Frank Fehrenbach: Giotto and the Physicists

Since Leon Battista Alberti the Florentine painter Giotto di Bondone (ca. 1267-1337) has been considered a pioneer of a new mode of visual storytelling. This mode, we would say, is distinguished by its intense concentration on the essential elements, so that the narrative focus often lies on a single significant gesture, the isolation of a significant encounter, and the direction of the depicted gaze toward this one event.

However, Giotto's paintings are also characterized in a hitherto unknown way by the representation of physical forces.

My paper focuses on a single painting by Giotto, the *Stigmatization of St. Francis* in the Louvre. I situate it briefly in the context of earlier and contemporary Franciscan hagiography and iconography and then move to two aspects in the history of science, first contemporary Franciscan optics, then in a bit more detail, contemporary Franciscan considerations on the transmission of forces. Finally, I inquire into consequences for Renaissance image theory.

1 The Painting

Giotto's large panel (313 x 163 cm), probably executed in Florence around 1298, seems to have been painted for the choir screen (*tramezzo*) of the huge church in Pisa dedicated to the saint - if we follow Donal Cooper's detailed analysis. Vasari saw the painting hung on a pillar next to the choir chapel before 1568.

The painting transforms the previously hieratic large-scale representation of the saint into a dramatic narrative scene. Additional narratives are limited to three smaller scenes at the bottom. Painted on the same panel, they probably represent the first example of a *predella*.

Giotto's St. Francis does not face the viewer. This sets him apart from the similarly oversized, non-narrative gabled panels around 1300 that Victor Schmidt has called "super icons." Instead, Francis turns to a heavenly apparition that pierces his body with thin, golden-reddish lines. As if under strong physical pressure, the lifesize, voluminous body of the saint recoils.

The viewer assumes the role of a direct witness to the dramatic event. Like the protagonist of the painting, viewers were originally exposed to light effects created by the polished silver foil of the angel's wings. Over the centuries, these wings have turned brown due to oxidation and have lost their original luster.

The Franciscan panels painted shortly after the founder's death (1224) mostly show the blessing saint in full body length, prominently exposing his spectacular wounds. These paintings directly served as visual "proof" of the stigmata; many miracles happened in front of them. In this way, images of a saint became powerful substitutes for relics. Just four years after his death, the body of Francis had been sealed deep beneath the altar of the lower church of San Francesco in Assisi, making it invisible but also preventing the distribution of body relics. Hence the importance of the iconic "forma accepta" in the "true images" of the saint.

These paintings conveyed a "new saint" who appealed to the spiritual conversion of the viewer through his images. It is therefore not surprising that his official biographers attributed the saint's conversion itself and also his *imitatio Christi* to the powerful presence of images. This begins with the

conversion of the young Francis in the presence of the speaking painted crucifix of San Damiano, and culminates in the vision of a seraph as the "image" of Christ.

2 Stigmata: Imagination and Impression

As is well known, Francis was believed to be the first person to receive the stigmata, or the wounds of Christ on the cross. These piercings on Francis's body distinguished him among all the saints in church history and confirmed his singular proximity to Christ. However, the order and the church struggled for many decades to establish the canonical version of this central biographical event in the life of the man from Assisi, who was already canonized two years after his death in 1226. Between 1237 and 1291, no less than nine papal bulls confirmed the miracle of the stigmata and threatened with severe penalties those who doubted it.

In the early *Vita prima*, the first biography of the saint, written before 1229, Thomas of Celano describes the event at Monte Penna in Eastern Tuscany as the result of extended meditations that followed the heavenly appearance of the seraph. During prolonged meditation, the wounds gradually began to appear on his body (coeperunt apparere).

Early depictions of the stigmatization echo this description. In the first known representation of the stigmatization, Bonaventura Berlinghieri's panel of St. Francis in Pescia near Lucca, dated 1235, a channel opens up between the seraph, who is hovering vertically and frontally, and the saint. This allows the gold background of heaven to flow onto the head of the saint, who already possesses the stigmata (without the side wound).

Scholars have pointed to the increasing physicality of the visionary experience in the written sources. The Order's general, Bonaventura, dramatizes it in his authoritative biography of 1263, which was to replace all other biographical texts after 1266. The date (September 17, 1224) and time of day (early morning), as well as the exact sequence of the miracle, are described in the 13th section of Bonaventura's *Legenda maior*. At the beginning of the vision, Francis saw in the sky a radiant seraph (from the highest of the nine choirs of angels), which quickly approached him, revealing an image of the crucified hanging on the wooden cross. The apparition stayed for a while in close proximity to the saint. Then the following happened: "As the vision disappeared (disparens igitur visio mirabilem), it left a fire in his [Saint Francis'] heart but also impressed an image of the Lord no less miraculous in his flesh (sed et in carne non minus mirabilem signorum impressit effigiem). For immediately (statim enim), the nail marks that he had just seen in the image of the crucified man began to appear."

