market situation and development expectations, we don't see a significant risk there. We believe Safran's decision to discontinue commodity (nickel, platinum and oil) hedging against fluctuations in 2016 shows how immaterial they are, thereby confirming our view. Nevertheless, MTU minimizes its risk mainly through commodity sales contracts and to a small extent through hedging of nickel prices on a 3-year basis. We assume that any price increases above this horizon can be compensated on the revenue side (passed on to customers).

All in all, our estimates imply lower EBIT margins in the next two fiscal years, with the economies of scale and normalized production yielding higher margins after 2020. Naturally, we expect OEM margins above MRO in the long-term, which goes against what was observed in the past, and as previously mentioned is tied to the shift in business model in this segment.

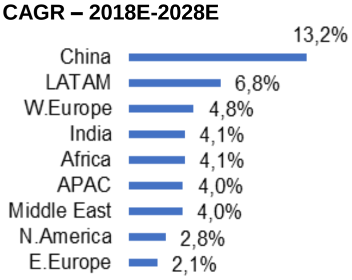
[46] Since 2003, MTU has engaged in developing additive manufacturing solutions that could be incorporated in all processes and units ranging from engine component research to production to maintenance

Graph 38 - Engine MRO market size in USDbn – 2018E *vs.* 2028E



Source: Oliver Wyman

Graph 39 – Engine MRO spending CAGR – 2018E-2028E



Source: Oliver Wyman

Historically, the engine MRO market was composed by:

(i) In-house airline shops or third-party airline MRO shops (Lufthansa Technik)
(ii) OEMs (GE, RR or PW)
(iii) OEM-affiliated MRO providers (MTU or Safran)
(iv) Independent MRO shops (ST Engineering)

Maintenance, repair and overhaul (MRO) segment

As of 2018, the global engine MRO market amounts to USDbn 32.7 in revenues and is expected to grow by c.61% over the next 10 years to USDbn 52.6. North America, Asia-Pacific (excl. China and India) and the Middle East represent almost 2/3 of the market today. In accordance with ongoing (and expected) global fleet growth, the engine MRO market will massively expand in China (+245%), Latin America (+93%), Western Europe (+60%) and India (+50%)[47]. While mature markets (Europe and North America) have an installed capacity that can be efficiently expanded, fast-growing markets (especially APAC, China, India and LATAM), require high investments in new facilities, equipment, tooling and training, which requires time and significant capital commitments. Therefore – in the short-term – we expect capacity constraints in these regions, which would likely result in redirecting maintenance needs to mature markets. MTU has an early-mover advantage here, with some spare capacity left in its Chinese facility[48] as well as worldwide locations.

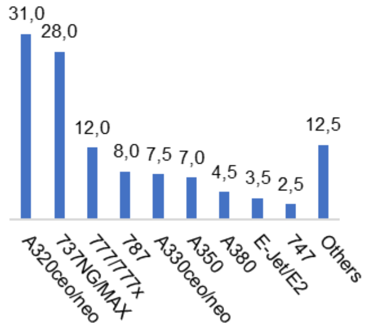
Naturally, demand for MRO grows in line with new aircraft fleet, but usually with a lag of 6 to 7 years after a new engine piece enters into service. In line with strong narrow-body demand, the future MRO market will be dominated by this segment, representing around 55% in market share in 2028F (c.USDbn 29). The A320neo family (which is highly relevant for MTU) and B737 MAX will constitute a major part of the market.

MRO market structure

The engine MRO market has been undergoing a structural change in recent years, with the (ii) showing strong commitment to increase their aftermarket presence (due to it is high-margin attractiveness) thereby forcing traditional service providers – (iii) and (iv) - to reposition themselves. Moreover, new engines are usually sold at a loss (for the OEM) with aftermarket then providing a lucrative business for the engine programs through high margin spare parts and maintenance. By owning intellectual property (IP), OEMs can control the spare parts market through usage restrictions and price increases, as well as engine manuals and training which is required for qualification of maintenance shops, managers and technicians. Therefore, OEMs have lately increased repatriation

[47] Oliver Wyman 2018-2028 fleet and MRO forecast
[48] MTU operates an engine maintenance facility in Zhuhai, China, under a JV with China Southern Air Holding Company; it specializes in market-leading engine platforms (e.g.: IAE V2500 and CFM56); capacity increased by 50% in 2012 and the Company – together with its JV partner – has pledged to invest in an additional 50% capacity increase in the next years, for which we account for in our projections

Graph 40 – Top 10 MRO spending by aircraft 2028F



Source: Oliver Wyman

A recent survey by Oliver Wyman of aircraft MRO provider has shown that 76% of IP MROs require for their operations is owned by OEMs

As an example of OEMs' increasing competitive pressure, small in-house shops have been discontinuing their MRO operations

Finnair was a turnaround moment in this market transformation and its impact on smaller or non-OEM affiliated shops, having divested its maintenance division to GA Telesis in 2012 (one of the largest independent providers)

Lufthansa Technik is yet another example of this shift, although on the positive side, having advanced in market share via partnering with key engine OEMs (including the GTF, side by side with MTU)

and buy-back of IP, therefore increasing pressure on (iii) and (iv) to step up. All in all, this has made non-OEM affiliated, independent and in-house MROs less attractive – and the trend is expected to continue in the long run – with OEMs squeezing out non-OEM affiliated MROs from the market[49]. Nevertheless, in the very short-term, strong demand growth in engine MRO will require capacity from independent shops, as executives from GE and RR have recently stated. But this should only yield – at most – a brief survival for small independent MROs[50]. Larger in-house shops are expected to remain on the market covering around 20% of engine MRO in the future[51]. In order to sustain or gain market share, they engage in partnerships with OEMs or OEM-affiliated MROs. MTU is well positioned to ride this trend, with the most recent engine programs (e.g.: GTF) already incorporating long-term maintenance and aftermarket partnerships with market-leading OEMs (GE and PW).

Impressive positioning in (i) independent MRO and rising share in (ii) OEM-cooperation

In the first segment, MTU is the world's largest independent MRO provider, offering customized services to more than 900 clients with over 15,000 experienced shop[52] visits in its 35 years of operations. Overall, it has the largest engine portfolio offering a full-service range including engine leasing, on-wing support, repairs and engine condition monitoring ("MTU Total Care"), thereby capturing a 10% market share in 2016[53]. The portfolio includes the most popular narrow-body and wide-body engines such as the CF34 of which currently 4,960 units are in service, the CFM56 (21,130), the GE90 (2,114) as well as the V2500 (5,960)[54]. This segment is characterized by comparatively higher margins (EBIT margins ~10%) in contrast to OEM-affiliated MRO (low to mid-single digit EBIT margin). Acknowledging the increasing OEM-cooperation trend, MTU has followed suit via engaging in MRO networks with OEMs across several aircraft engine programs, especially including partnerships for recent or in-development engines (GTF, GEnx and GE9X are good examples) which have long-term maintenance contracts embedded. This provides MTU with early provisioning and scheduling of cash flow dynamics as well as capacity and investment needs - driven by firm and expected workload amounts. In fact, 80% of new generation engines are expected

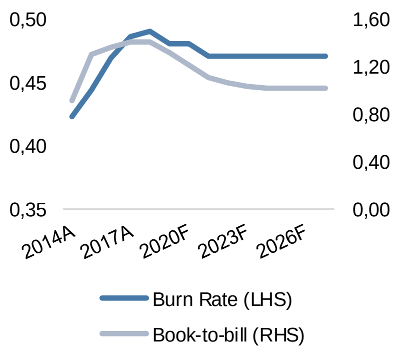
[49] The market exit for these players can take three forms: (i) full close-down of shops; (ii) acquisition by larger OEM-integrated MRO providers or OEMs themselves; (iii) as a surviving strategy: shift in business model – engage in partnerships or IP/technology-sharing agreements with MRO providers. MTU has engaged in the (iii) to preserve its relationship with large and established OEMs, thereby securing its market positioning and long-term prospects, despite the lower operating margins in this newer model
[50] www.mro-network.com/engines-engine-systems/engine-makers-share-views-role-independent-mrot
[51] www.mro-network.com/maintenance-repair-overhaul/independent-mros-must-adapt-survive
[52] One shop visit corresponds to "one engine maintained"
[53] MTU, Investor Presentation September 2018
[54] FlightGlobal 2017

Over the next 10 years, MTU will double its capacity in best-cost countries from 30% to 50%. In the long-run, MRO growth will be focused in best-cost locations helping MTU to position itself in important growth markets help tackle profitability headwinds

Despite this focus, MTU will sustain a large share of its MRO business in high-cost countries such as Canada or Germany

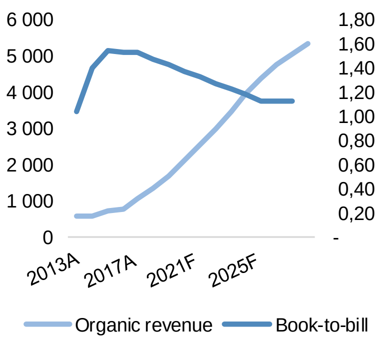
Currently, MTU holds an 85% share in the high-pressure compressor for the GTF engines, but could acquire the remaining 15% in the future, as confirmed by MTUs investor relations team

Graph 41 - BTB and Burn Rates - MRO



Source: MTU, Analyst Estimates

Graph 42 - Organic revenue and BTB - Zhuhai (China)



Source: MTU, Analyst Estimates

to be sold along with these contracts[55], hence MTU can counterweigh implicit lower operating margins with better working capital dynamics.

Location strategy – Shift towards best-cost countries to strengthen positioning in important markets; helps tackling rising labor costs

As of now, MTU operates six MRO facilities in Germany, Canada, Malaysia (JV with LH Technik) and China (JV with China Southern). Additionally, it is opening a new shop (JV with LH Technik) in 2020, in Poland, exclusively for the GTF family. In China, MTU is the number one MRO provider focusing on narrow-body V2500 and CFM56 engines. Over the next 10 years it is planning to increase its capacity by 50% to around 450 shop visits and enlarge its engine portfolio[56]. This will allow MTU to help serving rising demand and strengthen its positioning in the region. While regional capacity constraints in the short-term can be fulfilled at other locations given some spare capacity left, in the long-term we expect MTU will be required to invest in new facilities (e.g. Latin America) or further extend existing ones e.g. in Zhuhai (or even Poland further). Operating its own facilities allows MTU to not only meet demand for OEM-affiliated orders, but also to profit from new potential customers in the higher-margin independent segment. Therefore, we project increased CAPEX in the short-term until 2020 due to required investments of USDm 150 per partner (total required CAPEX between 2017 and 2020) in Poland, as well as the mentioned capacity increases in China[57].

