Where should an MRO focus its effort to extract productivity and efficiency gains from its business? What are some of the technological and commercial strategies being employed to improve maintenance mechanics' labour productivity and efficiency?

Systems to maximise labour efficiency and reduce cost per man-hour

The expression 'touching tin' means the overriding objective of ensuring that mechanics maximise their time working on the aircraft, free from irregular interruptions. This is achieved by eliminating idle and non-productive hours induced by unnecessary travel time and waiting for services. This helps realise production targets efficiently, thereby optimising existing capacity, and executing maintenance effectively. Disruption intrinsically affects productivity.

This is not achieved via a single solution, but via the aggregation of pivotal small improvements. This will realise the maximum possible savings for a mechanic's time, which leads to sizeable gains in labour efficiency.

Productivity and efficiency, otherwise put as quantity and quality, are two integral goals at the very core of any maintenance repair and overhaul (MRO) provider.

Productivity is the ratio of productive to unproductive hours, and while what is classified under each heading is subjective, this essentially indicates the man-hours (MH) an organisation can sell and the customer will pay for. While shift patterns will differ, and influence this indicator, typical deductions of time include holidays, training and sick days. Variations by regions, such as the Middle East, may consider correlative factors like prayer time and additional break periods for mechanics to recover from working in a hot environment on the line. Working culture and ethics will also play a role.

Efficiency serves as an index of how long it takes to complete a task versus the allocated time, and gauges whether there is any waste in the process. A task provisioned to take 1MH and accomplished in 1MH equates to 100% efficiency. Conversely, if that same task uses 2MH, efficiency falls to 50%.

Jeff Cass, vice president strategy & chief technology officer, aerospace & defense at IFS, explains that: "Efficiency has to do with how quickly an individual can perform an activity. We believe that making the individual more efficient in that chain, by either having them reduce time or becoming more effective at the job they are doing, is critical to not just their individual performance, but also to the collective performance of the maintenance organisation with returning aircraft to service.

"Productivity relates to the end goal of getting aircraft assets back up and in use," continues Cass. "It is about how we take processes and collapse timeframes, while obviously maintaining financial control of the cost of executing those activities. This is whether those involve turning wrenches to fix the aircraft, planning functions, supply chain provisioning, and so on."

Connected workforce

"When we looked at the penetration of digitisation in the aviation industry, maintenance is one of the sectors that makes the least use of digital tools and digitisation in general. This is partly because you physically need someone to perform aircraft maintenance," says Joost Groenenboom, principal at ICF.

Digitisation stands to reap major percentage gains around the productivity of a process by fine-tuning timeframes to ameliorate the flow of an activity from end-to-end. This is in part due to the continued application of antiquated practices in aircraft maintenance. Still prevalent are the use of both electronic systems and the completion of paper records, a redundancy which throws up efficiency and quality assurance problems.

Cass emphasises that a prime focus for IFS is the co-ordination of dependent people, or specialised players, intrinsic to the maintenance process, by quickly sharing information that contributes to making the individual more efficient. This can be described as a connected workforce. Connecting people real-time on the same information, via a single platform, is paramount for improving the productivity of an organisation.

"A mechanic at the gate who is dealing with an aircraft-on-ground (AOG) situation invariably reaches out to maintenance control, which in turn reaches out to engineering, whether they be structural or propulsion specialists. A communication chain of expertise is established, which focuses on helping that mechanic on the pivotal end of troubleshooting. We believe digital information passed through that chain can really help accelerate getting information from the point of maintenance back through expertise and then back to that point of maintenance, replacing walkie-talkies and phone calls," expands Cass.

Purpose-built user interfaces for each of the assets involved in the process chain, whether they are desktop power users or those relying on mobility and simple-to-use interfaces, serve to assist in an easily consumable fashion, rather than task the user with data entry. Expanding this scope of connectivity brings with it the challenges of ensuring that users are not impeded by IT outages.

