# Muhlbauer AG v Manufacturing Integration Technology Ltd
# [2009] SGHC 45

**Case Number** : Suit 80/2007

**Decision Date** : 23 February 2009

**Tribunal/Court** : High Court

**Coram** : Tay Yong Kwang J

**Counsel Name(s)** : Kenneth Tan SC, Max Ng Chee Weng, Colin Phan Siang Loong and Wong Yao Fong (Gateway Law Corporation) for the plaintiff; Foo Maw Shen, Koh Kia Jeng and Calvin Lim (Rodyk & Davidson LLP) for the defendants

**Parties** : Muhlbauer AG — Manufacturing Integration Technology Ltd

*Patents and Inventions*

23 February 2009

Tay Yong Kwang J:

1 This action involves a claim by the plaintiff for infringement of patent. Infringement is not denied should the plaintiff's patent be held to be valid. However, the defendant claims that the plaintiff's patent is invalid and counterclaims for a declaration of invalidity and an order that the patent be revoked.

2 At the conclusion of the evidence for the trial on the issue of liability only, the parties agreed to tender written submissions with the plaintiff having the right to reply to the defendant's submissions. This has been done.

**The plaintiff's case**

3 The plaintiff is a company incorporated in Germany. It is the registered proprietor of Singapore patent number 117982 entitled "Device for Inspecting and Rotating Electronic Components" filed here in December 2005. The patent is in force in Singapore, with its priority date being 16 February 2004. The patent was granted by the Intellectual Property Office of Singapore ("IPOS") in reliance on the documents submitted by the plaintiff in its Patent Co-operation Treaty ("PCT") application. The international filing date of the PCT application is 31 January 2005. The PCT application was in turn based on an initial submission made on 16 February 2004 to the German Patent & Trademark Office ("the German patent").

4 The patent describes a machine for picking and placing electronic components onto printed circuit boards or tape and reel packaging. It sets out the following 10 claims:

> 1 A device for checking and rotating electronic components, in particular flip chips, with a pivoting part attached to a pivoting point for rotating the electronic components, on the exterior of which part a first pickup element is fixed for taking up a single electronic component from a substrate and keeping hold of it during a rotational movement of the part, characterized in that a second pickup element is arranged externally on the part opposite the first pickup element in relation to the pivotal point in such a way that in each case one pickup element is facing the substrate for each rotation of the part through 180º, and that in the part a through opening is arranged between the pickup elements in such a way that the through opening is facing the

substrate for a rotation of the pivoting part through 90º or 270º.

2 Device according to Claim 1, characterized in that the first pickup element is attached on a first projection and the second pickup element on a second projection of the part.

3 Device according to Claim 2, characterized in that the through opening is developed between the projections as a through channel open on one long side.

4 Device according to one of the preceding claims, characterized in that on a side of the pivoting part facing the substrate a first optical facility is arranged for optical checking of surfaces and correct positions of the electronic components arranged on the substrate before being picked up.

5 Device according to Claim 4, characterized in that the through opening is formed in such a way that it permits an optical connection between the first optical facility and an electronic component arranged on the substrate during a rotational movement of the pivoting part.

6 Device according to one of the preceding claims, characterized by a second optical facility for checking a correct position of the rotated and deposited electronic component.

7 Method for checking and rotating electronic components, in particular flip chips, which are picked up individually from a sandwich of electronic components arranged on a substrate, by means of a first pickup element arranged on a pivoting part and are deposited in a rotated position, the pivoting part being placeable between the substrate and a first optical facility for checking the surface and the correct position of a single component arranged on the substrate, characterized in that during a 180º rotation of the pivoting part a pickup by the first pickup element of a single electronic component arranged on the substrate, a check of a surface and the correct position of a further electronic component arranged on the substrate, by means of the optical facility and a through opening arranged in the pivoting part, a depositing of the electronic component held by the first pickup element on a placing facility after a 180º rotation of the pivoting part and at the same time a further pickup of the further individual electronic component arranged on the substrate, by a second pickup element arranged externally opposite the first pickup element on the pivoting part, are executed.

8 Method according to Claim 7, characterized in that after the 180º rotation a 180º rotation going in the other direction is executed.

9 Method according to Claim 7 or 8, characterized in that by means of a second optical facility, a correct position of the turned and deposited component is checked and adjusted during or after its transport.