So, the wounds appeared at the very moment the heavenly apparition - which had lingered near the praying Francis - began to disappear. This minimal chronological difference is of great importance, as I will show shortly. Bonaventura interprets the stigmatization as a transmission of wound marks that appear right after the instigating vision began to fade.

Later Franciscans insist that the miracle was primarily a physical event. The almost ostentatious emphasis on the physical imprint did not exclude the participation of the imagination; however, the physical changes could not have been brought about solely by this, as the Franciscan François de Meyronnes emphasized.

In other words, the miracle did not need to change the body of the saint through the detour of his glowing imagination, his burning love for Christ. Instead, the miracle happened in the form of a physical impression (impressa stigmata, plaga impressa), made by a strong, visible sender onto a passive receiver, the body of Francis, who was "struck hardly" by the angel, as Thomas of Eccleston wrote already in 1257. And the sources increasingly emphasize that the appearance was shown to the *physical* eyes of the saint, not to the spiritual senses, as Chiara Frugoni has demonstrated.

3 Physics I: Optics

The increasing emphasis on the physicality of the stigmatization in hagiographical writings, and its echoes in the work of Giotto, shows significant parallels with developments in contemporary Franciscan natural philosophy, specifically optics and the theory of motion.

Starting from the metaphysics of light, Franciscan natural philosophy from the mid-13th century focused heavily on optics. The process of vision served as a model for multiple physical interactions. Frank Büttner summarized this development concisely a few years ago, suggesting that Giotto came into contact with optical theories no later than in Padua (i.e. in 1305), where Pietro d'Abano taught optics. Pietro d'Abano mentions Giotto in his writings as *pictor scient*e and collaborated with him on the lost decoration of the Palazzo della Ragione (according to Michele Savonarola).

Building on the new translations of medieval Arabic theories of light and perception, especially by Al-Kindi and Alhazen, English Franciscans such as Robert Grosseteste, but especially Roger Bacon and John Pecham, developed the first concise theory of perception in the West since antiquity.

Central elements of this theory remind us of accounts and images of Francis's stigmatization, above all, the punctiform optical transmission of rays emitted by a sender and transmitted to a receiver in straight lines. In Giotto's painting, clusters of 3 to 5 rays emanate from the wounds of the celestial apparition, for which there is no basis in the biographical texts (as a Dominican writer will later criticize). Such sets of rays were common as a representation of divine grace. In Giotto, they have become thin lines that seem to penetrate the flesh of the future saint. In their arrangement in the Pisa panel, these lines mark the event as a mirror projection (except for the side wound!) between Seraph and Francis and thus emphasize the physicality of the impact (the ray of the left angelic hand aims at the right of Francis directly opposite, etc.).

However, only the middle rays hit their human counterpart, where they leave brownish-red wounds in the body. In Arabic and Franciscan theory of vision, the central rays are at the same time the strongest rays because they are the shortest. The more peripheral the rays are to the central line, the more quickly they disappear in the medium, the weaker they are. Indeed, Giottos' lateral rays extinguish halfway between the celestial sender and the earthly receiver.

Presumably, the now brownish-red lines shimmered and gleamed through the applied silver before the metal oxidized or flaked off, as with the wings of the Seraph.

4 Physics II: Impetus

At the end of the 13th century, Franciscan scholars developed a new theory of dynamic transmissions and impressions - parallel to the strong emphasis on the corporeality of the stigmatization of their order's founder. There is a strong connection between Franciscan optics and Franciscan physics, the

common denominator for both being the transmission of "likeness" and the imprint it leaves on the receiver.

The new concept of *impetus* served primarily to eliminate the contradictions of Aristotelian physics, particularly the problems that arose from Aristotle's distinction between so-called natural and unnatural movements, i.e. between movements caused by the specific weight of an object (upward or downward) and "violent" movements acting against the "nature" of an object, e.g. a stone throne through the air.

One of the first Franciscans who elaborated the new theory was the Provençal Peter John Olivi, a leader of the Spirituals. Olivi conceptualized the transmission of moving force from the mover to the passive, movable object. This transferred force is capable of propelling the object "from within" further, even after it has lost contact with the mover. Olivi called this transmitted force *vis impressa*. A commonplace example of early impetus theorists was the potter's wheel, which continues to move on its own for some time after being set in motion.

The new theory spread rapidly, especially among Franciscans. In the early 14th century, secular canons Jean Buridan and Albert of Saxony further developed impetus theory. As Anneliese Maier and, after her, Edward Grant have shown, the concept dominated physics until the rise of the *scienza nuova* of Galileo and Newton with its two central parameters: inertia and gravity.