"At IFS, we absolutely believe that the main person to focus on is the end mechanic, and that is what our customers are telling us as well," says Cass. "We can

Critical path management allows complete visibility of the progress of an airframe check, and so ensures that target turnaround times are achieved.

have a lot of impact on the individual and their efficiency within this productivity chain. Today you can easily take an extremely complex SAP form and put it on a mobile device and present it to a mechanic. That is an overwhelming piece of technology," says Cass.

Change management and acceptance, for example, of electronic time capture are complex and sensitive issues to address and implement. For a unionised workforce, there is a need to change the mindset of fear that management are measuring an individual's performance, to single out that unproductive element, which might in turn lead to risk of unemployment.

"Labour efficiency has got to be at the collective level, not at the individual level," adds Cass.

Production control

Dynamic check planning and management, with analysis at a granular level, are fundamental to successful maintenance execution.

"The entire planning and performance process is something that needs to be clearly defined, and many airlines lack this ability. Setting very clear guidelines and boundaries as to how you create and perform work packs is one of the first key things you need to do. Once you have that, there needs to be interaction between planning and production control as to how you achieve your daily targets and milestones. Process discipline is very important. If you have that set, then the performance itself becomes somewhat more routine," explains Groenenboom.

Critical path management and analysis, provided by maintenance and engineering (M&E) systems, engages algorithms for scheduling all tasks required to complete a project, the duration of each task, interdependencies identified by predecessors and successors, and sets logical end points such as milestones and deliverables.

"The critical path is your shortest turnaround time (TAT). The top companies anticipate most defects and build them into the plan. If they find a defect, they expect to have it fixed within a pre-specified period of time, and will have the parts, tooling and labour ready in case they find it. For new defects, you need very fast engineering response, and fast logistics response," says Ray Kazmierczak, director at RFK Consulting.

Critical pathflow enables monitoring and comprehensive visibility throughout the lifecycle of the project, which owing to the inherent nature of aircraft maintenance, can change from one day to the next. Subsequently, any deviation from the flow can be quantified and reacted to in real time to effect realignment.

After event deviation analysis, the process of comparison between planned and actual events harvests pivotal knowledge to be implemented in planning future flows to avoid similar deviations. Increased visibility leads to increased accountability.

"Perform inspections fast. If you have critical inspections with critical paths, you want to do the bulk of the inspections in the first portion of your check, which typically sits around 25% of check time," says Groenenboom. "If you do not have real-time MH expenditure and task card closure, it is difficult to be accurate in planning. It is important to measure those MH, and to see how the check compared to historical checks. How much extra time, how many fewer MH did I spend, and what was the cause? Good data is the biggest challenge to measuring what you are doing and then how to improve. Only then can you become better."

Groenenboom underscores that when ICF goes into airlines, the issues typically encountered centre around components and manpower; essentially these two elements not being in the right place at the right time. One of the significant things that can be improved is the material process. On the one hand, you do not want to hold an extensive amount of inventory, but on the other, you do not want to be waiting 12-16 hours for a part when your check downtime is only 24 hours. It just delays the whole process.

"Most of the supply chain is still being macro-level forecasted to provision for heavy maintenance visits and is not necessarily being done by individual parts," says Cass.

"Supply chain is totally critical. The key is not to overstock," says Kazmierczak. "Otherwise, you will accumulate stock that ultimately needs to be depreciated. The general rule is that anything not used in two years is probably never going to be used again. Modern MROs might typically hold 70% to cover for whatever might be needed, but have to move very fast to get the other 30%. Boeing and Airbus now have hubs located in the Asia Pacific region and Europe, so not all parts are being shipped out of the US or France."

In terms of tooling, Kazmierczak advocates 'point of use', positioned as close as possible to the mechanic. This could be a board containing landing-gear tooling adjacent to the landing-gear team, a separate set of tooling alongside the engine team, and another set in the interior of the aircraft for the cabin team. This approach keeps the mechanic in the place of work.

