

Importance of automated candling and egg removal during incubation

Candling and removal of unsuitable eggs is the process of analysing the eggs in order to remove the infertile eggs or the eggs with dead embryos. Candling can be viewed as part of the incubation process since it has a great impact on the performance of the hatch.

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NECTRA, a company specialising in hatchery and laboratory automation, has developed several candling technologies and diagnostic tools. These tools allow the candling, removal and the mapping of eggs at a quite early stage from day three through day 19-20 for chicks.

Benefits of automated candling and robotic egg removal

Removing eggs that will not hatch provides many benefits:

- Improve day old chick visual quality in hatcheries using a high speed automated process to separate chicks from shells and unhatched eggs; removing the clear eggs and

early dead prevents the chick from being stained and contaminated by yolk or albumen. This is even more important when artificial insemination is used, such as turkey and guinea fowl.

- Reduction of bacterial contamination: the earlier the candling and removal of dead eggs is performed, the better the final result at hatch. NECTRA early candling technologies allow the identification and removal of dead embryos, which would otherwise turn into rotten and leaking eggs, a major source of contamination during incubation.

- Increasing hatchability and performance after the in ovo process and/or after artificial insemination: candling will greatly improve the hatchability and performance of the in ovo vaccination by avoiding the needle carrying contamination from egg to egg or being clogged by yolk or albumen and not able to deliver the right dose of vaccine.

- Additional new benefits from NECTRA early candling technologies can further impact hatchability and incubation performance in the future. By allowing the early mapping of dead eggs and embryo position among live eggs, NECTRA opens a new field of investigation on how dead eggs can impact live



NECTRA's automated candling line for duck eggs on traditional metallic egg trays.

ones, but also helps to outline the weak points to improve in incubators.

Candling with efficient equipment can become a complement in optimising incubators and hatch performance.

Causes for limited accuracy of current technologies

The great majority of automated candling machines use the current technology based on various levels of transparency and opacity of the eggs. This technology has a limited accuracy even when the analysis is carried out by regular sensors or camera sensors.

While some issues to overcome are common to all species, some are very specific:

- In chickens: brown shell eggs, as well as variation of shell colour or egg size between eggs – as is commonly the case in broiler breeder eggs – will downgrade the candling accuracy.

- In ducks: eggs may often have large stain from organic matter darkening the shell and impacting diagnostics. Furthermore, many duck eggs lie on their side in traditional incubation trays, which makes regular candling even harder.

- In pheasants and game birds: egg-

shell is extremely thick and dark and shell colours are extremely variable, going from dark green through to dark brown. Many species add a pattern of spots of various colours, yielding poor accuracy with traditional candling technologies.

- In turkeys: large variation in egg size, as well as variation in external specs or spots on the shell impacts accuracy.

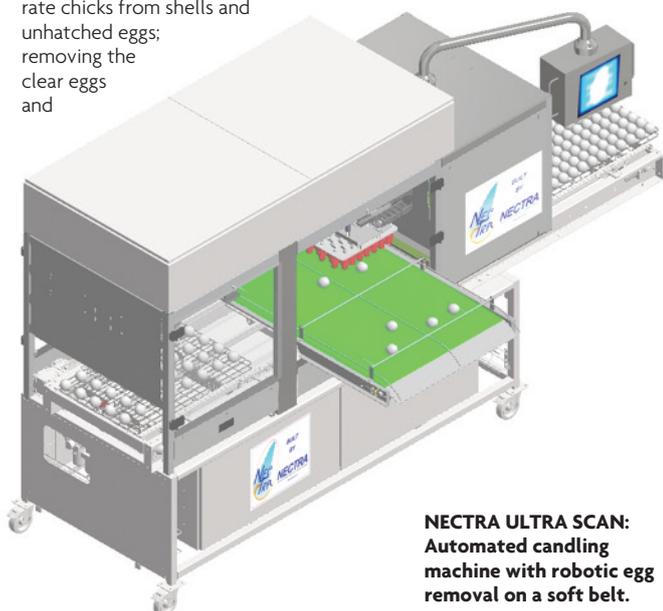
New advanced technologies such as those proposed by NECTRA greatly improve candling accuracy and predictability.

Candling at an early age yields poor accuracy with current technologies because they are based on egg transparency or opacity. Therefore it is usually carried out at the latest stage of incubation (18-19 days for chickens).

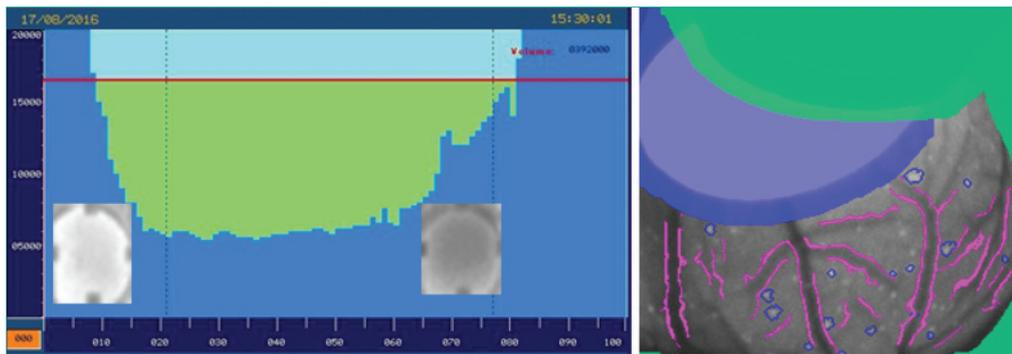
But at this age, many of the dead eggs already get their content loaded with nasty bacteria such as *Pseudomonas* or *E. coli*, and may be already leaking on good eggs.