However, the new theory of motion was embedded in quite surprising contexts. Around 1320, the Franciscan Franciscus de Marchia discussed the impetus (his explicit term) in the context of sacramental theology and the question of the "stored", continuous divine powers in the consecrated host. Peter John Olivi instead developed his thoughts on impetus in the context of economics and thus designed the first theory of capital (indeed, he introduced the term *capitale* with its familiar semantics into the economic debate; in this context, I refer to the excellent works of Michael Wolff).

For Olivi, the producer leaves a force in the artifact during his work, in analogy to the process of generation by a *virtus generantis*. Money can participate in this creation of value and promote it as credit, as capital, which justifies its growth - such as in interest.

It is evident that the considerations of the Franciscan scholars offer a striking parallel to contemporary developments in Franciscan hagiography. One should thus give as much weight to this specific Franciscan background as to economic and sacramental-theological contexts. As prescribed by their order, these authors internalized the Passion of Christ and the physical transformation of the Order's founder through repeated spiritual exercises. Olivi, De Marchia, the Franciscan Duns Scotus and others reflect and write about economy, generative powers, sacraments, after-images, and trajectories, but what informs all their analogies is the miracle of the stigmatization: the lasting imprint of a visionary image on the body of Francis.

Between 1287 and 1289, Olivi taught as a lecturer at the Franciscan Studium in S. Croce, Florence. At the Studium of S. Croce, which was accessible to laypeople like Dante, Olivi wrote his commentary on Peter Lombard's *Sentences*, where the key passage of impetus physics can be found in Quaestio 31: Motion "impulses" continue to act in the mobile body even after its separation from the mover: "...movent ipsa proiecta etiam in absentia proicientium".

A spectacular detail of Giotto's monumental *Croce dipinta* in Santa Maria Novella, which was probably created around the same time (ca. 1290, according to Max Seidel), proves Giotto's early interest in "unnatural" movements. It shows the splashing blood on the rock of Golgotha and thus

recalls the debate about the paradigm of the ball bouncing off the wall, which had been passionately discussed in the context of impetus physics. Even up to his late work, Giotto was interested in depicting throwing movements, the paradigm of impetus physics.

Already the Franciscan opticians of the mid-13th century had referred to the after-image of strong light in the eye as an *impressio* and attributed it to "intense," or particularly bright objects - as John Pecham did in the introduction to his immensely influential treatise on perspective (around 1270), which was kept in the library of S. Croce around 1300. The basis for this transmission of the new theory of force to the theory of perception, however, was provided by traditional rhetorical *genera*, especially the concept of "pathos". Already in classical Roman rhetoric, the powerful effect of pathos had been referred to as *impetus*. Like impetus, the force of speech leaves a deep "impression" on the listeners, not only arousing their emotions but also moving their bodies. Together with the younger order founded by Saint Dominic, the Franciscans based their success on powerful, even violently overwhelming prayers. (We know from an inventory of 1355 that the congregation of San Francesco in Pisa was particularly well equipped with manuscripts of classical rhetoric, including the works of Aristotle and Cicero.)

Thanks to the Franciscan discussion of *vis impressa* in the context of optics, it became possible to explain the effect of *images* with a residual force, the *virtus derelicta*: a force that is transmitted from the object through the external and internal senses of the perceiver - in clear analogy to the physical force of the heavenly image that imprinted itself on the body of Francis.

Not surprisingly, in the 29th Quaestio of his commentary on the *Sentences*, Olivi equates the transferred force with "similitudo" or similarity: that is, with an image. The agent of movement leaves an "image" of its power in the mobile object.

At this point impetus physics, hagiography, and image theory converge: Francis was able to receive the imprint of the image of the crucified because of his previous assimilation to Christ. This similarity was a result of his burning love of Christ, which was described superlatively by all biographers. It corresponds to the fiery creature of the seraph and thus made the duplication of the wounds possible in the first place (see the red cheeks).

5 The Forces of Art

Read in the horizon of *vis impressa* or impetus (here only roughly sketched out), Bonaventura's chronology of the stigmatization proves to be highly instructive: the signs began to appear in Francis's body precisely at the moment when the vision of the crucified disappeared - a transfer process in which the force propagates its motion impulse after the contact, the *tactus motoris* (to quote Olivi), between motor and mobile has ended, or faded.

In this context, Giotto's Louvre painting and his invention of the rays of the stigmata convincingly visualize the transmission of force, i.e. the impetus that is impressed or hammered into a movable object by a mover. This "embossment" of the body and soul of Francis found its completion, as Bonaventura (Leg. maior XIV) says, two years later in the death of the saint (tamquam ductile opus sub multiplicis tribulationis malleo ad perfectionem adductus). Such metaphors must have been immediately plausible to Giotto, the son of the blacksmith Bondone (and incidentally also a busy moneylender).