"Production control templates are effectively what IFS believes to be the best practice for flowing a production visit, for an aircraft at a point in its life cycle," explains Cass. "That flow is made up of a number of placeholders for non-routines. Those placeholders are not just big project buckets, but are buffers that sit around each of the individual phases and milestones within a project plan. Typically, most of the buffers are time periods later in the project that become really critical for maintaining the out date for the visit's turn time.

"Overall, we are using the actual findings from past checks to refine the sizes of those non-routine buffers. The buffers built into the production control templates, by return on experience, are replaced by specific unscheduled corrective actions," continues Cass. "Some of our customers are experienced enough that they are positioning the corrective actions in the production templates long before the aircraft visit has started. KLM is one of the most advanced clients from that point of view, typically positioning several hundred corrective actions it anticipates it will be executing through a 737 or A330 heavy maintenance visit."

"Speed drives efficiency. Keep putting work in front of the mechanic aided by good materials, good documentation and good engineering support," says Kazmierczak.

Productivity via analytics

Phil Bathurst, managing director at Embraer Aircraft Maintenance Services, Inc (EAMS), located in Nashville, Tennessee, highlights the importance of maintaining a flow when developing a critical path by including routine work, as well as non-routine, as it is generated. On adding the non-routine to the workflow, its EmpowerMX FleetCycle® for MRO software establishes what skills are required, which milestone it is to be worked under, its predecessors and successors, the start and completion dates, and estimated MH.

"Every project we do, each job is within a milestone and there is a flow. We know on a daily basis if we are on or off schedule," says Bathurst.

Leveraging shop floor data collection (SFDC) provides a benchmark against previous checks and performance, and opens up powerful learning opportunities which can be applied to fine tune future checks.

EAMS, drawing on the experience of critical path analysis from historical light checks, has been able to pinpoint the areas that need to be inspected first. This is demonstrated during a C4 inspection on an Embraer E-Jet, where they are aware there is a high probability of finding corrosion in a distinct location. This is a direct result of following through from a past check and using history to update previously established templates for routine tasks.

"We will adjust our routine tasks to ensure that areas that could potentially lie in the critical path are inspected first. We can then determine whether or not they are in fact in the critical path and compress that critical path span by getting started earlier. It is all about using analytics to plan as far in advance as possible. The bottom line is we try to eliminate the unknowns. Most of our non-routines are therefore fairly routine," explains Bathurst.

Analytics also play a salient role in refining estimated MH required to complete a task, which ensures EAMS stay as realistic as they can with everything they do.

"If a job is estimated to take 10MH and our mechanics routinely achieve it in 8MH, we adjust that estimate down accordingly. We are also willing to increase MH for a task, but the mechanics have to compensate by reducing MH for another task, so that overall we are still on the same page," says Bathurst.

He says that they advocate a project buffer over an individual task buffer which accounts for an extra 20%. The buffer is standalone and put at the end of the project. It is monitored for impact and managed throughout the life cycle.

"We do every job based on what we think we can do it in, and we have an overall project buffer that compensates for that potential extra 20%. So, our target is a minimum of 20% off what the contract schedule is. As a result of doing this, our team has begun to feel that an aircraft that delivers on time is perceived to be off schedule," says Bathurst.

The ability to realign to the critical path when deviation occurs is driven by visibility and understanding workflow, the constituents of which are flowing each task

Preventing disruption of work improves productivity, keeps the individual mechanic at their place of work, and drives efficiency.

within a milestone, having daily deliverables, and knowing the available manpower.

"The software will show you that certain skills are technically behind on their check milestones, and how many MH are needed to catch up," explains Bathurst. "We see that in advance and will assign manpower to the path. We will do the same thing the other way around. Most of our customers want their aircraft back as soon as possible. If they have a 20-day check and we can get the aircraft back in 16 days, they are fully backing that outcome. Conversely, we have other customers that do not need the aircraft back in less than 20 days because the yield time is where it needs to be. In which case, we will do the opposite. If we are well ahead of schedule, we will pull manpower off that aircraft by the skills that are ahead to have it delivered in 20 days."

