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 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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rotten eggs before they contami-
nate 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 auto-
mated candling technology is based
on the transparency of the eggs, to
indicate whether the egg is trans-
parent 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 auto-
mated 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 struc-
ture, 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 trans-
parency. 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 technolo-
gies, developed and/or used by
NECTRA, that significantly increase
the accuracy of the candling at an
earlier age, but also allow identifica-
tion of clear eggs from dead
embryos, upside-down and rotten
eggs.

● The NECTRA ULTRA SCAN is a
hybrid technology based on spec-
tral 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 varia-
tions, 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, dif-
ferentiates and separates clear eggs
and early dead from mid term dead
embryos, live embryos and can
eliminate a large proportion of rot-
ten eggs. It is the best price com-
promise 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 differ-
entiate 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 oper-
ated 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 algo-
rithm 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 every-
thing from live or dead embryos,
upside-down eggs, or eggshell
default 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
dose.

Summ ary of best options

Some of the latest technologies
using the heart beat and metabolic
heat are therefore efficient at late de-
velopment stages.

Instead, volume based or hybrid
innovative technology such as
ULTRA SCAN or NECTRA LIFE
allows accurate candling at various
dates, 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 afford-
able for the hatchery industry.

Future evolution

The latest technologies developed
by NECTRA allow not only accurate
candling at various age of incuba-
tion, 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 hatcha-
bility, 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 incuba-
tor and that dead eggs may influ-
ence negatively the development of
good ones.

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