Furthermore, most rotten or mid dead embryos cannot be identified by regular candling technology, since their opacity is similar to the one of good eggs. At the same time, early age candling has several benefits and may be required in several situations. It is common in ducks to remove and replace clear, dead and

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NECTRA ULTRA SCAN:
Automated candling
machine with robotic egg
removal on a soft belt.



Aspects of live, upside-down and rotten eggs analysed through NECTRA's innovative candling technologies.

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rotten eggs before they contaminate good eggs and in turkey or guinea fowl, to assess fertility after artificial insemination. But to be accurate, early age candling requires new technologies such as those developed in NECTRA ULTRA SCAN, to achieve results at high speed.

The vast majority of regular automated candling technology is based on the transparency of the eggs, to indicate whether the egg is transparent or opaque. A simple light sent through the egg at late age (80% or more of incubation time) will go through it and indicate the opacity or transparency of the eggs to the light.

This technique is quite useful for manual candling, since the operator can analyse what he sees; but it has poor accuracy when used in automated candling machines, where the eye of the operator is replaced by various sensors or by camera sensors, that only measure light without any analysis capability.

Variation of shell colour, as well as shell thickness and shell structure, generates great variation in egg transparency and poor accuracy.

The results are even worse at an early age of embryo development, since the small size of the embryo has little impact on egg transparency. Therefore this technology is limited to late candling (after 18

days), a few days prior to hatch, where mostly clear eggs remain transparent, while the majority eggs (dead embryos, rotten eggs, live embryos) are opaque.

It cannot recognise embryos that died during the mid or final term of incubation, nor the rotten eggs.

Advantages and limits of new technologies

There are several modern technologies, developed and/or used by NECTRA, that significantly increase the accuracy of the candling at an earlier age, but also allow identification of clear eggs from dead embryos, upside-down and rotten eggs.

- The NECTRA ULTRA SCAN is a hybrid technology based on spectral analysis of the whole volume of the eggs. It is highly accurate and can be performed at early stage during incubation, or at late stage prior to hatch. It is not sensitive to shell colour, nor shell colour variations, nor to shell thickness, nor shell external structures, neither to dirt/stain on the shell.

It can carry out accurate candling of eggs at mid or late age and can be performed at very high speeds (up to 120,000 eggs/hour), based on the type of tray used. It detects, differentiates and separates clear eggs and early dead from mid term dead

embryos, live embryos and can eliminate a large proportion of rotten eggs. It is the best price compromise for the modern hatchery.

The detection technology using signs of embryo life, such as the 'heart beat', or the 'metabolic heat' produced by the embryo, can differentiate live embryos from other eggs, but these technologies are not effective at early or mid stage of incubation.

They do not separate clear eggs from dead embryos and do not recognise upside down eggs.

- The NECTRA LIFE is a hybrid technology developed by NECTRA using life signal combined with spectral analysis. It proves to be very accurate and it can be operated both at mid and late stage of incubation, to detect clear eggs, dead embryos, all rotten eggs, as well as late dead embryos and upside-down eggs.

- The NECTRA CARE technology is the latest development. It uses full artificial vision and a powerful algorithm to identify the very first development of embryo life and internal egg structures, as well as eggshell. It starts as early as two or three days of age, up to late stage and it is also able to detect everything from live or dead embryos, upside-down eggs, or eggshell defects or air cracks, the quality of allantoic fluid etc. Because of its accuracy, it can be used for pharma-

ceutical egg candling for human flu vaccine production, as well as most egg based animal vaccine, to replace human candling with 100% accuracy.

Summary of best options

Some of the latest technologies using the heart beat and metabolic heat are only efficient at late development stage.

Instead, volume based or hybrid innovative technology such as ULTRA SCAN or NECTRA LIFE allows accurate candling at various ages, early mid, late, as well as a permanent separation between clear eggs, dead embryos, rotten eggs, live embryos and even upside-down eggs.

NECTRA CARE provides the best of all, but is reserved, for now, to the vaccine pharmaceutical industry until its cost becomes more affordable for the hatchery industry.

Future evolution

The latest technologies developed by NECTRA allow not only accurate candling at various age of incubation, with detailed analysis and separation of the various unwanted eggs, but also mapping of large volumes of the various egg types on the tray, in real time, which allows an innovative way of analysing how dead eggs and live embryos are positioned in the incubator and may interact on each specific tray.

It permits analysis of the impact of a specific incubator, or trolley, or tray, or egg positioning on hatchability, down to the tray level.

An initial analysis carried out by Dr Adjanohoun on 20,000 eggs, shows that dead eggs may not be positioned randomly in the incubator and that dead eggs may influence negatively the development of good ones.

This opens a whole new field of opportunities to further improve hatchability. ■