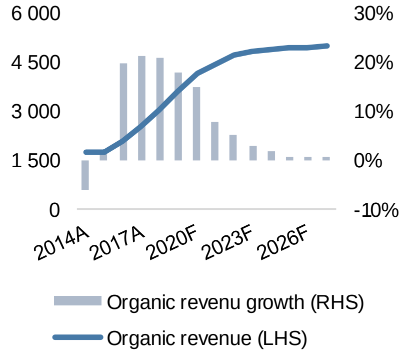
MRO revenue projections[58]

As the overall MRO segment is mainly dependent on (the high) worldwide engine output, we forecast book-to-bill ratios to be constantly above 1, especially because MTU is able to capture a large overall engine market through independent work.

For 2018F we expect revenues to be up by c. 20% (organic) followed by c. 17% and c. 10% in 2019F and 2020F, respectively. The main revenue drivers in the short-term (2018F – 2020F) are the V2500 and CFM56[59] (independent work) on the A320ceo and B737NG which predominantly come into overhaul age. The active fleet equipped with it is on average around 8.5/9 years old. Therefore, future demand within the next 7-10 years is highly robust (half of the 6,000 V2500 engines in active fleet are on their 1st run with no shop visit yet). The overall

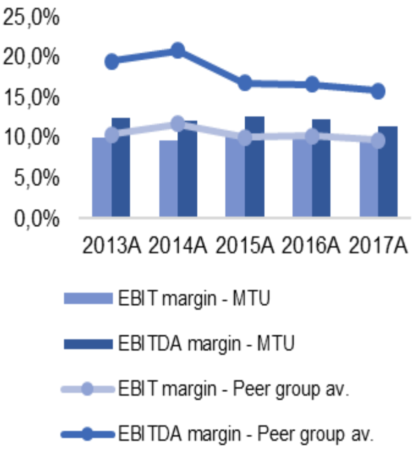
[55] www.mro-network.com/maintenance-repair-overhaul/independent-mros-must-adapt-survive
[56] MTU Company Presentation September 2018
[57] We develop further on this in the following section on company-level investments
[58] We forecast revenues in MTU's China and Poland facilities separately from consolidated MRO revenues
[59] In total, there are c. 21,500 commercial CFM56 engines in operation (FlightGlobal FleetWatch 2017; excl. parked aircraft)

Graph 43 - Organic revenue and growth rates



Source: MTU, Analyst Estimates

Graph 44 – EBIT and EBITDA margins - MTU vs peer group



Source: Company data, Bloomberg

capacity in the consolidated income statement will stay more or less constant in the future, so we keep burn rates stable (0.49 in 2018F and 0.47 after 2021F).

The strongest revenue growth will come from Zhuhai given the future demand, location strategy and ramp-up, with revenue growth constantly above 10% in the projection period. As in the consolidated income statement, huge MRO needs for the V2500 and CFM56 engines drive revenue in the short term (c.27% in 2018F and c. 24% in 2019F). The ramp-up pushes burn rates up to a max. level of 0.6 in the projection period (up from 0.5 in 2017A).

All in all, organic revenue CAGR 2017A – 2027F is expected at c. 9% in the consolidated income statement and 19% in Zhuhai, China.

The cost side – Intentions to tackle shrinking margins and rising labor costs

Within the MRO segment, MTU has been performing at a similar fashion as its closest peers[60], with EBIT margins tightly catching up in the last three years, showing MTU's increased focus on operating performance-benchmarking in MRO as well. As mentioned, the ongoing industry trend towards low-margin OEM-cooperation[61] will put pressure on operating margins. As of today, MTUs portfolio consists of 30% OEM cooperation and 70% independent work. This split will develop to 50/50 in the mid-to-long-term, particularly driven by strong GTF sales which are sold with lifetime OEM-cooperation contracts[62]. Overall, the EBIT margin in this business are approx. 3% to 4%. What is more, new contracts are predominantly based on flight hour agreements (FHAs), shifting cost responsibility to the MRO provider in case of unpredicted shop visits, complications during maintenance or more than planned spare part requirements[63]. The share of such contracts has developed from around 30% in 2004 to 60% today. For GTF engines, contracts are even 80% based on FHAs. MTU and PW incorporated these factors in the development of the GFT family, therefore being able to tackle potential cost issues and improve profitability. Essentially, the whole design

[60] Suppliers in the A&D sector often focus on several channels of the supply chain, different components and regional markets, therefore not disclosing relevant financial data for each sub-segment. MTU focuses solely on engine maintenance whereas virtually all its peers perform maintenance on airframe, interiors, engine components, systems, avionics etc. Nonetheless, the end-market is the same. Therefore, we consider Lufthansa Technik, ST Engineering and AirFrance/KLM (aircraft and engine maintenance division) to be the most reasonable competitors, constituting the MRO peer group for operational benchmarking purposes

[61] Essentially, MTU has comparable costs to independent MRO work but receives lower revenues from OEM partners, resulting in lower operating margins. OEMs are contract holders and subcontract MRO at transfer prices to MTU which is required to source spare parts at list prices, which increases its material cost burden, therefore driving margins further down

[62] According to Matthias Spies, Senior Manager of IR at MTU, contacted by the team in June 2018

[63] Flight hour agreements: Essentially, maintenance contracts are developed on an hourly basis which is clearly positive for airline operators that face fixed maintenance costs, but negative for MRO operators as they might face increased/unexpected maintenance or spare parts costs; this obviously constitutes an additional profitability barrier.The GP7000 and GEnx, already operating for a while with some MRO activity have been sold under OEM-cooperation and FHA agreements

concept behind the GTF family[64] was to design an engine solution that requires less maintenance – mainly due to simpler architecture (read: fewer parts). Indeed, compared to its predecessor (V2500) – GTF yields c.15% maintenance cost savings; this puts MTU in a significant competitive advantage *vis-à-vis* its direct competitor in the narrow-body segment – CFM's LEAP – which reportedly has the same maintenance costs as the CFM56 (predecessor). Additionally, MTU capitalizes on predictive analytics and real-time engine monitoring which allows to decrease the number of unscheduled shop-visits and increase on-wing time. As a conclusion, we expect that the Company will be able to keep costs under control, but margins will definitely stand lower than what investors observed in the past.

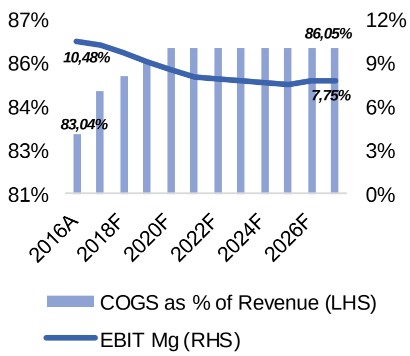
The GFT family relies on a much simpler architecture compared to predecessors. The number of stages is expected to be reduced by 25%, the number of airfoils by 45% and operating at a lower cycle temperature – significantly reducing maintenance costs

Moreover, the industry has been experiencing a trend of critically rising wages. 97% of those surveyed by Oliver Wyman[65] confirm they have experienced upward pressures on technician wages, mainly due to a lack of supply and global wage inflation – trends which are not expected to be resolved in the near future. The Company designed a two-sided strategy to tackle the problem: firstly, its relocation strategy oriented to best-cost countries allows it to get a grip on rising personnel costs. Certainly, developing economies also experience labor shortages and rising wages; nonetheless, salary levels are much more favorable and are not expected to reach levels of developed countries in a foreseeable future. Secondly, its Industry 4.0 program (especially data analytics, predictive maintenance and automation) has started generating improvements in labor productivity; the Company has shown signs of maintaining R&D levels to support this type of intra-company development, and we view this as an on-going trend.

MRO technicians' wages in the US have increased by 7-12% between 1999 and 2016, adjusted for inflation

Industry experts have been bullish on the power of digitalization in MRO which helps to get costs under control and loosen dependency on labor

Graph 45 - MRO COGS & EBIT margins



Source: MTU, Analyst Estimates

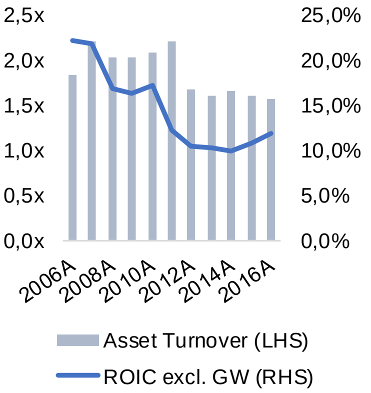
Hence, we account for slightly higher COGS (materials and personnel) – reflecting the two abovementioned factors, which we believe MTU is able to tackle – but only up to a certain point. On the SG&A side, as a result of the partial shift towards OEM-cooperation, we have been observing a decreasing trend from 5.3% to 2.6% of revenues in the last five years. Indeed, as the company locks-in contracts and secures revenue and cash flows for very long periods in the future, it does not require the same level of sales and marketing efforts as before. Nonetheless, we assume the level reached in 2017 to be the bottom as the company is stil engaged in independent MRO (recall 50/50 split). Moreover, as with the recent past, there is still some spare capacity expected to be left at the end of the next years for which we expect some sales activity. All in all, implicit in our cost assumptions, EBIT margin is expected to sequentially contract until 2023F, recovering in the following five years to achieve a level that is relatively in line with its historical and

[64] The core revenue driver – starting in 2022/2023 – when MRO needs will start kicking in aggressively
[65] MRO Survey 2018: Tackling Industry Disruption – Oliver Wyman

peer group performance by 2027F, clearly reflecting a strong execution of the above-mentioned strategy.

Investments and working capital dynamics[66]

Graph 46 - Historical asset turnover and return on invested capital

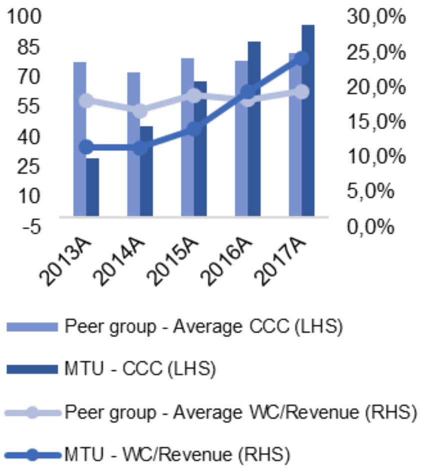


Source: Company, Analyst estimates

MTU's operating cycle can be described by sequential investment and consolidation phases, whereby in the first it engages in significant intangible and fixed asset investments to acquire or upgrade machinery, equipment, tools and materials, increase space and capacity, acquire program stakes in engine programs, etc. In the following phase, the goal is to capitalize on the investments, ramp-up production, reach maximum capacity utilization and serve demand from end-customers – usually aircraft OEMs and leasing companies. Hence, the levels of invested capital, NOPLAT and asset turnover shift considerably in between these cycles.