10 Method according to one of the claims 7 – 9, characterized in that the first optical facility is activated with a predefinable time delay after a rotation of the through opening into an optical connection line between the first optical facility and the electronic component still arranged on the substrate.

5 As a result of increasing demand for smaller electronic devices, there was a need to design faster machines to assemble smaller electronic components onto printed circuit boards or tape and reel packaging to increase the rate of output. In addition to speed, the machine has to be able to assemble the electronic components accurately. One way of achieving accuracy of placing electronic components onto a substrate is by determining the position and orientation of the electronic

components by optical means, usually a camera, before picking them up and placing them onto the substrate. However, use of the camera for inspection increases the time needed for the process because the camera has to first inspect the electronic component to determine its position and orientation so that there could be corrective repositioning before the pickup head moves directly over the electronic component to pick it up. Since both the camera and the pickup head have to be directly over the electronic component to perform their tasks, the pickup head has to move out of the line of sight and then move back to pick up the electronic component. Alternatively, the table holding the electronic components has to move from its position directly below the camera to another position directly under the pickup head so that the electronic components could be picked up. The movements in both methods result in time loss during production.

6 The plaintiff's invention has two pickup heads in order to reduce the cycle time. One pickup head picks up an electronic component by its top surface while another pickup head concurrently transfers a previously picked up electronic component to another placing head which receives the electronic component by its bottom surface. The two pickup heads are arranged directly opposite each other on a pivoting part that rotates 180º each time. By means of a through opening located transversely between the two pickup heads, the camera inspects the electronic component below while the pivoting part is rotating through an angle of 90º or 270º. As optical inspection is carried out during the rotational process, no additional time is incurred in having to move the various components of the machine to and fro. The cycle time for the process is thus reduced, resulting in greater productivity.

7 The defendant, a Singapore company, is alleged to have infringed the patent by making, disposing of, offering to dispose of, using or importing the patented product and/or keeping the patented product, whether for disposal or otherwise. In particular, the plaintiff complains that the defendant has manufactured and marketed a device for inspecting and rotating electronic components which is distributed under the trade mark or name "CAERUS". The defendant has acknowledged in evidence during the trial that its machine infringes all 10 claims of the plaintiff's patent as set out in [4] above.

8 The plaintiff disputes the defendant's contentions that the patent lacks novelty and inventiveness or inventive step and is accordingly invalid.

**The defendant's case**

9 The defendant relies on the following four patents and a machine as prior art in support of its assertion of invalidity against the plaintiff's patent:

(a) Advanced Systems Automation Limited's ("ASA") Singapore patent number 104292 filed on 7 January 2002 ("the ASA Patent") which relates to a flip chip bonder;

(b) US Patent number 5,839,187 dated 24 November 1998 ("the Matsushita Patent");

(c) US Patent number 6,364,089 filed on 10 December 1999 ("the National Semiconductor Patent");

(d) US Patent number 6,311,391 B1 filed on 23 November 1999 ("the Shinkawa Patent");

(e) ASA's flip chip die bonder known as the AFC 800, which incorporates the ASA Patent.

10 Claim 1 of the German patent was amended in November 2004, even before the PCT application was made. The amendment pertained to the position of the word "characterized" which was moved down to right after the words "rotation of the part through 180º, and". The PCT application and the

application to IPOS were based on the unamended version of the German patent.

11 The defendant accepts that its CAERUS machine operates on a concept similar to that in the plaintiff's patent, namely:

(a) the use of 2 flipper heads or pickup heads; and

(b) a gap or through opening between the 2 flipper heads which allows optical inspection to take place for the second chip to be picked up while the first chip is being rotated through 180º.

As mentioned earlier, infringement is acknowledged if the patent is valid.

12 The key claims in the plaintiff's patent are Claim 1 (a product or device claim) and Claim 7 (a process or method claim). The essential features of the device as described are:

(a) two flipper heads;

(b) a gap or through opening between the two flipper heads; and

(c) an arrangement such that the said gap or through opening faces the substrate when the flipper heads rotate through 90º or 270º.

The essential features of the process are:

(a) concurrent optical inspection of the second chip to be picked up;

(b) such inspection taking place via the gap or through opening between the two flipper heads; and

(c) such inspection being done while the first chip is being rotated through 180º.

No mention has been made in the plaintiff's patent regarding the dimensions of the flipper heads or of the gap. The inventive concept asserted is therefore "inspection on the fly".