Giotto's image of the stigmatization itself functions as a transmitter of force; its dynamics aim at the eyes and imagination of the viewer, to finally set the affects and even the body in motion. This is no longer the *imago agens* of the icon in the sense of a hieratic, frontal representation. The image does not claim to be a "personal representation" of the saint (Krüger) on whose surface miracles like the widespread appearance and disappearance of the wounds might happen. Through the "trick of temporalization" (Hans Belting), Giotto's painting becomes a *historia* that assigns the viewer the role of a witness of the most dramatic scene from the life of Francis, and thus allows him or her to participate in the dynamics of the depicted imprinting process.

The dynamics of transmission visible in Giotto's Louvre Pala are aesthetically more complex than in the case of the iconic presence of the saint in "cult images" (altarpieces, icons), for which there are, to be sure, numerous examples even among the Franciscans in the 13th century. In the dynamics of transmission as redefined by the new image, the power of divine presence is substituted by artistic *virtus*, the powers of the artist. In other words, what had previously been the numinous powers inherent in the icon must now be compensated for by artistic invention: by an intensification of visual attractions. The icon becomes an artifact into which the artist transfers his or her *virtus*, similar to the craftsman who transfers his or her skills and labor to the finished product - or like the thrower of a stone who transfers his or her impetus to the projectile, or the moneylender who puts his or her *capitale* into an enterprise in order to create a surplus. It is no coincidence that Giotto confidently signed the Pisan panel in the center of the frame: Opus Iocti Florentini (there are only three signed works by the painter).

Research that attempts to measure the resonant space between the histories of art and natural philosophy is repeatedly suspected of degrading art to an illustration of the history of science; a suspicion that, incidentally, is much less common when looking at well-established art historical areas of reference - such as theology, literature, political and social history. However, to claim that art is responsible for the subsequent visualization of scientific theories would be a gross misunderstanding. Instead, my aim is to reconstruct the shared resonances to a central PROBLEM in art and science. Around 1300, painting, theology, natural philosophy (optics, physics, psychology), and economics all revolve intensely around the question of the transmission of forces.

To claim that art is responsible for the subordinate illustration of science would be absurd. On the contrary, if we're not mistaken, art had a share in the physical 'revolution' of the Middle Ages, insofar as images already presented the paradigm of a force transitioning from motor to mobile, even before the corresponding theory was emerging. The medial conditions of the static image forced painters since Berlinghieri's early depiction of the Stigmatization of 1235 to establish, through pictorial simultaneity, a temporal proximity and thus implicitly a causality between vision and impression.

The contribution of these 'contracting' images to the development of Franciscan hagiography should not be underestimated. They show how the visionary figure expresses itself by imprinting itself simultaneously as an image in the saint: "avea espressamente impressa la immagine e similitudine del nostro Signore Gesù Cristo crocifisso," as the somewhat later Fioretti beautifully put this transfer process into words. The developments of Franciscan impetus theory would then have been decisively shaped by this increasingly 'physical' depiction of the Stigmatization in the biographies of Francis.

Their paradigm was the transfer of "similarities," "images" – of similitudines, species – whose paradoxical ontological status would accompany the debate about motive forces for a long time. That the new physics of the 17th century was so successful precisely because it increasingly sidelined

such questions is well known. That the problem of 'qualitative' forces thereby almost inevitably migrated into the fields of art and aesthetics is something that needs to be further examined.

The new images have been abandoned by the touch of the Holy, as it were, the *tactus motoris* (Olivi) of the prototype that was at work in the older cult images. Instead, these new images take on the task of transmitting forces that are provided primarily by the visual forms of art.

In the 15th century, the *forza* and *virtù* of the image will explicitly move into the focus of art theory. In 1435, Leon Battista Alberti attributes a "divine force" to painting because it keeps the dead alive, makes absentees present, and strengthens belief in "the gods." Alberti's paradigm for the sympathetic effect (*compassio*) of depicted emotions and their powers of transmission is Giotto's *Navicella* of St. Peter's.

The zenith of this development is reached in the art discourse of the 16th century. For Giorgio Vasari, *forza* serves as a category of artistic progress: since Giotto and his followers, the force of art has grown and it finally culminates in the sublime power of Michelangelo's work, his *terribilità*. Already before, Leonardo da Vinci had emphasized that the imagination (imaginativa) and therefore poetry can only produce short-living, weak inner images that quickly fade from memory. The strong images of painting, however, irresistibly move the minds and bodies of viewers through the powerful affects of desire, terror, and devotion - - one might add: as compellingly as Francis's Seraph, who Giotto transformed from a vision into art.