MTUs working capital (WC) metrics have worsened over the years - especially since 2013. Its cash conversion cycle (CCC) increased from 29 days to 97 days in the 5-year period. According to the company, the main reason lies in significantly increased prepayments for inventories in the military division for the Eurofighter and TP400 production. At the same time, the CCC has converged to the peer median, and is still much better than the CCC of its closest competitor Safran (114 days). MTU indicated it will decrease prepayments and improve inventory turns during the consolidation phase. Furthermore, with its Logistics 4.0 project, MTU will be able to increase on-time delivery in the mid-to-long term. Also considering in-house additive manufacturing activities, we forecast a further decrease in WC in the mid-to-long term. Overall, we model a decrease in the CCC to around 93.6 days by 2027F keeping it stable as of then. This is based on a continuous decrease of prepayments predominantly in the military segment increasing DPO to 88.3 days. Additionally, we expect an improvement in DIO starting in 2021F due to increased inventory turns and released pressure related to the ramp-up.

Graph 47 – Cash conversion cycle 2013A-2017A; MTU vs. peer group

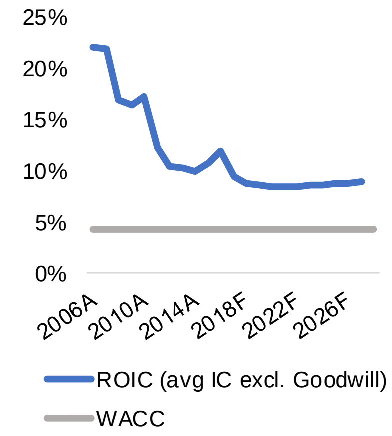


Source: Company data, Bloomberg

Regarding fixed investments, contrarily to what we expected before the Investor & Analyst Day in November, we now account for significant (and necessary) investments in capacity across several facilities, apart from those already well-known (Zhuhai, EME Aero). Indeed, management announced that (especially on the back of increased Airbus production rates, increased V2500 MRO demand, as well as the higher commercial success of the GTF) the company will have to elevate CAPEX efforts for a few years down the road, spicing this consolidation

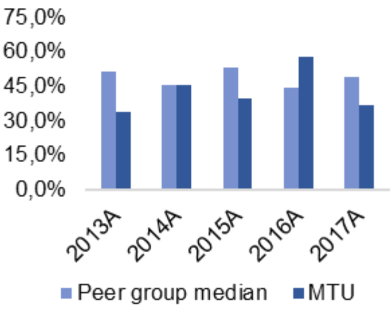
[66] Given the lack of balance sheet data for OEM and MRO, and in order to avoid unreasonable and ungrounded breakdowns, we proceed to project investment needs on a group-level basis

Graph 48 - ROIC vs WACC



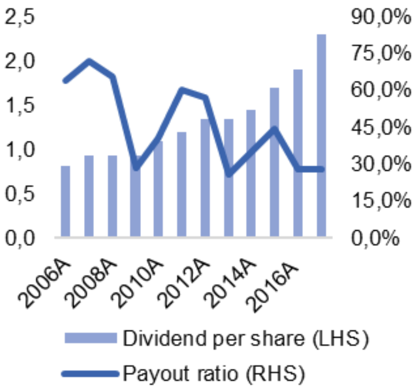
Source: Company, Analyst estimates

Graph 49: D/E ratio (at book value)



Source: MTU, Bloomberg

Graph 50: Dividend per share and payout ratio 2006A-2017A (MTU)



Source: Company data

phase with significant cash outlays to space and machinery to couple with demand. As a result, we expect ROIC to decrease slightly in 2018F from its 2017 level of 12%, to 9.5%; value creation potential should stabilize at slightly lower levels by 2025 (c.9 %) – this reflects our view of an industry that's undergoing significant technological changes, requiring severe investments, as well as elevated levels of working capital to meet production needs. Graph 48 shows how MTU's ROIC develops (again) in between cycles; however, the last consolidation cycle was described by highly significant capital returns from the V2500 program, which did not require the same level of investments by MTU as the GTF did (and still does). Hence, the team does not see the Company achieving previously-seen levels hovering around 18-19% average between 2007 and 2011, and rather forecast a lower ROIC, which reflects higher investment needs that come with participation in such a significant engine program, very much required for MTU to "stay relevant" in the industry, now and in the long-term

Capital structure and cost of capital

Given the industry nature and need to pre-finance program shares by large amounts of debt, the D/E ratio fluctuates widely over time[67]. MTUs comps do not only acquire different program shares but also operate in other (additional) engines programs, aircraft parts and industries, so that the cycles and levels may naturally deviate[68].

Importantly, MTU states a target leverage of 1x (Net Debt/EBITDA)[69] which we assume to be approached by the end of the consolidation phase in order to have a good debt capacity to invest in a new engine program. Nevertheless, it doesn't intend to deleverage the company too much[70], so we interpret the target leverage as the bottom. MTU has confirmed that it will do so by increasing its payout policy from today around 30% to 40% after 2018/2019 – gradually. Historically, the Company has been maintaining a dividend friendly policy constantly increasing dividend per share based on strong net income growth. Despite the fluctuating debt behavior, we're confident about MTUs overall capital structure, financial stability and liquidity, thus bearing no significant risk[71]. Moreover, Moody's rates MTU with a Baa3 and stable outlook, further supporting our view[72].

67 Typically, the industry standard is to finance large program acquisitions by debt. For example, MTU issued a corporate bond in 2012 to finance its program share in IAE (V2500 engine)
68 Therefore, a comparison over time doesn't deliver reasonable results.
69 MTU AR 2017 IR Presentation (February 2018)
70 CFO commentary according to MTU AR 2017 IR Presentation (February 2018) transcript
71 An analysis of MTUs capital structure and financial stability since 2006A yields the same results
72 www.moodys.com/research/Moodys-changes-outlook-on-MTU-Aero-Engines-AGs-Baa3-rating--PR_380580

Cost of Capital

Table 2: Regression results

Beta	1,01
Low er bound	0,96
Upper bound	1,06
Adjusted beta	1,00
Standard error	0,02
R-squared	0,29

Source: Bloomberg, Analyst Estimates

Table 3: MTUs target capital structure and CoC

Cost of equity	4,79%
Cost of debt	2,53%
After-tax cost of operating leases	2,68%
E/EV	81,92%
D/EV	15,97%
Capitalized operating leases/EV	2,11%
Statutory tax rate	32,20%
WACC	**4,26%**

MTUs current capital structure

E/EV	87,23%
D/EV	10,11%
COL/EV	2,66%

Source: MTU, Bloomberg, Analyst Estimates

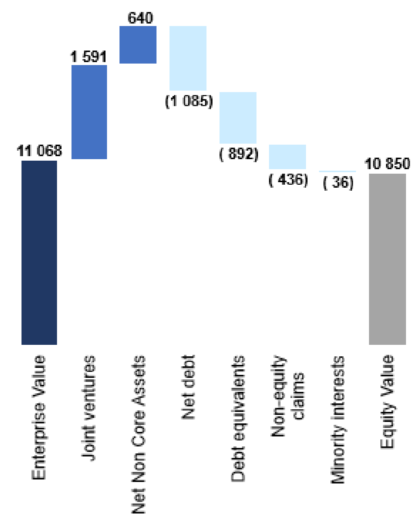
We use a risk-free rate of 0.31% which is based on the current German 10-year government bond yield. MTUs beta (1.01) is based on a 2-year weekly regression vis-à-vis the MSCI World Index. The 2-year rolling beta has been fairly stable showing a 6.45% standard deviation. Moreover, the result is in line with MTUs comps median beta (0.96) and average (0.96). For the market risk premium, we assume 4.77%[73]. As a result, we arrive at a cost of equity of 4.79%[74]. Given the potential changes in the risk-free rate in the near future the following table provides a sensitivity analysis on the cost of equity.

	Risk-free rate										
Beta	**0.06%**	**0.11%**	**0.16%**	**0.21%**	**0.26%**	**0.31%**	**0.56%**	**0.81%**	**1.06%**	**1.31%**	**1.56%**
0.96	4.56%	4.56%	4.57%	4.57%	4.57%	4.57%	4.58%	4.60%	4.61%	4.62%	4.63%
1.01	4.80%	4.80%	4.80%	4.80%	4.80%	4.79%	4.79%	4.79%	4.79%	4.79%	4.79%
1.06	5.03%	5.03%	5.02%	5.02%	5.02%	5.02%	5.00%	4.99%	4.97%	4.96%	4.95%

MTU has only one non-traded registered convertible bond outstanding. Therefore, cost of debt (2.53%) is based on the risk-free rate on top of a default spread of 2.22% according to MTUs Moody's rating (Baa3) with a stable outlook. The target capital structure used in the WACC (4.26%) is based on an average capital structure of global aerospace and defense companies[75]. Table 3 provides a comparison of MTUs target and current capital structure.

Valuation

Graph 51 - EV to Equity bridge



Source: Analyst estimates

Our SOTP valuation separately encompasses MTU's core business (DCF), its two key joint ventures (Zhuhai and EME Aero; Cash Flow to Equity), as well as its remaining non-operating assets and liabilities (composed of goodwill, investments in associates and financial assets; Book Value); Graph 51 provide a summary of the valuation results. Our DCF methodology is based on a 10-year explicit horizon allowing for significant flexibility to account for varying margin, growth and investment assumptions during the different investment and consolidation phases. The continuing value relies on a base-year NOPLAT of €552m by 2028, tied to an expected 1.9% long-term growth rate and a WACC of 4.3% as mentioned above, which we link directly to the company's long-term capacity of creating value from new invested capital. Indeed, our vision of MTU in the current context and in the next 10-15 years is marked by its ability to hold a competitive advantage, allowing for significant value creation. Nonetheless, it is hard to picture how the company will perform in future engine programs in the very long term, in an industry where

[73] Historical MRP from 1928 to 2017 based on a geometric average of S&P500 and 10-year US treasury bond
[74] Based on CAPM model
[75] A. Damodaran's "Global Capital Structure Ratios"; Updated as of January 2018; Global-level (#firms=229)

technology, design and engineering change very often, and are crucial for companies' competitive success. Naturally, entry of new players is largely not expected, but the few existing players have been competing intensely on many levels. As a clear example - recent news reporting that GE and UTC are looking to definitely break itself apart would result in much more focused GE Aviation and Pratt & Whitney units, which could either harm or strengthen MTU's competitive situation.