13 The defendant submits that Claims 1 and 7 are anticipated by the ASA patent which also has two flipper heads and are therefore not novel. Claim 7 is also anticipated by the AFC 800. In addition, the defendant argues that there is no inventive step in the plaintiff's patent because the invention described there is obvious to a person skilled in the art, given the state of the prior art. The defendant also relies on the Matsushita Patent and the National Semiconductor Patent for the issues of novelty and inventive step and on the Shinkawa Patent for the issue of inventive step.

14 Although the ASA patent was published on 21 June 2004 and granted in September 2005, for the purpose of the issue of novelty, the material date is its priority date and that is 7 January 2002, a date earlier than the plaintiff's priority date of 16 February 2004. In any event, if publication date is the key (which the defendant denies), the international publication date of the contents of the ASA patent PCT application is 17 July 2003.

**The decision of the court**

15 Section 14(1) and (2) of the Patents Act (Cap 221, 2005 Rev Ed) set out the test for the issue of novelty. An invention shall be taken to be new if it does not form part of the state of the art. The state of the art comprises all matter which has at any time before the priority date of the invention in

issue been made available to the public, whether in Singapore or elsewhere, by written or oral description, by use or in any other way.

16 In deciding the issue of novelty, Lai Kew Chai J in *Trek Technology (Singapore) Pte Ltd v FE Global Electronics Pte Ltd (No. 2)* [2005] 3 SLR 389 set out the following guiding principles:

(a) the issue is determined by asking whether an invention forms part of the state of the art ;

(b) the prior art must, in order to invalidate the patent, be such that a person of ordinary skill and knowledge of the subject would at once perceive and understand and be able to practically apply the discovery without the necessity of making further experiments;

(c) the prior art documents must be construed as at the date of publication and it is not permissible to perform an *ex post facto* analysis;

(d) each prior art document has to be considered separately and not combined into a mosaic to arrive at the invention;

(e) the person skilled in the art is an unimaginative person of competent but average technical skill;

(f) the prior art document must contain clear directions to do what the patent claims to have invented.

17 The fundamental features of Claim 1 of the plaintiff's patent are the two pick up heads placed opposite each other on a pivoting part, with one pick up head facing the substrate for pick up of a single electronic component and holding the component during rotation through 180º and the through opening between the pick up heads arranged in such a way that the through opening faces the substrate when the flipper heads rotate through 90º or 270º. The inventors state that the motivation for the invention was the reduction of the time required to check and to rotate the flip chip components resulting in cost savings. They also assert that in prior art, inspection, pick up and rotation of the flip chip device must be done sequentially or in successive steps as the pick up head would block the optical connection line between the camera and the flip chip. The plaintiff's patent allows the optical connection line to be established between the camera and the substrate during rotation of the pivoting part through 90º or 270º.

18 The defendant's expert witness is John Briar, who has 20 years experience in electronics and manufacturing and who was involved in research and development of various machines used in the semi-conductor industry in the course of his employment, including flip chip machines and multi-chip module assembly. He is the inventor/co-inventor of several patents related to various types of integrated circuit package assembly. He has extensive experience in flip chip packaging technology and equipment development for use in the semi-conductor industry. I find him to be a very competent expert in this field and accept his expert opinion which covers all the prior art stated in [9] above although the defendant's representative at trial was content to confine the attack against the plaintiff's patent on the basis of the ASA Patent.

19 Having done a thorough review of the plaintiff's patent and completed extensive research and obtained information from public sources and other industry related publications and documents, he produced an expert report. In this expert report, he opines that the plaintiff's patent is not new or novel because the invention disclosed in Claims 1 and 7 have been clearly anticipated by the ASA Patent. AFC 800, the flip chip die bonder machine which incorporates the ASA Patent, also clearly

anticipates Claim 7 and its dependent claims.

20 In the ASA Patent, there is clear disclosure of two pick up heads for flip chips arranged opposite each other at a pivot point, one element facing the substrate or wafer during rotation of 180º, rotary motion to invert flip chip, the use of optical detection of the flip chip prior to its pick up, optical detection at the target placement site and optical detection and corrective movement of the flip chip after placement. It would be clear to a person skilled in the art that an image of a flip chip could be detected during rotation of the pivoting part through 90º or 270º.