Bathurst adds that in terms of long-range manpower planning, by using the software and analytics gained from their short-term plans, they can forecast the number of mechanics needed on each shift by skill to flow the aircraft. This allows at least a six-month lead time to visualise the resources required and either cross-train, cross-utilise, or bring in additional skills rather than react to the situation when the aircraft is in the hangar.

Analytics are used to derive the number of MH it takes the average mechanic to complete a specific task. This is by weighing up that a new mechanic might consume X plus 20% MH, and an experienced one can achieve the same job in X minus 20% MH. Bathurst explains that it is the mechanic's responsibility to understand how many MH the task is expected to take, and also his duty to report to the project lead, halfway into that task, should he encounter a problem and require longer than the allotted time. The target of halfway into the estimate is used so that the mechanic can either receive advice, or get additional support.

Visibility promotes healthy competition between maintenance bays and encourages the exchange of information to achieve leaner processes. TV screens in each bay, fed by the company's M&E system, display live key performance indicators (KPIs) for safety, quality, budget and delivery with attributes such as injuries, quality escapes, warranty repairs and a live version of the workflow and current check status.

"Three of the maintenance bays might each be performing a B6 inspection with landing-gear replacement, either for the same or a different customer. They will all have the same flows. One line might be delivering the aircraft in 20 days, the other in 18," says Bathurst. "There will be an exchange of information to determine what is being done differently to achieve delivery in 18 days. As the original equipment manufacturer (OEM), our focus is on improving the product and keeping maintenance costs down for the airlines. If a customer has requested a work package to perform a B3 inspection and embody a service bulletin (SB), we can advise them that it would be more efficient and cost-effective to perform the SB during a B4 inspection, when access to relevant area has already been gained. There is no commercial and financial sense for us to perform low value-added work. As an MRO, we focus on turnaround times. It is all about throughput."

Before every check, EAMS provisions all parts for routine tasks. Additionally, using analytics, they have the ability to assess parts usages based on previous checks. If history shows there is a 50% probability that a part requires replacing when inspected, EAMS will perform a pre-draw. This means that it is available instantly if it is required, rather than having to be ordered.

"Supply chain is key, but even more important is supply-chain planning. You should have a plan in place for what you are going to use," continues Bathurst. "Our supply chain evaluates the usages from previous checks, in collaboration with our operations team. We look at lead times and if something typically takes five days, we are more likely to order that in advance than something that would have a one-day lead. It is all logic, a whole set of analytics to determine what we do and do not order in advance. This is based on A, how quickly we can get it; and B, how often it fails during a specific type of check. Another advantage of having everything based on milestones is, instead of requisitioning every part AOG, it is ordered based on the timeframe it is needed for when that job starts."

Adhering to the underlying efficiency ethos, supply chain clerks deliver parts to the aircraft, to keep the mechanics at their place of work. Tooling is also delivered, and again as everything is based on milestones, timeframes for use are known in advance.

"Our principal factors are safety and quality. We preach that both safety and quality are not variables. You have to be safe and you have to produce work of the utmost quality, but we also expect you to work as efficiently as possible," says Bathurst.

Work execution

Working in extremes of temperature is one of the influencing factors that affect efficiency and productivity.

To execute a wheel change on the line in the Middle East, with exposure to summer highs of 50 degrees C, will inevitably have an impact on the human body, and necessitate more periods of rest and recovery. Freezing lows of -35C in Northern Canada and Alaska will likewise limit a mechanic's abilities.

Cultural and ethical variations might

To fill empty hangar slots in a low season, MROs may choose to be more competitive with pricing to attract customers. Offering lower pricing is aided by improved labour efficiency.

identify one region as synonymous with accountability, punctuality and quality, where higher labour costs stipulate higher efficiency. Another region might see higher staffing levels due to lower labour costs, where individualism is less part of the culture, and bureaucracy demands greater management attention to resolve problems.