Moreover, as a measure to sense-check our intrinsic valuation results, a focused yet unusual peer group[76] is taken into account to derive relative implied valuations[77]. EV/EBIT is - in our view - the most relevant metric to watch in this highly capital-intensive industry, uncovering asset efficiency deviations across peers; moreover, the "lease *vs.* own" choices may also deviate significantly using other common metrics such as EV/EBITDA. The peer group includes both key MTU competitors, partners and end-clients, as they all are exposed to the same industry dynamics and external environment, facing very similar long-term growth prospects and exposure to external developments and effects.

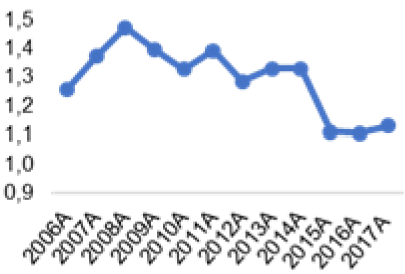
Graph 51 - Football Field (Part II)

Metric	Multiples Range			Enterprise Value / Equity Value ranges		
DCF @ WACC 3.8% - 4.8% (Enterprise Value)				11956	DCF EV €13.3bn	15003
EV / Sales 2019e	1,18x	-	2,63x	7700		17135
EV / EBIT 2019e	13,8x	-	23,0x	9165		15326
P / E 2019e	16,3x	-	34,4x	7089		14942
DCF @ WACC 3.8% - 4.8% (Equity Value)				9507	DCF EqV €10.9bn	12554

Source: Analyst estimates

Sensitivity analysis

Graph 52 – Historical EUR/USD intra-year rate



Source: European Central Bank

Based on our sensitivity analysis we are mainly concerned about two variables which may considerably influence the valuation. While a change in the continuing value growth rate has a rather low effect, a change in the WACC and especially FX rate, affect our valuation significantly. Particularly an increase in the discount rate we see as very likely to happen soon due to changing monetary policies as well as macroeconomic dynamics happening in the most relevant and developed markets[78]. A 10-cent increase in the EUR/USD rate in the continuing value, for example, destroys around 5.5% in value (table 4), Despite the current pressure on the USD, looking back at the historical exchange rate, this scenario seems to be

[76] Rolls-Royce, Safran, Senior, Meggitt, Airbus and Boeing
[77] Market data taken into account is based on peers' -3m average trading prices as of 22 December 2018. Looking-forward estimates were obtained using FactSet aggregate consensus from several accredited research analysts and are all adjusted for non-recurring/immaterial events and effects. Moreover, the bridge items (EV-EqV) were calculated by the team by inspecting the companies' latest quarterly/semi-annual reports
[78] We provide a sensitivity analysis on the risk-free rate and some key facts on our view on the trend of the risk-free rate in the cost of capital section

rather possible. Finally, the burn rate in the CV can have a significant impact as well. A 10% increase/decrease creates / destroys c. 13% in value (table 5). In our view, it certainly is possible that the burn rate may change in the future. Nonetheless, we don't expect this driver to deviate significantly from our forecast.

Table 4: Sensitivity analysis - FX rate EUR/USD

FX rate	EV	Share price
1,0	15,1	224,0
1,1	14,1	208,6
1,2	13,3	195,7
1,3	12,6	184,7
1,4	12,0	175,4

Table 5: Sensitivity analysis - Burn rate

Burn rate	EV	Share price
80%	10,5	144,7
90%	11,9	170,2
100%	13,3	195,7
110%	14,7	221,1
120%	16,1	246,6

Source: Analyst estimate
Note: EV in EURbn; share price in EUR

Base-case Total EV (2019E)

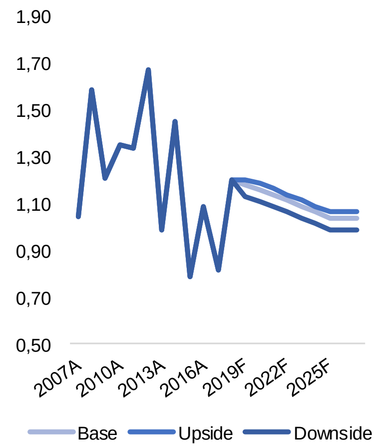
WACC \ Growth rate	1,15%	1,40%	1,65%	1,90%	2,15%	2,40%	2,65%
3,36%	16 623	16 661	16 698	16 736	16 774	16 812	16 851
3,66%	15 298	15 332	15 366	15 400	15 435	15 471	15 506
3,96%	14 175	14 206	14 237	14 269	14 301	14 334	14 367
4,26%	13 211	13 240	13 269	13 299	13 329	13 359	13 389
4,56%	12 376	12 403	12 430	12 457	12 485	12 513	12 542
4,86%	11 645	11 670	11 695	11 721	11 747	11 774	11 800
5,16%	11 000	11 023	11 047	11 072	11 096	11 121	11 146

Base-case share price (2019E)

WACC \ Growth rate	1,15%	1,40%	1,65%	1,90%	2,15%	2,40%	2,65%
3,36%	255,6	256,3	257,0	257,6	258,3	259,0	259,7
3,66%	231,7	232,3	232,9	233,6	234,2	234,8	235,5
3,96%	211,5	212,0	212,6	213,2	213,7	214,3	214,9
4,26%	194,1	194,6	195,1	195,7	196,2	196,7	197,3
4,56%	179,0	179,5	180,0	180,5	181,0	181,5	182,0
4,86%	165,8	166,3	166,7	167,2	167,7	168,2	168,6
5,16%	154,2	154,6	155,1	155,5	155,9	156,4	156,8

Scenario analysis – GTF as the prime valuation factor[79]

Graph 53 - Book-to-bill development (OEM)

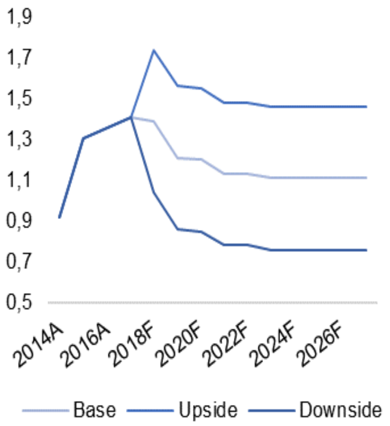


Source: MTU, analyst estimate

As mentioned across the note, we implicitly and explicitly mention the GTF as a key part of MTU's equity story. Indeed, 2017 was already an eventful year, 2018 is on its way to be so as well, but we expect 2019 and 2020 to be decisive years. Indeed, on both sides of the spectrum, the program can be a major success and achieve a higher-than-expected market share vs. the LEAP, or it can also enter successive operating disruptions, causing potential (undecided) clients to flee for the CFM-designed engine solution. Hence, we are confident that a structured approach to model these two scenarios is highly relevant, so as to incorporate extreme up and down-side scenarios in the valuation. Our approach is based on a qualitative analysis of the abovementioned market dynamics and their impact on the team's base forecasts in the explicit period[80].

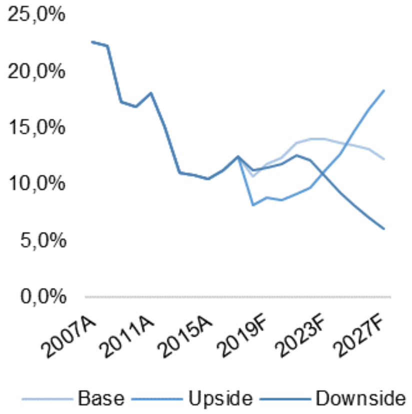
[79] Based on 2019F target price (TP)
[80] We assume that the military segment would be left unchanged for these scenarios as it solely focuses on GTF market share success/failure – again: key part of MTU's valuation; moreover, its lack of strategic focus both for the company and the market led the team to classify it as much less material compared to the commercial OEM and maintenance divisions

Graph 54 – Book-to-bill development (MRO)



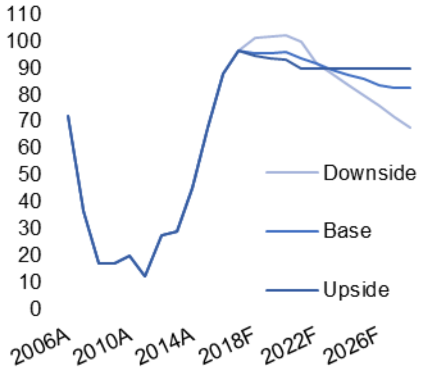
Source: MTU, analyst estimate

Graph 55 – ROIC development (group-level)



Source: MTU, analyst estimate

Graph 56 – Cash Conversion Cycle (nº days) across scenarios



Source: MTU, Analyst Estimates

Upside case: MTU successfully captures higher narrow body market share /GTF) vs. The LEAP

In a world where the LEAP sequentially loses market share on currently undecided customers and future orders, GTF partners such as MTU widely stand to benefit from positive synergies coming from – especially – significantly higher OEM and MRO revenue growth (as a result of stronger demand reflected in higher BTB ratios). Nonetheless, the increased market share requires significant capital commitments in new production and maintenance facilities; also, in the short-term, negative impacts are highly likely due to an even stronger ramp-up in production. As a result, FCF would be significantly negative in the first years. Moreover, the company would see its MRO business shift even more towards OEM-cooperation business, assuming it would be unable to service independent work at the same level, as it would have to comply with long-term commitments for new engines, which as previously mentioned yields lower operating margins. Hence, in this extremely positive scenario, we forecast constantly higher BTB ratios across OEM and MRO divisions starting precisely in 2018F, reflecting short-term order announcements for GTF-powered A320neos, which would not only reflect engine production demand as well as long-term MRO contract commitments, which would obviously impact the size of MRO backlog as well; the impact on revenue growth would be clear on both segments, with significantly higher revenue CAGRs across the whole explicit period (9.2% for MRO and 8.9% for OEM vs. 7.7% and 6.6% in the base-case scenario). All in all, returns on capital commitments since 2012A would be higher, with ROIC reaching a level of 9.4% in 2027F, even accounting for the significant investment commitments that we reflect in CAPEX and intangibles projections. Moreover, given the superior commercial position hypothetically achieved under this scenario, there would be more reasons to believe that MTU could hold a significant long-term competitive advantage, therefore we adjust RONIC upwards (above WACC) in the CV assumptions.