21 The defendant's expert is also of the view that Claim 1 was anticipated by the Matsushita Patent and that Claims 1 and 7 were anticipated by the National Semiconductor Patent. Based on his interpretation of these two patents, he opines that they disclosed in their text and in the illustrations a space and/or opening through the pick up heads that permits vision system access during rotation of a pick up element through 90º or 270º.

22 The defendant's expert explained that some of the key challenges were the speed and accuracy of alignment of the flip chip integrated circuit devices and mechanical flipping or reversing orientation of the integrated circuit. Since flip chips are normally attached in a face-down manner, the inter-connects are hidden from direct view during placement. Vision inspection system concepts had to be modified so that they could inspect the integrated circuit prior to placement in a carrier or on a substrate. The time needed to complete the vision inspection process on flip chip equipment had to be balanced with the subsequent mechanical flipping and placement procedures carried out on the equipment.

23 The challenges related to the use of vision inspection systems were overcome by using and expanding on concepts developed on standard face-up die attach equipment and applying them to flip chip placement equipment. Several prior inventions claimed speed improvement by the utilisation of vision inspection processes concurrently with the rotary inverting of the flip chip device after removal from the wafer frames. Most of them used optical detection and corrective alignment, something well understood as an integral function for flip chip die pick and place systems since the 1990s. This kind of optical alignment was commonplace and is clearly documented in prior art well before the plaintiff's patent's priority date.

24 The ASA Patent describes and illustrates the use of multiple flip chip pick up heads situated opposite one another in reference to a pivoting point at the centre. The pick up heads are said to be used for changing the orientation of flip chips after they are picked up from a wafer. In the illustrations, only four pick up heads are shown but there are several references in the text where a plurality of heads is discussed. In the defendant's expert's opinion, this confirms that a fixed number of pick up heads is not important in the invention. It is also stated in the ASA Patent that different die sizes and throughput requirements may need a design with more than four heads. There is also mention that two pick up heads mounted opposite each other may be deployed.

25 In the ASA Patent, the explanation for the use of four instead of two pick up heads is that it shortens the travelling distance of the die from the pick up location to the transfer point and allows increased throughput. Concurrent motion of many of the components is also described as improving throughput. It is obvious from the patent that in order to have the increased throughput, the concurrent action of optical detectors, pick up heads, fluxing heads and transfer heads would need to be maintained. In the case of the pick up turret assembly, the vision inspection system for aligning the die on the wafer mount would need to be taking an image after pick up of the flip chip die and during rotation of the turret.

26 The use of vision was so well established by this time that the ASA Patent need not disclose full details of its vision system. The patent states that the optically assisted pick and place system would be known to one skilled in the art and elaboration is therefore not provided in the patent. By the time of the filing of the ASA Patent, the vision inspection system for the wafer input area could be said to be an integral part of pick and place equipment in the market and would be obvious to a person skilled in the art of semiconductor assembly operations. Based on the defendant's expert's understanding of the vision inspection system as deployed on the AFC 800, an image of the flip chip device on the movable wafer mount could be detected during the rotation of the pivoting part through 90º or 270º.

27 The ASA Patent therefore has anticipated all of the key concepts in the plaintiff's patent. They include the pivoting part having two pick up heads placed opposite each other with one pick up head facing the substrate for pick up of a single electronic component and holding it during rotation through 180º, the rotary motion to invert the flip chip, the use of a vision inspection system to inspect the flip chip prior to its being picked up in that the image would be detected during rotation of the pivoting part through 90º or 270º, optical detection at the target placement site and optical detection and corrective movement of the flip chip after placement. Accordingly, the ASA Patent clearly anticipates Claims 1 and 7 of the plaintiff's patent. It also anticipates all the other dependent claims.

28 The defendant's expert has personal knowledge and experience of what the state of the art was at the material time (*i.e.* the plaintiff's patent's priority date of 16 February 2004). By late 2001/2002, ASA had produced a prototype AFC 800 flip chip die bonder. This was confirmed by one of the five inventors of the ASA Patent (Eddy Lim, who also testified at the trial). In about August 2001, the defendant's expert was hired as President of Advanpack Solutions Pte Ltd, a subsidiary of ASA. Advanpack Solutions Pte Ltd and its parent company were involved in joint development and marketing activities and worked closely with each other to produce and to advertise AFC 800. In May 2002, the AFC 800 was shown to many potential customers during a public event called Semicon Singapore. Another of the co-inventors of the ASA Patent made a presentation during this conference. A video recording of the AFC 800 in operation was also displayed on a monitor and CD-ROMs thereof were handed out to the public. The AFC 800 was also featured in the September 2003 issue of Advanced Packaging magazine.