"If you do not match your capacity to the workload, it drives inefficiency because people naturally do not want to just sit around and do nothing. Companies that are losing a lot of money are wasting 40% of the MH available to them from their workforce due to overstaffing. You see twice as many people for the work and there is a tendency to stretch that work," says Kazmierczak.

Health and safety is a further element to consider, with Europe imposing strict rules. Groenenboom puts forward the example that you cannot enter a fuel tank without first venting it. The task requires a minimum of two people and both must wear full-face masks. In another region, where the regulatory rules are different, the same stringent requirements might not apply, so it is easier to enter a fuel tank. There may be no lengthy venting procedures, and you might need only one person. Fuel tank entry in one region might require more MH than in the other region. While this might not affect labour efficiency, per se, it reduces the efficiency of performing the task.

MRO market strategy

To manage seasonal fluctuations in workload, MROs could consider redeploying mechanics from heavy checks to line maintenance. This would serve to address both the increased aircraft activity in peak season and to cover for any manpower shortages due to annual leave.

Flexible working arrangements could also see staff sent on training, and any overtime worked in winter months 'banked', rather than paid, and taken off as time in lieu in summer months.

"To get work in the summer months, you need to approach the big carriers. They cannot perform all their maintenance in the winter. The fleets are too big. There will be more planes on the ground in the winter, but they still have to put aircraft on the ground in the summer. The smaller carriers tend to fly and have very little on the ground in the summer," advises Kazmierczak.

MROs may choose to be more competitive with pricing in the low season to entice airlines to fill empty hangar slots, rather than have mechanics standing idle.

A consideration is to focus on potential markets in regions that experience opposite seasons: summer in the northern hemisphere versus winter in the southern hemisphere.

From the airline's perspective, they will evaluate total price when weighing up their options, factoring in downtime and positioning costs. A narrowbody aircraft requiring a C check, costing a few hundred thousand dollars, will travel a shorter distance than a 747 widebody necessitating a D check, valued at a few million dollars. The delta on a few million dollars could be more for an MRO that is located further away than one that is closer. The airline could justify positioning the aircraft outside its network to Asia or the Middle East.

"There are also variations in downtime. If a D check for a widebody takes 25 days in one location and 30 days in another, then those five days are five days of additional flying. For certain airlines that is quite important," explains Groenenboom.

Cass foresees that the demand in the marketplace to build facilities and increase capacity to execute base maintenance, will continue to grow aggressively in the appropriate labour cost market.

"In general, obviously the move is towards lower-cost labour countries. There are several major MRO organisations that have formed alliances with local MROs and then applied their own philosophies, principles and processes. The output is good. For example, Lufthansa Technik Philippines is a joint venture of Lufthansa Technik AG and Philippine aviation service provider MacroAsia Corporation. In Europe, there are also a few subsidiaries in Malta and Ireland, and those are good strategies. HAECO, which has facilities in Hong Kong and Xiamen, also has HAECO Americas with four locations across the United States. We see the same principle. They try and capture particular markets. Certain aircraft types travel better than others, and if you want to capture the North American narrowbody market, you need to have a facility there. Nobody is going to fly an A320 from Europe to Hong Kong," says Groenenboom.

Kazmierczak explains that in the Asia-Pacific region, there are plenty of good independent colleges that provide the foundations for a competent technician. There can be investment by the airlines into the colleges with an agreement to induct the best students through the airline's proprietary training programme. This in turn encourages the colleges to maintain a high standard of training. The Philippines, for example, follows the Federal Aviation Administration (FAA) system and students gain the equivalent of an A&P licence.

"When you set up an MRO, a partnership with the local airline gives you base load, political co-operation, and airport collaboration," says Kazmierczak.