Downside case: GTF loses share to the LEAP and MTU captures limited narrow body growth

On the other side of the spectrum, another scenario to consider would involve MTU seeing its share of the narrow body demand growth severely hindered. As a result, we model significant BTB reductions on both OEM and MRO, reflecting worsening demand compared to the base case scenario. Moreover, investment needs as well as ramp-up costs would be significantly reduced, therefore positively impacting short-term outlook for FCF. Nonetheless, the reduced market share and commercial position would result in lower ROIC over the explicit period, meaning that MTU would fail to capitalize on its GTF-related investments since

Graph 57 - Valuation summary (Y/E 2019)

Downside Case	
Core Enterprise Value	**10 093**
Net Debt	(1 076)
Operating Subsidiaries	1 294
Net non-operating assets	640
Other EV adj.	(748)
Implied share price	**172,5**
Base Case	
Core Enterprise Value	**11 068**
Net Debt	(1 085)
Operating Subsidiaries	1 591
Net non-operating assets	640
Other EV adj.	(725)
Implied share price	**195,7**
Upside Case	
Core Enterprise Value	**13 358**
Net Debt	(952)
Operating Subsidiaries	2 151
Net non-operating assets	640
Other EV adj.	(1 121)
Implied share price	**242,3**
Scenario-weighted TP	**197,4**

Source: Analyst Estimates

2012, as well as the on-going ones (including capacity increases in Zhuhai and on-going investment in Poland).

Overview of valuation results[81]

All in all, our scenario projections imply a core EV range from EURbn 10.1 to 13.4bn, where the latter consists in an extreme scenario implying a 24% premium to our base-case share price of EUR 195.7 and the former a discount of 12%. We model a probabilistic approach to these scenarios, accounting for an equal, yet small probability for both the extreme scenarios, arriving at a final weighted target price (YE 2019) of EUR 197.4.

Final valuation considerations – last remarks

There is a myriad of factors impacting our view of MTU that go far beyond engine OEM and MRO market mechanics, competition and program success/failures. As initially described, the entire engine production and maintenance market strongly depends – with certain exceptions – on the end customers. These are mainly airlines that source aircraft from Airbus, Boeing, Embraer, etc. As widely known and experienced, airlines are strongly exposed to many macro and micro factors that are often interrelated. Moreover, the commercial positioning that MTU will be able to maintain or achieve is naturally also a crucial aspect. Indeed, future partnerships, engagements and investments in engine programs are key for both OEM and MRO activities. Moreover, Industry 4.0 pinpoints a turning point for the broad manufacturing industry, where the A&D sector is riding as a top innovator, therefore MTU will have to allocate resources to remain technologically competitive. We are confident that a thorough analysis of these factors would strengthen an assessment of MTU. Therefore, a more detailed overview of some of the abovementioned drivers will be discussed in depth, as per the following attachments: “Final valuation considerations, Parts 1/2 and 2/2”.

[81] Share prices across scenarios based on 2019F TPs

NOVA SCHOOL OF BUSINESS & ECONOMICS

Appendix (1/3) – Summary sheet

	2015A	2016A	2017A	2018F	2021F	2024F	2027F
Margins							
OEM							
COGS as % of Revenue	82.33%	80.75%	76.86%	81.86%	79.86%	76.86%	76.86%
EBIT Margin	7.06%	8.22%	10.92%	8.77%	8.81%	9.89%	9.68%
EBITDA Margin	11.74%	13.19%	16.58%	12.35%	13.92%	16.20%	15.96%
NOPLAT Margin	5.37%	6.33%	8.24%	5.94%	5.97%	6.70%	6.57%
MRO							
COGS as % of Revenue	82.64%	83.04%	84.55%	85.05%	86.05%	86.05%	86.05%
EBIT Margin	9.60%	10.48%	10.25%	9.79%	8.05%	7.63%	7.75%
EBITDA Margin	12.13%	12.62%	12.16%	11.46%	9.56%	9.59%	9.81%
NOPLAT Margin	7.69%	7.97%	7.89%	7.39%	5.46%	5.17%	5.25%
Consolidated							
COGS as % of Revenue	81.5%	82.4%	81.7%	80.3%	83.3%	81.8%	81.2%
EBIT Margin	8.4%	8.3%	9.1%	10.5%	8.3%	8.6%	8.8%
EBITDA Margin	12.4%	12.1%	12.8%	14.4%	11.4%	12.6%	13.1%
NOPLAT Margin	6.7%	6.3%	7.0%	7.9%	5.6%	5.8%	5.9%
Net Income Margin	6.5%	6.3%	6.8%	7.8%	5.4%	5.6%	5.7%
Valuation							
Implied P/E			25.7x	30.5x	25.7x	22.3x	21.3x
P/E (-3m avg market cap)			25.5x	28.7x	23.0x	20.0x	19.1x
P/E (last closing)			22.6x	25.5x	20.4x	17.7x	17.0x
EV/Sales			2.46x	2.21x	1.73x	1.57x	1.51x
EV/EBITDA			17.2x	19.1x	14.6x	12.1x	11.5x
EV/EBIT			23.5x	24.7x	20.6x	17.9x	17.1x
EPS	4.3	6.1	7.4	6.6	8.2	9.5	9.9
Return on Invested Capital	9.9%	10.7%	11.9%	9.4%	8.5%	8.7%	8.8%
Ratios							
FCF/Sales	1.2%	0.5%	0.1%	1.8%	-1.9%	2.0%	5.8%
Net Debt/EBITDA	1.2x	1.3x	1.4x	1.7x	1.3x	1.2x	1.1x
CAPEX/Sales	2.7%	3.2%	3.8%	4.8%	5.3%	3.3%	3.2%
R&D/Sales	1.5%	1.5%	1.5%	1.5%	2.0%	2.5%	2.7%
D&A/Sales	3.78%	3.75%	3.90%	2.62%	3.44%	4.25%	4.31%
Working Capital/Sales	20.61%	25.71%	27.82%	27.78%	28.43%	26.49%	26.48%
Asset Turnover	1.7x	1.6x	1.6x	1.7x	1.6x	1.5x	1.5x
Order backlog							
OEM							
Commercial (USDm)	6,888.50	7,113.60	6,617.70	7,322.93	9,279.82	10,546.34	11,527.10
Growth	*-7.5%*	*3.3%*	*-7.0%*	*10.7%*	*7.0%*	*3.1%*	*3.0%*
Military (USDm)	547.94	524.41	355.95	356.34	363.44	382.96	403.54
Growth	*-28.1%*	*-4.3%*	*-32.1%*	*0.1%*	*1.2%*	*1.8%*	*1.8%*
MRO							
Consolidated business (USDm)	4,439.1	5,183.6	6,220.6	7,474.8	9,960.2	10,479.7	10,649.9
Growth	*13.5%*	*16.8%*	*20.0%*	*20.2%*	*5.2%*	*0.5%*	*0.5%*
Zhuhai, China (USDm)	1,726.3	2,117.3	2,666.0	3,361.8	5,967.6	8,743.9	10,689.3
Growth	*19.3%*	*22.6%*	*25.9%*	*26.1%*	*18.6%*	*11.1%*	*6.1%*

	2015A	2016A	2017A	2018F	2021F	2024F	2027F
Income statement							
Revenue	**4,435.3**	**4,732.7**	**5,036.3**	**5,804.8**	**7,668.8**	**8,459.2**	**8,828.5**
Commercial OEM	2,391.1	2,357.9	2,410.7	2,938.4	3,632.8	4,031.7	4,316.1
Military OEM	478.5	494.9	394.7	326.3	329.2	345.0	363.5
MRO	1,565.6	1,879.9	2,230.9	2,540.1	3,706.9	4,082.6	4,148.9
Gross profit	**778.9**	**867.9**	**993.9**	**972.0**	**1,315.1**	**1,582.4**	**1,661.7**
EBITDA	**535.1**	**606.1**	**723.4**	**672.4**	**909.1**	**1,102.9**	**1,156.3**
EBITA	**437.3**	**504.7**	**614.0**	**553.7**	**704.4**	**823.1**	**877.3**
EBIT	**367.5**	**428.6**	**527.2**	**520.3**	**645.6**	**743.3**	**776.1**
Net interest result	(1.1)	(11.9)	(7.2)	(20.5)	(22.2)	(25.3)	(25.2)
Income taxes	(87.8)	(95.9)	(127.5)	(160.9)	(200.7)	(231.2)	(241.8)
Net Income	**278.6**	**320.7**	**392.5**	**338.8**	**422.6**	**486.8**	**509.1**
Balance Sheet							
Operating current assets	**1,992.5**	**2,202.7**	**2,289.5**	**2,730.7**	**3,712.9**	**3,968.5**	**4,139.1**
Operating current Liabilities	**(1,078.3)**	**(985.9)**	**(888.3)**	**(1,118.0)**	**(1,532.8)**	**(1,728.0)**	**(1,801.0)**
Fixed Assets	**732.8**	**843.6**	**1,099.4**	**1,221.9**	**1,492.5**	**1,641.7**	**1,855.1**
Net PP&E	632.0	681.5	763.4	923.2	1,518.3	1,798.7	1,799.7
Capitalized operating leases	100.8	162.1	336.0	385.2	368.6	301.0	269.8
Other long-term operating assets	**1,821.9**	**1,842.0**	**1,898.5**	**2,028.0**	**2,474.5**	**2,952.5**	**3,401.1**
Intangible assets (excl. goodwill and	469.0	550.0	615.0	698.0	989.6	1,310.0	1,636.9
Program assets	1,352.9	1,292.0	1,283.5	1,330.1	1,484.9	1,642.5	1,764.2
Other long-term operating liabilities	**(520.0)**	**(707.7)**	**(893.4)**	**(959.1)**	**(1,186.6)**	**(1,468.1)**	**(1,816.3)**
Invested capital	**2,948.9**	**3,194.7**	**3,505.8**	**3,903.6**	**4,960.5**	**5,366.7**	**5,778.0**
Non-Core Invested Capital	**336.5**	**485.4**	**772.3**	**772.3**	**772.3**	**772.3**	**772.3**
Net financial assets	**(1,984.6)**	**(2,179.8)**	**(2,324.6)**	**(2,529.1)**	**(2,956.1)**	**(2,336.3)**	**(1,363.0)**
Shareholder's equity	**1,300.8**	**1,500.3**	**1,953.5**	**2,233.4**	**3,171.1**	**4,260.7**	**5,401.8**
Free Cash Flow							
NOPLAT	**279.4**	**329.9**	**397.9**	**352.7**	**437.7**	**503.9**	**526.2**
Operating cash flow	**447.4**	**507.5**	**594.1**	**504.9**	**701.3**	**863.6**	**906.4**
Investing cash flow	**(442.9)**	**(423.4)**	**(507.3)**	**(636.5)**	**(703.2)**	**(378.0)**	**(454.7)**
Free cash flow from core business	**4.5**	**84.1**	**86.8**	**(131.7)**	**(1.9)**	**485.6**	**451.7**
Free cash flow from non-core busine	**46.8**	**(169.7)**	**(234.0)**	**39.0**	**39.0**	**39.0**	**39.0**
Total free cash flow	**51.3**	**(85.5)**	**(147.2)**	**(92.7)**	**37.1**	**524.6**	**490.7**
Financing cash flow	**(51.3)**	**85.5**	**147.2**	**92.7**	**(37.1)**	**(524.6)**	**(490.7)**
Key value drivers							
OEM							
Commercial book-to-bill	0.79	1.09	0.82	1.20	1.14	1.07	1.07
Commercial burn rate	0.36	0.38	0.38	0.53	0.50	0.47	0.46
Military book-to-bill	0.60	0.96	0.62	1.00	1.01	1.02	1.02
Military burn rate	0.70	1.00	0.85	1.10	1.10	1.10	1.10
MRO							
Consolidated MRO book-to-bill	1.30	1.36	1.41	1.41	1.11	1.01	1.01
Consolidated MRO burn rate	0.44	0.47	0.49	0.49	0.47	0.47	0.47
Zhuhai, China book-to-bill	1.40	1.53	1.52	1.52	1.37	1.22	1.12
Zhuhai, China burn rate	0.48	0.42	0.50	0.50	0.50	0.50	0.50