29 The optical components used in the AFC 800 are the camera and the beam splitter, a prism used to redirect the optical path 90º so that the camera can see the flip chips on the wafer. In order for the camera to obtain an image of the die on the wafer, there must be a through opening in the pivoting device permitting the camera to recognize the image projected, first onto the beam splitter and then from there to the camera. While an image cannot be captured during rotation of the part exactly at 90º, it can be clearly captured at any time when one of the four through openings is facing the wafer. The AFC 800 therefore anticipates Claim 7 of the plaintiff's patent. The other dependent claims of Claim 7 are likewise anticipated by the AFC 800.

30 The Matsushita Patent describes a device for picking up and placing flip chips. There are three pick up heads arranged around a pivoting rod at the centre, each 120º apart. There are through openings between the pick up heads. There is a camera for vision inspection placed above the pick up station, used for observing and detecting defects as well as the position of the flip chip before the nozzle picks it up and rotates horizontally to transfer it to a transferring head.

31 The defendant's expert states that it is reasonable to assume that the vision inspection process takes place during the time when the pick up head is rotated out of the field of view of the camera. The through openings are large enough for inspection to occur at a range of angles of rotation of the pick up heads. Notwithstanding the fact that the three pick up heads in the Matsushita Patent are

placed 120º apart, this patent demonstrates pick up heads in relation to the pivotal point such that one pick up head is facing the substrate for each rotation and that a through opening is arranged between the pick up heads such that the through opening faces the substrate during rotation of the pivoting part through 90º and 270º. Again, although the plane of rotation in the Matsushita Patent is along the horizontal axis while that in the plaintiff's patent is along the vertical axis, this is not a material difference so long as an optical connection line can be maintained between the camera and the flip chip. Accordingly, Claim 1 of the plaintiff's patent is anticipated by the Matsushita Patent too.

32 The National Semiconductor Patent describes a prior art example that uses a flipper arm with two heads opposite each other in relation to the pivot point. The pick up heads are located at the ends of the flipper arm and are used to pick up a flip chip, with bumps facing upwards, from a loader arm. The flipper arm is then rotated 180º and the flipped die is then placed on a platform. Two cameras are used for vision inspection. One camera looks downward at the wafer frame to ensure that the correct die is being picked up while the second one looks downwards at the tape and reel cavity to ensure that the die is positioned in the cavity properly.

33 The National Semiconductor Patent also describes the use of a rotary wheel or rotary flipper to replace the two element flipper arms described in the prior art. The change from two to multiple pick up heads is to achieve a more balanced speed or throughput. Any number of pick up heads may be used depending on the size of the wheel, with examples of two, eight and even 64 described. The illustration shows a rotary pick up head for picking flip chips from a wafer and a vision apparatus used to determine that the correct die is being picked up. The camera is placed opposite the pick up head and would need to look through an opening in the rotary transfer head in order to establish an optical connection line with the flip chips on the wafer. Although this patent is very limited in text description, the illustration shows the concept of a vision inspection system looking through an opening in the pick up tool attached to the rotary pick up head. It follows that Claims 1 and 7 are anticipated also by the National Semiconductor Patent.

34 In respect of inventive step, s 15 of the Patents Act provides:

> An invention shall be taken to involve an inventive step if it is not obvious to a person skilled in the art, having regard to any matter which forms part of the state of the art by virtue only of section 14(2) and without having regard to section 14(3).

On this aspect, our Court of Appeal in *First Currency Choice Pte Ltd v Main-Line Corporate Holdings Ltd* [2008] 1 SLR 335 has again adopted the oft-cited four-step test laid down by the English Court of Appeal in *Windsurfing International Inc v Tabur Marine (Great Britain) Ltd* [1985] RPC 59 at 73 -74 (see [41] and [44] of our Court of Appeal's judgment).