Cass expands on this disruption in the market caused by the lower cost of labour and points to the fact that for some time

Inspections with critical paths need to be performed in the first 25% of check downtime. Planning checks this way allows non-routines to be factored into the critical path, and so mitigate disruption to check progress.

there has been the notion that quality matters and airlines and MROs like Air France–KLM and Lufthansa have tried to make sure work is being done in Europe. They are branding that work with a level of quality that is the differentiator to justify the price. Quality is both compliance, as well as the measurement of follow-on issues once the aircraft has been returned to customer.

"The tier of operator will influence project flow. The top-tier airlines with large fleets come with fast OEM responses, and parts support programmes. Maintenance workscopes are more predictable, they pay more, and are generally easier to work with. Lower-tier airlines with smaller fleets and minimal parts support, are bottom of the queue when they go to the OEM. They are harder to work with and want to pay the minimum price. The higher up you go in the value chain, the easier it gets," says Kazmierczak.

"Customers want an end product. Ultimately, maintenance is an insurance for trouble-free operation. Certain airlines are price shoppers, they focus less on quality. Other airlines want a brand name. They want to make sure that the aircraft is maintained to the highest quality and will send over large teams to perform supervisory inspections," says Groenenboom.

Narrowbody aircraft form more than half of the world fleet, so they inevitably produce a lot of maintenance, and account for one of the biggest portions of the MRO market.

"There are still a lot of older aircraft in operation that have to go through maintenance. This poses an interesting problem, because there is not a lot of emphasis being placed on this sector, partly because they do not have the glamour of being modern digital aircraft, such as the 787 or A350. There are really big opportunities for companies to focus on older 737s or A320s. Those are the planes that require heavy maintenance visits, the labour-intensive C and D checks. There is ample opportunity for improvement because those aircraft are not equipped with the latest diagnostic capabilities that have emerged to assist with maintenance. There is also not a lot of retro-fit work being undertaken by the aftermarket or OEMs to help with those aircraft," says Cass.

"Airline MROs in general have a big base load from their parent airline. And very often you see that either the airline owns 100% of the MRO, they have some shares in it, or they used to own the MRO so there is some historical link. But typically, that sort of a baseline allows them a certain volume and allows them to build the organisation in a way that makes some form of profit, or at least has a basis for profit. This in turn makes it easier to sell competitive work to third-party providers. The downside is that typically if you have an airline MRO, the parent airline is going to be a higher priority than a third-party customer coming in with two aircraft. If you are a third-party customer coming in with 100 aircraft, they might think differently," says Groenenboom.

Kazmierczak advises that the best MROs try to maximise the revenue out of the contract by upselling. Instigated at team leader level when the aircraft is in the hangar, they will tender for additional workscopes, such as cabin refurbishment and exterior paint detailing, to the airline representative. These stand outside the contract, but critically are to be performed within the original downtime.

"It is all about selling the maximum amount of work per day in terms of MH without extending the ground time. The best companies are selling more than they produce. They are so efficient that the market does not realise how efficient they are. They are selling 20% more than they actually clock with an efficiency of 90%," says Kazmierczak."

Accounting for other costs

"Overall you need to include elements such as investment, depreciation, utilities, and insurance. There are massive hangars in the Middle East that are completely enclosed and air-conditioned, and this all needs to be taken into consideration. So, your efficiency, labour cost, and overheads together with some form of annual loading will provide you with the fully burdened labour cost," explains Groenenboom.

"The Middle East has a heavy reliance on ex-pat labour due to local staff shortages. To attract the workforce, they have to pay a premium on the wages, excellent remuneration packages, which is typically double what would be expected at home. Ultimately that becomes a burden on the parent airline," says Kazmierczak.

Summary

Where are the biggest opportunities for maximising labour efficiency in aircraft maintenance?

Is it via digitisation; planning and production control; critical path management and analysis; benchmarking through analytics; deviation analysis; daily milestones and production targets; electronic time capture; supply chain planning; process discipline and accountability; and change management? All of these constituents have implications for productivity and efficiency, both at an individual and collective level. Understanding how these elements combine to create repeatable processes that incorporate optimal plans from a return on experience is essential. AC