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Buy	Expected total return (including expected capital gains and expected dividend yield) of more than 10% over a 12-month period.
Hold	Expected total return (including expected capital gains and expected dividend yield) between 0% and 10% over a 12-month period.
Sell	Expected negative total return (including expected capital gains and expected dividend yield) over a 12-month period.

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Appendix (2/3) – Final valuation considerations (1/2)

Individual Work Project, presented as part of the Field Lab – Equity Research 18/19

The importance of the GTF for MTU's valuation

Maksim Defer

Student number: 31764

A Project carried out in the Master in Finance Program, under the supervision of:

Professor Rosário André

4 January 2018

Introduction

Throughout the report we mentioned various factors influencing MTUs valuation. On the one hand, we argued for external factors such as economic growth and the currently low oil price and low interest rates. On the other hand, we stressed the success of the current engine programs MTU is participating in, especially the GTF.

I would like to consider MTUs valuation on a company and business model specific level thereby neglecting market wide factors which have a very similar effect on the industry and main competitors[82]. Besides these market wide factors, investors in MTU have mainly reacted to issues with the Company's MRO business and GTF engine. This section is a qualitative analysis into the main driving factor behind the scenario analysis, the success of the current GTF engine program.

The importance of GTF sales

MTU operates in two phases in which free cash-flows and ROIC fluctuate significantly[83]. The (1st) investment period (~5 years) in which engines are developed requires large cash-outflows. During the (2nd) consolidation phase (~5 years) engines are sold, however oftentimes below production costs due to the bilateral oligopoly and strong competition for market share[84]. After additional 6 to 7 years engines come into the MRO stage in which MTU starts to turn its investments / losses from engine development and sales into profits. The ongoing shift away from independent MRO towards OEM-affiliated MRO lifetime contracts makes MTUs business even more dependent on early OEM engines sales with MTU participation. These new contracts, however, provide lower operating margins of around ~3-4% compared to ~8-10% for independent MRO contracts. Hence, economies of scale in production and MRO become even more important. Overall, project specific profits are oftentimes realized after more than 16 years since the first investment.

[82] See appendix 1
[83] See page 23
[84] This is especially true for aircrafts which have more than one engine choice such as the A320neo family (GTF or LEAP) or 787 (GEnx or Trent 1000)

MTUs current potential is largely skewed towards the narrow-body segment and the GTF engine. The narrow-body engine portfolio is largely in the aftermarket and phase-out stage[85]. The most significant engine, the V2500 of which at the moment 6,118 (FlightGlobal 2018) pieces are operated will largely be phased out over the next decade. Currently, there are only two engines in series production with one more to be launched in 2019[86]. The PW1100G for the A320neo family has the most significant impact on MTUs revenues with currently 139 operated aircrafts (FlightGlobal 2018) and 5,716 outstanding orders[87] (Airbus 2018). With a market share of c. 44% (CAPA Centre for Aviation 2018) on the A320neo family, MTU has a potential for c. 5,000 engines orders as of today. In this segment, MTU competes with the LEAP which owns the remaining 56% market share. An increase in MTU's market share to (c.) 50%, as expected by the management in the long-term would allow for c. 700 more engine unit sales as of today.

The wide-body portfolio is partly close to final phase-out and partly in the mid phase-out stage with only three[88] engine types in series production. The 787 and 747-8 engines (GEnx) are currently in series production and are entering the after-market phase. At the moment, 1,042 GEnx engines are in operation (FlightGlobal 2018). With further 639 outstanding orders (Boeing 2018) for the 787 and a market share of c. 60% on this aircraft type, there is a potential for around 760 more engines for MTU. The competition for engines sales on this aircraft is currently skewed towards the GEnx given recent issues with the Trent 1000 (Reuters 2018). Finally, the engines for the 777X which will start operations in 2020 will enter the after-market stage approx. in 2027. MTU will profit from all aircraft orders and likely from a large part of the after-market on this aircraft as it is the sole supplier for it.

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[85] See appendix 2 for an overview of MTUs current narrow- and wide-body engine portfolio
[86] All three egnines are GTF type engines for different narrow-body aircrafts. Additionally, MTU participates in the PW6000 for the A318. However, this engine is negnectible as there are only 6 aircrafts operated (FlightGlobal 2018) with only 80 orders (Airbus 2018)
[87] Outstanding orders for the A320neo family as of November 2018 (Airbus 2018)
[88] Including the GP7000 engine for the A380 which is neglectible with only 50 expected orders over the next 10 years (Oliver Wyman 2018), resulting in a potential of 200 engines

Together with the V2500 and GEnx the PW1100G provide 3/4 of MTU's commercial OEM revenues (MTU 2018)[89]. What is more, in addition to the current potential of the narrow-body segment, the segment is expected to further grow in the foreseeable future while the wide-body segment is forecasted to decline[90]. Overall, in the commercial segment future cash-flow streams will therefore heavily rely on the success of the GTF and its after-market and are thus highly crucial for MTUs valuation and future potential sales. Hence it is highly important for MTU and its partners to compete for higher market share on the GTF and not to further lose any as happened in the recent past[91].

While customers of the GTF have been positively commenting on its good fuel efficiency, it has drawn negative attention due to various reliability issues. As a result, the GTF has lost some market share from 46% to 44% (CAPE Centre for Aviation). Lower orders or cancelations are particularly critical. Qatar Airways, for example, canceled its orders of 32 GTF engines and opted for 72 LEAP engines when it increased its order for A320neos in 2017 as a reaction of delayed deliveries due to technical problems with the GTF. In February 2018, MTU's stock price dropped by ~14%[92] as a reaction to the knife-edge seal problems which have caused some groundings and production delays (Airline Suppliers 2018, FlightGlobal 2018). By September 2018 the GTF experienced issues with increased vibrations. In order to repair the engines, PW had to ground an average of around 10 aircrafts at one time (IndustryWeek 2018) leading to significant losses for airlines. Moreover, over the summer 2018 IndoGo, for example, had to ground 9 planes due to a lack of spare parts and replacement engines. Due to production delays in connection with technical issues of the GTF, Airbus delivered only half of the ordered A320neos to Lufthansa which were then be able to fly only 50% of scheduled flights due to technical problems and lack of spare parts and replacement engines.

[89] 2017E. Given the fact that the last V2500 engine will be sold in 2019 and the GEnx has only a low quantity potential compared to the PW1100G, it can be expected that the GTF will be MTU's main revenue driver. MTU confirms this view (MTU 2018)
[90] See pages 6-7 and 9-10
[91] A quantitavive analysis based on prices and costs is not possible due to unavailability of data. Unlike with aircraft prices which are publicly available, this is not the case for engines prices
[92] See appendix 1

Overall, of the 140 A320neos equipped with GTF engines, 15 were grounded (10.7%). In comparison, of the 205 A320neos delivered with CFM engines only 7 were grounded (3.4%) (Airlinewatch 2018). While MTU has not been responsible for any of these issues, these cases also show how heavily its stock performance relies on other program partners. So far, besides the not very critical lost market share and some cancelations, there haven't been any crucial losses. Trust issues in such concentrated markets with high pre-financed investments, and returns realized only after many years can have long-term negative financial implications. Engines are not released every year but every 10 years or more when a new aircraft model is released and then operate for decades. Should an engine model fail or not attract enough buyers, there will be a (much) smaller or no existent market until a new aircraft model is released. What is more, highly crucial MRO sales in the profitable after-market phase would decrease and may not be sufficient to make up losses from development and sales with low or even negative margins. For MTU, depending on the extent, this would imply a negative project ROI with at the same time high R&D expenses as well as investments in e.g. program shares and production equipment for new engine models. Overall this will negatively impact MTU's cash flow generation and thus the valuation for a longer-term.

Based on current outstanding orders for the A320neo family, the 2% lost market share amount for only c. 230 less GTF sales for MTU. However, future sales of new GTF engine models depend to a certain extent on current sales. As with aircrafts, airlines largely try to align its equipment all over their fleet. For example, based on the good experience with their large portfolio of CFM56 engines, Lion Air ordered 380 LEAP engines for their new A320neo fleet in 2018 (Lion Air 2018). Based on this fleet alignment behavior of airlines it is important to gain a large engine customer base and "lock them in". In the future, this will increase the chances of follow-up orders from existing customers. The large number of current outstanding orders for new aircrafts as well as the great market prospects for the near future make the time favorable to grow MTU's customer base. Especially emerging markets in which fleets are growing tremendously constitute a very important chance for the GTF. With a higher installed GTF engine fleet, MTU will be able to sustain and further expand its positioning in a highly competitive market in the future.