35 On this issue of inventive step, the defendant's expert notes that the plaintiff's patent states that in the prior art, inspection, pick up and rotation of the flip chip device had to be done sequentially or in successive steps since the pick up head would block the optical connection line between the camera and the flip chips. The plaintiff's patent explains that the through opening in the pivoting part allows for such optical connection during rotation of the pivoting part through 90º or 270º. However, in the opinion of the defendant's expert, the inspection angles of 90º and 270º are merely derived from the number of pick up heads used. The rotary pick up with two heads and a through opening in the ASA Patent and the National Semiconductor Patent would, like the plaintiff's patent design, be similarly blocked at 0º and 180º. For the Matsushita Patent's three pick up heads, the blockage would take place at 0º, 120º and 240º but the angles of 90º and 270º would be clear. For the four pick up heads system in the ASA Patent, the blockage takes place at 0º, 90º, 180º and 270º.

36 The crux of the inventive concept in the plaintiff's patent is therefore the carrying out of vision inspection concurrently during the rotation of the pick up heads and via the through opening between the pick up heads. Such a concept was already disclosed in the ASA Patent's two head system. Further, such a concept involving four pick up heads was also public knowledge and commonly known to a person skilled in the art, notwithstanding the narrower windows of vision available between each pair of heads. The vision inspection process in the Shinkawa Patent's one head system (see [37] to [39] below) is also similar to the one contained in the plaintiff's patent. There can therefore be no inventive step in having two flipper heads, as further evidenced by the Matsushita Patent and the National Semiconductor Patent.

37 The documents show that the plaintiff's patent was granted on the basis of the PCT search and examination report which listed only two prior art documents, namely, the Kwan patent and the Shinkawa Patent. Although the PCT examiners were of the view that the Kwan patent was the closest prior art relating to the subject matter, the defendant's expert opines that the Shinkawa Patent, which was not considered, was the closest prior art. The Shinkawa Patent in November 1999 disclosed details of a flip chip bonding apparatus and explained in detail the use of vision alignment with the subsequent pick up, rotation and flipping of the flip chip devices. The system described in the Shinkawa Patent is that:

(a) it consists of a die inverting device connected to a pivoting point;

(b) a flip chip device with bumps facing upwards is picked up by a vacuum nozzle or pick up head mounted onto a die inverting device;

(c) an optical recognition system is fixed to the die inverting device and it rotates round a pivot point. The illustrations in the patent show a window or through opening which allows the optical recognition device to establish an optical connection line to the flip chip device and obtain an image of the die and calculate the amount of positional deviation;

(d) the window or through opening is created to allow vision inspection of flip chips during rotation of the die inverting device through 90º.

38 One of the advantages of the Shinkawa Patent is that the die recognition operation is performed immediately when the vacuum nozzle is rotated by the die inverting device so that the overall bonding time can be shortened, thus reducing cost. The Shinkawa Patent states that while the die inverting device is rotating through 90º, the optical recognition system will be recognizing the flip chip devices on the wafer and the positional deviation of the flip chips will be calculated. This can only be done if a through window is facing towards the wafer during the rotational movement.

39 The Shinkawa Patent also describes the use of a rotary flip chip inverting device. There is a single die inverting element that rotates through 180º in one direction and then 180º in the other direction. There is a through opening allowing for vision recognition of the flip chips on the wafer while the entire assembly is being rotated. Concurrent vision inspection takes place while the flip chip is being inverted for further processing to a substrate. The text and illustrations in that patent show a space or opening through the pick up head that allows vision system access during rotation with the vision inspection system being an integral component of the die inverting device, unlike the plaintiff's patent where it is a separate component. However, the concept of vision inspection through an opening in the pivoting unit is similar. The key difference between the Shinkawa Patent and the plaintiff's patent is that the latter has two pick up heads on the pivoting part arranged opposite each other in relation to the pivot point while the former has only one pick up head.

40 On the basis of the above analysis, the defendant's expert opines that the plaintiff's patent fails on two of the three conditions governing patentable inventions in s 13(1) of the Patents Act, namely, the invention must be new and must involve an inventive step.

41 In answer to the plaintiff's criticism that the ASA Patent in fact "teaches away" from the use of two pick up heads, the defendant's expert states that the ASA Patent teaches that two heads may be employed but it also acknowledges that there is a risk of the die flying off as a result of centrifugal force where two heads are used. However, as an engineer and one skilled in the art, he would simply slow down the rotation speed to address this risk. With four heads, the distance travelled during rotation is reduced and, at the same speed, centrifugal force would also be reduced. Speed of throughput is an important concern in the semiconductor industry. Another way of addressing the risk of centrifugal force is to make improvements to the equipment used, such as increasing the strength of vacuum suction of the pick up heads.