Conclusion

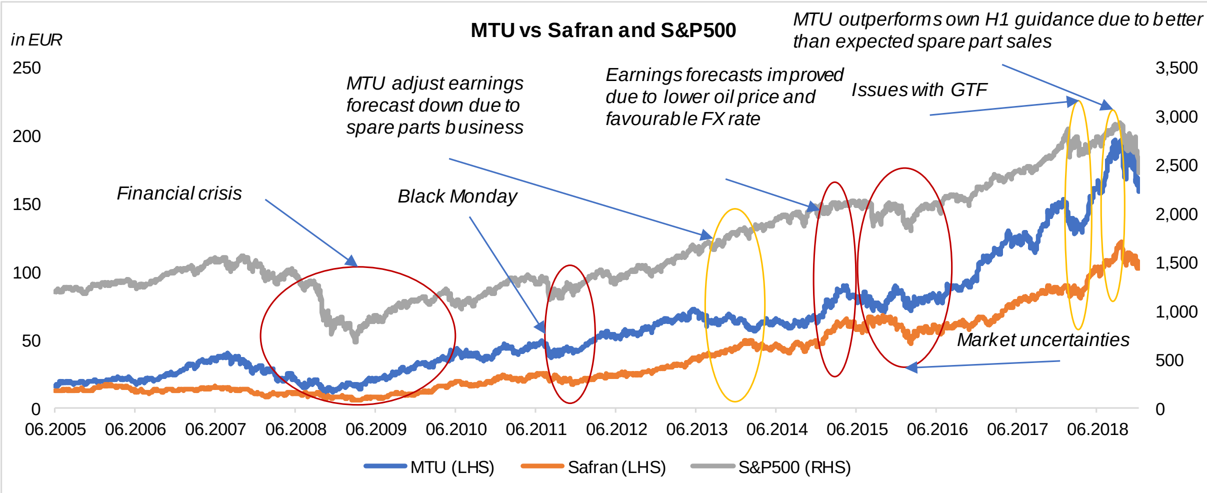
Given MTUs engine portfolio and market demand, the Company's valuation as of today is highly dependent on current and future GTF sales.

Future profitability mainly depends on the after-market phase which in turn increasingly depends on OEM sales. Should the recent issues with the GTF widen so that MTU and its partners miss to sell "enough" GTF engines, they will likely be at a disadvantage in the future after-market harvesting stage. Cash-flow streams will decline (significantly) for a long period until new engine models start generating revenues and more importantly profitability. At the same time MTU would need to make cash available for high R&D expenses and other required investments for future engine programs. As a result, the share price is likely to suffer for a longer period and investors might stay away from MTUs stock over this period. Additionally, lower GTF sales will likely to shift future engines sales to competitors, thereby additionally putting pressure on MTUs stock.

By contrast, the effect of selling a larger number of current GTF engines will give investors more confidence into MTU's stock due to (1) largely secured future positive cash-flows during the MRO stage as well as (2) future potential sales of flowing engine models to existing customers.

Appendix

Appendix 1 – Share price development of MTU, Safran vs S&P 500 index[93]



Source: Bloomberg

[93] Development is only considered since MTUs IPO in 2005

Appendix 2 – Overview of MTU's narrow- and wide-body engine programs

Narrowbody engine overview

Aircraft	Engine	Program partners	MTU program share	Phase
Boeing 757, C-17	**PW2000**	PW, GKN Aerospace, Avio Aero	21.2%	Aftermarket and phase-out
A318	**PW6000**	PW, Mitsubishi	18.0%	Series Production and Aftermarket
A320neo	**PW1100G - JM**	PW, GKN Aerospace, JAEC	18.0%	Series Production and Aftermarket
A319	**V2500**	PW, JAEC	16.0%	Aftermarket and phase-out
A320	**V2500**	PW, JAEC	16.0%	Aftermarket and phase-out
A321	**V2500**	PW, JAEC	16.0%	Aftermarket and phase-out
Boeing MD-90 range	**V2500**	PW, JAEC	16.0%	Aftermarket and phase-out
Boeing MD-80 range	**JT8D - 200**	PW, GKN Aerospace, Mitsubishi	12.5%	Aftermarket and phase-out
Irkut MC-21	**PW1400G**	PW, GKN Aerospace, JAEC	18.0%	R&D phase
Bombardier C-Series	**PW1500G**	PW, GKN Aerospace, JAEC	17.0%	Series Production (recently launched)

Widebody engine overview

Aircraft	Engine	Program partners	MTU program share	Phase
Boeing 777X	**GE9x**		4.0%	Initial development
Boeing 767	**CF6-50/80A**		n/a	Close to final phase-out
A310 and A300	**CF6-50/80A**		n/a	Close to final phase-out
DC 10-30	**CF6-50/80A**		n/a	Close to final phase-out
A330	**CF6-80E**		n/a	Entering phase-out
Boeing 787 Dreamliner	**GEnx**		6.6%	Entering aftermarket
Boeing 747-8	**GEnx**		6.6%	Entering aftermarket
Boeing 747-400	**CF6-80C**		9.1%	Mid phase-out
Boeing 767	**CF6-80C**		9.1%	Mid phase-out
A310 and 300	**CF6-80C**		9.1%	Mid phase-out
Boeing MD-11	**CF6-80C**		9.1%	Mid phase-out
Boeing 777	**PW4000G**	PW, MTU	12.5%	Entering phase-out
A380	**GP7000**		22.5%	Mid series production

Source: MTU

Appendix (3/3) – Final valuation considerations (2/2)

Individual Work Project, presented as part of the Field Lab – Equity Research 18/19

MTU and Additive Manufacturing (AM)

The case for material long-term margin gains and value creation

Francisco Almeida e Silva Centeno Castanho

Student number: 4232

A Project carried out in the Master in Finance Program, under the supervision of:

Professor Rosário André

4 January 2018

Industry 4.0[94] is a widely discussed topic, frequently mentioned by top executives active in the broad manufacturing spectrum when discussing industrial innovation. MTU has been showing analysts and investors how it is preparing for it, having pooled talent and resources to research everything from advanced manufacturing techniques and IoT to AI and Blockchain, with potential effects in manufacturing processes, predictive maintenance and analytics and robotic process automation. However, above all, MTU has proved to be much more motivated by the potential of Additive Manufacturing (AM) as an alternative to its core and well-established manufacturing processes. As Figure 1 depicts, MTU is in a very-well regarded position in both AM activity and installed machine capacity, while GE is considered to be the leading A&D player in the space. Indeed, the latter has significantly engaged in inorganic initiatives (via M&A and partnerships) targeting start-ups and mid-sized companies that are solely engaged in developing this technology. Instead, MTU has been organically investing in the technology for years, but only taking a more serious step in early 2018, by launching a dedicated unit with 30 professionals to pool expertise and resources together. The goal is to find and develop methodologies and strategies to implement AM in serial production, maintenance and spare parts servicing. As of today, the company only uses the technology to develop useful but basic tools and materials for human intervention in manufacturing and maintenance processes, such as borescope bosses used in maintenance for the new PW1100G.

Simply put, the technology involves "manufacturing" parts, components or actual end-products, with computer-aided software (CAD) by successively mounting several layers of chosen materials (from metal powder, ceramics and composites to glass, edibles and thermoplastics) to create the desired "object". AM applications in A&D are not at all a novelty. In fact, its first applications root back to 30 years ago, when the technology started being used for prototyping and tooling. Today, it is considered one of the most mature advanced manufacturing technologies - no longer only for test

[94] Also coined as the "4th Revolution", Industry 4.0 is related to technological breakthroughs in manufacturing and industrial processes leveraged by new systems, software, data analytics and automation, featuring key concepts such as advanced manufacturing techniques, internet of things (IoT), machine learning (ML), artificial intelligence (AI), blockchain, etc.

and research purposes, but for actual implementation[95] - it has the largest potential impact on manufacturing processes over the next 5-10 years, according to industry executives[96]. Nonetheless, the key current applications still comprise mostly modeling and prototyping, and to a very limited extent, low-volume, simple and replacement parts. Indeed, the A&D industry is highly complex and intertwined by several players along the value chain, so the number of different parts and components needed to assembly an aircraft is immense, and these naturally come from several manufacturers. Maintenance is also very delicate and follows equally-complex standards, regulation and certification requirements, for obvious reasons. Hence, most players are still on the "wait-and-see" game: some CEOs and CFOs are skeptical on the tangible benefits; nonetheless, others are fully engaged and might risk making abrupt strategic moves in terms of capital deployment, which might not deliver on expected gains and significantly hurt returns to shareholders (GE?).

Assessing the benefits and barriers presented by AM

This technology has the potential to yield several benefits that can strengthen manufacturing efficiency, scale economies and end-product performance, especially due to the reduced productions costs via lower cost of materials and personnel intervention. Moreover, AM also allows for higher product customization and flexibility, allowing A&D players to build increasingly complex engine parts/components seamlessly, as is the case for MTU. Indeed, MTU's manufacturing and maintenance activity is focused on three particular components: high-pressure compressors, low-pressure turbines and turbine center frames, that are highly complex with delicate internal cavities. Management has stated that AM in full deployment can indeed simplify and leverage efficiency onto

[95] For example, GE Aviation has been able to leverage AM expertise from its GE Additive unit, and in November it successfully obtained a "change in design" approval by FAA to use an additively manufactured power door opening system bracket for the GEnx engines (in which MTU also participates). This component will enter mass production in early 2019 allow for a c. 10% weight reduction and 90% scrap waste reduction, naturally reducing the production and future maintenance costs, as well as lowering fuel costs and emission levels for the end-customers (airlines)

[96] Ernst & Young's Global 3DP study, April 2016

its manufacturing processes, especially given the reduction in the number of sub-parts needed. As a consequence, it would be able to drive better economies of scale and returns on investment, facing lower production and maintenance costs, thereby increasing margins and cash flow conversion potential, as well as a reduced engine program development time and costs, narrowing the length of investment phases[97]. The result is clear: with AM under considerable utilization rates, the room for value creation in future investment and consolidation phases is significantly large.