42 The defendant's expert agrees that the ASA Patent does not mention the exact location of the first inspection camera. However, because it is an optically-assisted pick and place system, it would be obvious to one skilled in the art that there is a camera mounted somewhere along the optical line. Obviously, the camera cannot be in the way of the moving parts. The camera would therefore have to be in the centre of the rotating wheel or placed above it. Although the ASA Patent does not mention a prism, that is also an "optical device" and it could be placed at the centre of the wheel. A prism can have different reflective angles. By a deductive process, the camera would then be located at the turret or outside it.

43 The plaintiff points out to the defendant's expert that the plaintiff's system reduces the distance between the two pick up heads to 5 to 6 cm as contrasted to AFC 800's 15 to 20 cm to meet the challenges of centrifugal force. The defendant's expert replies that there is nothing in the plaintiff's patent about reduced dimensions reducing the effects of centrifugal force. The only reference therein to size is that of the through opening, which measures about 2 cm. The plaintiff's alleged invention has nothing to do with compactness. He could not agree with the plaintiff's suggestion that the inventive step in its patent is the specific relationship between the two pick up heads such that they are arranged opposite each other and with the through opening facing the substrate while the heads rotate through 90º and 270º.

44 He acknowledges that the plaintiff's system has increased throughput to 20,000 units per hour or about 5.5 dies per second. The AFC 800 using the ASA Patent managed to increase throughput to 6000 units per hour. Only four units of AFC 800 have been sold while the plaintiff has sold more than 100 of its DS10000 die sorter machines using the system in the plaintiff's patent.

45 The defendant's expert explains that different machines may have different throughputs because they are built for different purposes. The plaintiff's machine is a die sorter which does not require a great deal of accuracy while the AFC 800 is a die bonder with different downstream requirements, needing much more accuracy of placement. As time passes, with better equipment, throughput would naturally improve but there is no novelty or inventive step in this.

46 I accept the defendant's expert's opinions set out above and prefer them over the contrary views (set out in two affidavits of evidence-in-chief) of the plaintiff's expert witness, Associate Professor Tay Meng Leong, who teaches at the School of Mechanical and Aerospace Engineering, Nanyang Technological University. With respect, the plaintiff's expert's previous work experience (from 1979 to 1985, he worked as a project engineer and head of department in various companies) prior to his taking up the teaching post at the university 23 years ago was not in the semiconductor industry and he was not familiar with flip chip machines before being instructed in this case although he had

prior experience in machine design generally. He has also accepted that the defendant's expert is much more experienced in this area than he is.

47 Where commercial success of an invention is concerned, this factor alone is not conclusive. A product that sells well is not necessarily novel or one involving an inventive step. Good advertising, marketing and pricing could also play a part. The converse is also true. As stated in *Main-Line Corporate Holdings Ltd v United Overseas Bank Ltd* [2007] 1 SLR 1021 at [71]:

> Something that is new and inventive does not automatically become an overnight success or "the next big thing". Even if it is not, like the plaintiff's Teh Kor Lak said, "a big deal", it is nevertheless something new and inventive which, after the invention is known, others may wish they had thought of or wonder why they had never thought of it. Some patents achieve much more commercial success and are more life-changing than (many) others. The fact that the invention has not been widely adopted in the credit card industry is therefore not an adverse reflection on its inventive quality.

48 It seems to me that what the plaintiff has succeeded in inventing is not that described in its patent claims (set out in [4] above) but a more efficient utilisation of two pick up heads (perhaps by decreasing the size of the rotating parts and improving on the vacuum suction) thereby enhancing the speed of throughput on its machine.

49 It follows that the defendant succeeds in its counterclaim that the plaintiff's patent be declared invalid and that it be revoked on the grounds of lack of novelty and of inventive step, at least on the basis of the ASA Patent. The defendant also claims a declaration pursuant to s 77(1) of the Patents Act that the plaintiff's threat of infringement contained in its letter dated 5 July 2006 is unjustifiable and an order to assess damages in respect of any loss which the defendant has sustained by the threat pursuant to s 77(3). To the extent that the defendant has shown that the plaintiff's patent is invalid, it is entitled to the relief sought. The plaintiff's claim is dismissed accordingly. The plaintiff has to pay the defendant the costs of this trial on liability.