On the other hand, there certainly are reasons supporting the fact that AM is still not used in series production by any manufacturer. Indeed, A&D executives face significant strategic and operational challenges: AM-enabled technology, machinery and systems require material investment efforts as well as integration with other processes and systems, in a supply chain where different participants need to do business "in tandem" as they depend on each other for engine and aircraft programs to be successful. Moreover, there is also a lack of qualified experts able to implement and run AM-led processes, as well as fears that product quality and standards could be driven down, in an industry where regulation and product certification is paramount. However, perhaps more importantly, companies are simply much more comfortable with the current manufacturing processes, which are well established and deeply entrenched in its operations and respective supply chains. Moving to a revolutionary standard would imply significant risks that could derail their companies' ability of generating returns, especially given the substantial investment that would involve incorporating AM in their core manufacturing activities.

Building scenarios to contextualize different margin gain potential

In order to incorporate the potential effect of AM in MTU's future performance, an additional scenario analysis was developed, as to incorporate hypothetical benefits generated by the use of this

[97] The whole engine development lifecycle is shortened given the simplified modeling, handling and logistics

technology with varying levels of "success", or degree to which it is actually entrenched in the company's activity. This analysis is then naturally based in long-term assumptions, with the explicit DCF analysis extended to 2038F, after which the CV methodology is still applied.

MTU has officially entered its new consolidation phase in 2018: it is now reaping the benefits of last years' research and investment efforts towards the new engine programs that have entered into service or are soon to do so. The GTF and GEnx are the company's key revenue drivers in what concerns OEM series production, and this year's topline and bottom-line development will largely start reflecting the results of these initiatives, especially the first (GTF). The base-case scenario ("original") previously developed entails lower and stable CAPEX and R&D outlays as is normal for every consolidation phase (albeit with some short-term needs). This naturally drives up ROIC as MTU sees its topline expand, especially when the ramp-up "cools down", series production normalizes and aftermarket servicing needs start kicking in, margins start going up.

For this analysis, in building these scenarios, the underlying dynamics are projected to be quite different; for MTU to be able to reap the benefits from AM-based manufacturing processes in its next consolidation phase (post-2030F), it needs to invest materially in R&D (research initiatives, qualified personnel, prototyping and modeling, etc.) and CAPEX (machinery, systems, perhaps additional space, etc.). Hence, an extended and more intense investment phase is accounted for, starting in 2022F (as opposed to 2025F, as is expected by management) and ending in 2030F, when MTU expects to deploy an improved/upgraded version of its recently launched GTF engine family. Importantly, this analysis assumes these investments are deployed across all scenarios, independently of the assumed success rate, which purposefully incorporates the risk that MTU may not be able to reap the benefits of the significant investments later on. As mentioned above, this reflects one of the fears that inhibits executives from engaging more seriously in AM.[98]

[98] GE appears to be the only A&D player that actually is in that situation right now. Its investments (organic and inorganic) in AM have been quite significant, but material returns are yet to be seen.

The scenarios are based on how significantly AM is expected to be implemented in core/series production, as figure 2 suggests. The first scenario, more "bullish" by nature, calls for a 75% integration of additive manufacturing processes in MTU's production capabilities, entailing a significant yet gradual gain in margins of c. 10% by 2034F.[99] The other scenarios account for a 50% and 25% integration in core manufacturing capabilities, resulting in 5% and 2.5% total margin gains, respectively. A fourth scenario ("base-case") involves MTU failing to successfully implement AM in its manufacturing and maintenance practices, despite the material investments committed between 2022F-2030F, therefore driving down its returns on capital and severely affecting the company's value. As a result, the cash flow and value creation dynamics are severely altered, with the worst-case scenario, where MTU is not able to incorporate AM technologies despite the investments, being the one with the most hindered value creation capacity. Indeed, the 7.8% ROIC in perpetuity is well-below the projected ROIC in the original scenario. Conversely, the most likely case with AM effects (30% probability), leads to a long-term ROIC of c. 10%; naturally, the most bullish case calls for outstanding value creation capacity (c. 16% ROIC) likely justified by outstanding market positioning, leveraged by much stronger technological and commercial competitive edges. In the end, each scenario implies differing enterprise values and upside/downside potential compared to the original case. Based on an existing survey of industry executives[100], a blended and probabilistic valuation approach is employed, from which an upgraded Dec. 2019 PT of €235.8 is derived, based on a c. €16bn Total Enterprise Value, result of the modified DCF analysis of MTU's core operations[101], and the unchanged assessment of the company's non-operating assets, liabilities, debts, etc. The goal of this brief analysis was to incorporate the possibility of MTU engaging more intensely with AM in the mid-to-long term, integrating the upside and downside risks that are likely

[99] The margin gains are reflected in the 'COGS' line item in the supporting DCF model. This reflects both the decrease in the cost of materials as well as personnel expenses, both included in this item

[100] Ernst & Young's Global 3DP study, April 2016

[101] Except the extended explicit forecast window and changes across scenarios in cost margins and investment-related assumptions, the valuation model is completely unchanged. As such, eliminating the two latter factors, the DCF value would be exactly the same as in the original equity research report, as would be expected, given that an extended FCF window simply alters the breakdown of the total value of the company, and not the whole

associated with it. There are naturally many other effects and consequences of incorporating this technology, especially in what concerns MTU's surrounding supply chain, commercial relationships and top-line development opportunities. Perhaps most importantly, it would be interesting to understand the type of competitive position achieved by MTU compared to Rolls-Royce, GE and Safran, the long-standing reference players, both competing and partnering with it. However, an improved competitive positioning would likely involve developing other components, which appears to be miles away from the company's historical drive, strategic goals and management's vision.

Appendix

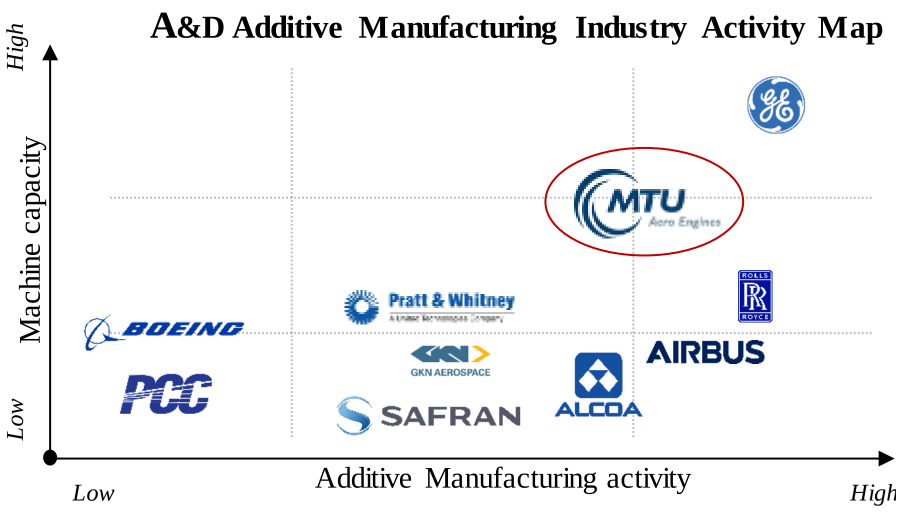


Figure 1 – Aerospace and Defense (A&D) Additive Manufacturing Industry Activity Map. Adapted from Roland Berger "Additive Manufacturing in Aerospace and Defense", May 2017<

Scenario	Cost of Sales	R&D	CAPEX PP&E
1. Base-case - no implementation	Null	+25bps **(OEM)** and +15bps **(MRO)** increments every year until 2030F. Then trends down back to cycle-average levels (in perpetuity)	Remains high for longer, until 2025F, then trends down to cycle-average levels (in perpetuity)
2. 25% implementation	-2.5% in 5 years		
3. 50% implementation	-5% in 5 years		
4. 75% implementation	-10% in 5 years		

Figure 2 - Key assumptions to each scenario. The DCF Model presented as part of the full equity research report is the underlying base for these hypothetical scenarios, and should be checked in conjunction with this report for any other information and details

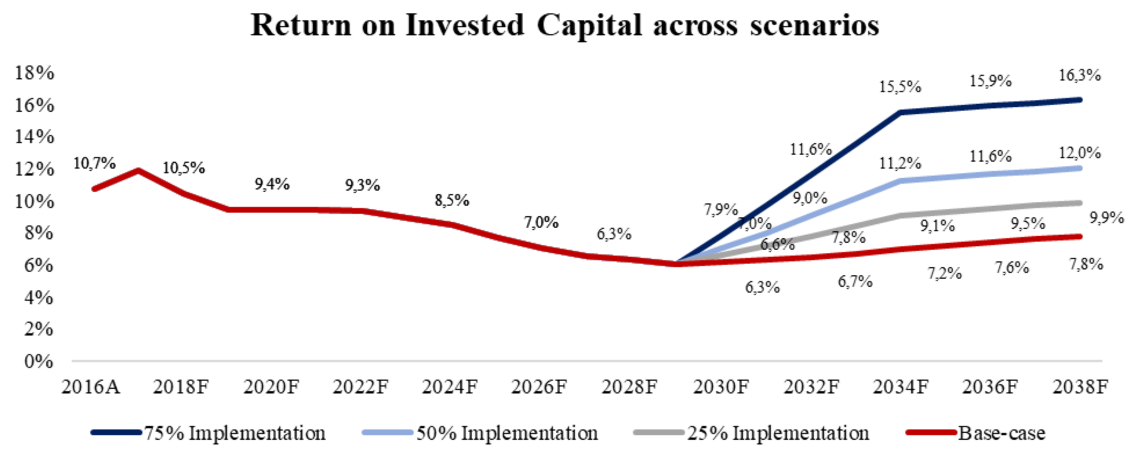


Figure 3 - ROIC results for each of the hypothesized scenarios. The average invested capital is taken into account for the ROIC calculations for all scenarios

Scenario	Probability	Resulting total EV	Resulting share price	Upside (downside) to original case
0. Original scenario	n/a	12047	203	n.a
1. Base-case - no implementation	30%	12206	168	-17%
2. 25% implementation	30%	14873	217	7%
3. 50% implementation	25%	17540	265	30%
4. 75% implementation	15%	22874	361	78%
Blended approach		**15940**	**236**	**16%**

Figure 4 – Results of each scenario analysis and blended valuation approach;
Note: The Original Scenario does not refer to the latest valuation assessment compiled by the team, as there were significant adjustments made to estimates as we were provided with more information from the company and the market, therefore the base share price differs from the EUR 195.7 presented in the main valuation report

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